**Twin Cities Campus**

**Agricultural Education M.S.**

**College of Food, Agricultural and Natural Resource Sciences**

Link to a list of faculty for this program.

**Contact Information:**

Agricultural Education  
146 Ruttan Hall  
1994 Buford Ave.  
St. Paul, MN 55108  
Email: ageddgs@umn.edu  
Website: [http://ag-ed.cfans.umn.edu](http://ag-ed.cfans.umn.edu)

- Program Type: Master's  
- Requirements for this program are current for Fall 2018  
- Length of program in credits: 30 to 45  
- 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.

This Master's degree leads to an initial licensure in Agricultural Education. Master of Science (MS)/initial licensure programs are for individuals with bachelor's degrees who want to become licensed teachers. These graduate-level programs provide rigorous, professional teacher preparation in accordance with Standards of Effective Practice for Teachers (SEPT) and content standards of the Minnesota Board of Teaching.

The agricultural education initial licensure program at the University of Minnesota is designed to help students become accomplished professional educators who can help students succeed in the classroom. The program prepares inquiring, analytical, and reflective professional educators who can teach in the classroom and lead in the schools.

Students enter a 12 to 15-month program integrating educational theory with classroom practice. Working closely with experienced teachers, students observe firsthand the daily rewards and pressures of their profession.

Flexibility is an important advantage of this program. Students may enroll in any semester and are welcomed into the entire agriculture education program, building valuable professional support. A second advantage is that most program credits may be applied toward completion of the MS degree.

This program includes two components: initial licensure and the MS degree. After successfully completing licensure requirements and appropriate work experience, students are recommended for state licensure to teach agricultural education in grades 5-12.

**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 2.50.

Relevant professional experience and/or a relevant undergraduate major is required.

Other requirements to be completed before admission:  
A minimum of 100 hours of experience in youth education.

**Special Application Requirements:**

In addition to other required materials, applicants must submit Statements #1 and #2, a résumé and two letters of recommendation from individuals who can attest to the applicant's potential in the field.

Admissions is done on a rolling basis with the following semester deadlines: March 1 (Summer), July 1 (Fall), and November 1 (Spring).
Applicants must submit their test score(s) from the following:

- NES Essential Academic Skills for Minnesota Teacher Licensure

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 (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 C: Plan C requires 30 to 45 major credits and up to null credits outside the major. There is no final exam.

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.

Courses must be taken A - F (unless only offered S/N) and students must earn a grade of C- or better.

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.

Initial Licensure

This sub-plan is limited to students completing the program under Plan C.

In addition to the required coursework, content course credits are required for licensure. Students can take these courses as an undergrad prior to entering the program or enroll in these courses concurrently (totaling 39 credits).

Agricultural Science (4)
Animal Science (7)
Applied Economics and Agribusiness (6)
Food Science (3)
Natural Resources (3)
Plant Science (6)
Soil Science (4)
Technology [Ag Mechanics] (6)

General Psychology (3)

Agricultural Education Licensure Courses

- AFEE 5111W - Agricultural Education: Methods of Teaching [WI] (4.0 cr)
- AFEE 5112 - Agricultural Education Program Organization and Curriculum for Youth (3.0 cr)
- AFEE 5114 - Agricultural Education Teaching Seminar (1.0 cr)
- AFEE 5116 - Coordination of SAE Programs: Work-based Learning (2.0 cr)
- AFEE 5118 - Strategies for Managing and Advising the FFA Organization (2.0 cr)
- AFEE 5697 - Teaching Internship: School and Classroom Setting (2.0 cr)
- AFEE 5698 - Teaching Internship (2.0 - 8.0 cr)
CI 4602 - English Learners and Academic Language (1.0 cr)
CI 5163 - Child and Adolescent Development for Teaching and Learning I (1.0 cr)
CI 5164 - Child and Adolescent Development for Teaching and Learning II (2.0 cr)
CI 5307 - Technology for Teaching and Learning (1.5 cr)
CI 5452 - Reading in the Content Areas for Initial Licensure Candidates (1.0 - 2.0 cr)
EPSY 4001 - Teaching Students with Special Needs in Inclusive Settings (1.0 cr)
OLPD 5005 - School and Society (2.0 cr)
OLPD 5009 - Human Relations: Applied Skills for School and Society (1.0 cr)
PUBH 6003 - Fundamentals of Alcohol and Drug Abuse for Teacher Education (1.0 cr)

Post-Licensure Courses
AFEE 5995 - Integrating Paper--Master of Education: Agricultural and Extension Education (1.0 - 5.0 cr)
AFEE 5220 - Special Topics in Agriculture Education and Extension (1.0 - 3.0 cr)
AFEE 5280 - Current Issues for the Beginning Agricultural Education Teacher (1.0 - 3.0 cr)
AFEE 5993 - Directed Study in Agricultural Education and Extension (1.0 - 4.0 cr)
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 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/graduate-program

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- 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
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: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- 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.

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
Twin Cities Campus
Animal Sciences Ph.D.
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: https://www.ansci.umn.edu/graduate-program

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- 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.

Students in the PhD 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
24 credits are required in 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 5091 - Research Proposals: From Ideas to Strategic Plans [WI]** (3.0 cr)
- **or ANSC 8134 - Ethical Conduct of Animal Research** (3.0 cr)
- **or APSC 8123 - Research Ethics in the Plant and Environmental Sciences** (0.5 cr)
- **or ENT 8061 - Scientific Communication and Ethics** (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)

**Major Coursework**
Students are required to take 15 to 17.5 credits in consultation with adviser.
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 2018
- 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 MS 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 MS 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 MS 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

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
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 to 16 major credits and 10 to 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.

MS 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 MS 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 one course from each sub-group and both seminar courses, with a minimum of 11 credits. Courses must be taken A-F only excluding seminar.

Complete one of the courses from this group A-F only.

- APEC 5031 - Methods of Economic Data Analysis (3.0 cr)
  or APEC 8211 - Econometric Analysis I (4.0 cr)

Complete one of the two 5XXX level courses or the 8XXX level series A-F only and a minimum of 3 credits.

- APEC 5152 - Applied Macroeconomics: Income and Employment (3.0 cr)
  or APEC 5032 - Economic Data Analysis for Managerial and Policy Decisions (3.0 cr)

- Must complete entire series A-F

- ECON 8105 - Macroeconomic Theory (2.0 cr)
- ECON 8106 - Macroeconomic Theory (2.0 cr)

Complete the 5XXX level course or the 8XXX level series A-F only and a minimum of 3 credits.

- APEC 5151 - Applied Microeconomics: Firm and Household (3.0 cr)
  or Must complete entire series A-F

- 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 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). 3 credits must be chosen from APEC, ECON, STAT (excluding STAT 5021, 5022, 5031). 6 credits may be chosen from APEC, ECON, STAT or a related field in consultation with advisor. All courses must be at 5XXX or 8XXX level.

Recommended course APEC 5032.

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). 3 credits must be chosen from APEC, ECON, STAT (excluding STAT 5021, 5022, 5031). 6 credits may be chosen from APEC, ECON, STAT or a related field in consultation with advisor. All courses must be at 5XXX or 8XXX level.

Recommended course APEC 5032.

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/MBASTudent 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 2018
- 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.

The Director of Graduate Studies must approve minor coursework.
Courses must be taken at the 5XXX or 8XXX level.

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: https://www.apec.umn.edu/graduate-program

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- 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. 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

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
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 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). Up to six credits of 8-level ECON courses (excluding micro theory, macro theory, 8105 and 8106) may be accepted as electives.
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 - Trade and Development I (2.0 cr)
- APEC 8702 - Trade and Development II (2.0 cr)
- APEC 8703 - Trade and Development III (2.0 cr)
- APEC 8704 - Trade and Development IV (2.0 cr)
- APEC 8801 - Applied Production Theory (3.0 cr)
- APEC 8803 - Marketing Economics (3.0 cr)
- APEC 8804 - Managerial Economics (3.0 cr)
- ECON 8119 - Cooperative Game Theory (2.0 cr)
- ECON 8205 - Applied Econometrics (2.0 cr)
- ECON 8206 - Applied Econometrics (2.0 cr)
- ECON 8207 - Applied Econometrics (2.0 cr)
- ECON 8208 - Applied Econometrics (2.0 cr)
- ECON 8401 - International Trade and Payments Theory (2.0 cr)
- ECON 8402 - International Trade and Payments Theory (2.0 cr)
- ECON 8403 - International Trade and Payments Theory (2.0 cr)
- ECON 8501 - Wages and Employment (2.0 cr)
- ECON 8502 - Wages and Employment (2.0 cr)
- ECON 8503 - Wages and Employment (2.0 cr)
- ECON 8581 - Advanced Topics in Labor Economics (2.0 cr)
- ECON 8601 - Industrial Organization and Government Regulation (2.0 cr)
- ECON 8602 - Industrial Organization and Government Regulation (2.0 cr)
- ECON 8603 - Industrial Organization and Government Regulation (2.0 cr)
- ECON 8701 - Monetary Economics (2.0 cr)
- ECON 8702 - Monetary Economics (2.0 cr)
- ECON 8704 - Financial Economics (2.0 cr)
- ECON 8705 - Financial Economics (2.0 cr)
- ECON 8801 - Public Economics (2.0 cr)
- ECON 8803 - Public Economics (2.0 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)
- PA 8331 - Economic Demography (3.0 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)
- APEC 8221 - Programming for Econometrics (2.0 cr)
- APEC 8222 - Big Data Methods in Economics (2.0 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](http://www.appliedplantsciences.umn.edu)

- Program Type: Master's  
- Requirements for this program are current for Fall 2018  
- 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 and Microbial 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)
- APSC 8270 - Graduate Seminar (2.0 cr)
- APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)

At least 3 credits of graduate-level statistics
- AGRO 5121 - Applied Experimental Design (4.0 cr)
- or BIOL 5272 - Applied Biostatistics (4.0 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 GIS 5555 - Basic Spatial Analysis (3.0 cr)
- or NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
- or PUBH 6450 - Biostatistics I (4.0 cr)
- or STAT 5021 - Statistical Analysis (4.0 cr)
- or STAT 5201 - 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)

**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 14 credits with 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 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
- AGRO 4605 - Strategies for Agricultural Production and Management (3.0 cr)
- AGRO 5021 - Plant Breeding Principles (3.0 cr)
- AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
- AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
- APSC 8201 - Advanced Plant Breeding (3.0 cr)
- APSC 8280 - Current Topics in Applied Plant Sciences (1.0 - 3.0 cr)
- GCC 5017 - World Food Problems: Agronomics, Economics and Hunger [GP] (3.0 cr)
- SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

**Plant Biology**

Students must complete one course in plant biology such as:
- PMB 5516 - Plant Cell Biology (3.0 cr)
- PMB 5412 - Plant Physiology (3.0 cr)
- PMB 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)
- EEB 4068 - Plant Physiological Ecology (3.0 cr)
- EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
- EEB 5609 - Ecosystem Ecology (3.0 cr)
- ESPM 5108 - Ecology of Managed Systems (4.0 cr)
- ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
- ESPM 4695 - GIS in Environmental Science and Management (4.0 cr)
- HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
- HORT 5071 - Ecological Restoration (4.0 cr)
- PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
- PLPA 5202 - Field Plant Pathology (2.0 cr)
- PLPA 5480 - Principles of Plant Pathology (3.0 cr)
- PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
- SOIL 4111 - Introduction to Precision Agriculture (3.0 cr)
- 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 14 credits in Areas 1, 2 and 3; with at least one course in Area 1 and at least one course in Area 2.

**Area 1: Cross Commodity Horticulture**

Students must complete at least one course in Area 1.
- AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
- AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
- HORT 4071W - Applications of Biotechnology to Plant Improvement [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)
or HORT 5023 - Public Garden Management (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 6055 - Buyer Behavior (4.0 cr)
or MKTG 6082 - Brand Strategy (2.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

**Area 2: Commodity-based Horticulture**

Students must complete at least one course in Area 2.

HORT 4061W - Turfgrass Management [WI] (3.0 cr)
or HORT 4063 - Turfgrass Science (3.0 cr)
or HORT 5011 - Common Medicinal Plants: Classification, Identification, and Application (3.0 cr)
or HORT 5012 - Common 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 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.

AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or APSC 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 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 PMB 5412 - Plant Physiology (3.0 cr)
or PMB 5516 - Plant Cell Biology (3.0 cr)
or PMB 5601 - Topics in Plant Biochemistry (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/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 plant breeding, at least two courses from genetics and genomics, with any additional credits determined in consultation with the students advisor and advisory committee.

**Plant Breeding**

Take at least one course from the following:

AGRO 5021 - Plant Breeding Principles (3.0 cr)
or APSC 8201 - Advanced Plant Breeding (3.0 cr)
or AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)

**Genetics and Genomics**

Take at least two courses from the following:

AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
or EEB 5042 - Quantitative Genetics (3.0 cr)
or HORT 5058 - Plant Cytogenetics (2.0 cr)
or HORT 5059 - Plant Cytogenetics Lab (1.0 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 5321 - Ecology of Agricultural Systems (3.0 cr)
or
AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
or
HORT 5011 - Common Medicinal Plants: Classification, Identification, and Application (3.0 cr)
or
HORT 5012 - Common Medicinal Plants: Growing and Processing (3.0 cr)
or
HORT 5023 - Public Garden Management (2.0 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 5071 - Ecological Restoration (4.0 cr)
or
SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 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
HORT 5011 - Common Medicinal Plants: Classification, Identification, and Application (3.0 cr)
or
HORT 5012 - Common Medicinal Plants: Growing and Processing (3.0 cr)
or
HORT 5023 - Public Garden Management (2.0 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 5071 - Ecological Restoration (4.0 cr)
or
SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 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
PMB 5501 - Topics in Plant Biochemistry (2.0 cr)
or
GCD 4034 - Molecular Genetics and Genomics (3.0 cr)
or
GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
or
HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
or
HORT 5007 - Advanced Plant Propagation (3.0 cr)
or
PLPA 5301 - Large Scale Omic Data in Plant Biology (3.0 cr)
or
Computational Biology/Bioinformatics
BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
or
CSCI 4041 - Algorithms and Data Structures (4.0 cr)
or
CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
or
CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
or
CSCI 5980 - Special Topics in Computer Science (1.0 - 3.0 cr)
or
EEB 5221 - Molecular Evolution (3.0 cr)
or
PMB 5412 - Plant Physiology (3.0 cr)
or
PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
or
PLPA 5202 - Field Plant Pathology (2.0 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 8103 - Plant-Microbe Interactions (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
BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
or
CSCI 4041 - Algorithms and Data Structures (4.0 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)
or
STAT 5201 - 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)

Applied Plant Sciences
Students who choose to complete the Applied Plant Sciences 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)
or
AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
or
AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or
AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)
or
AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
or APSC 8201 - Advanced Plant Breeding (3.0 cr)
or EEB 5042 - Quantitative Genetics (3.0 cr)
or GCD 4034 - Molecular Genetics and Genomics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (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 PLPA 5301 - Large Scale Omic Data in Plant Biology (3.0 cr)

Organismal Biology
Take at least one course from the following:
HORT 5007 - Advanced Plant Propagation (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 8103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 8104 - Plant Virology (2.0 cr)
or PLPA 8105 - Plant Bacteriology (2.0 cr)
or PMB 5412 - Plant Physiology (3.0 cr)
or PMB 5516 - Plant Cell Biology (3.0 cr)
or PMB 5601 - Topics in Plant Biochemistry (3.0 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 4065 - 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 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)

Integrated BS Plant Science/MS APS Plant Breeding
CFANS offers an integrated Bachelor of Science (BS) in Plant Science and Master of Science (MS) in Applied Plant Sciences (Plant Breeding and Molecular Genetics track). The integrated BS/MS program offers students the opportunity to complete coursework for both degrees in five years by working toward a master's degree while simultaneously working toward their undergraduates degree. Plant Science undergraduate students in the Plant Breeding and Genetics sub-plan are welcome to apply to this program during their 3rd year of undergraduate study. During the 4th year, students take undergraduate and graduate courses concurrently and are advised by an undergraduate and graduate program adviser. Students must complete undergraduate degree requirements before the end of their fourth year.

Students in this program will complete the 120 undergraduate credits required for a BS degree in Plant Science by the end of the 4th year and must be awarded an undergraduate degree at the 4th year mark or earlier. During the 4th and 5th years, students will complete 30 graduate credits and a Plan A or B research project with a final oral defense as required for the Applied Plant Sciences MS degree. Students cannot double-count credits to meet credit requirements for both the undergraduate and graduate degrees. At least one course must be taken from each of the Plant Breeding areas and at least two courses from the Genetics & Genomics area. Additional course requirements are flexible and are determined in consultation with the student's advisor(s) and advisory committee.
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 2018
- 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 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.

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.

Required Course (1 Credit)
All students pursuing the applied plant sciences minor must complete one course from the following:
APSC 8270 - Graduate Seminar (2.0 cr)
or APSC 8280 - Current Topics in Applied Plant Sciences (1.0 - 3.0 cr)

Electives
Master's students select at least six credits, and doctoral students select at least eleven credits from the following:
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 5021 - Plant Breeding Principles (3.0 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 8203 - Evolution of Crop Plants (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)
APSC 8201 - Advanced Plant Breeding (3.0 cr)
EEB 5042 - Quantitative Genetics (3.0 cr)
GCD 4034 - Molecular Genetics and Genomics (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 Medicinal Plants: Classification, Identification, and Application (3.0 cr)
HORT 5012 - Common 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 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 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)
PLPA 5202 - Field Plant Pathology (2.0 cr)
PLPA 5203 - Introduction to Fungal Biology (3.0 cr)
PLPA 5301 - Large Scale Ominric Data in Plant Biology (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)
PMB 5412 - Plant Physiology (3.0 cr)
PMB 5516 - Plant Cell Biology (3.0 cr)
PMB 5601 - Topics in Plant Biochemistry (3.0 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
Take at least six credits from the list of electives, in consultation with the applied plant sciences director of graduate studies, to complete the 7-credit minimum. Electives will be chosen from courses on genetics and plant breeding; organismal biology; or cropping systems, communities, and commodities.

Doctoral
Take at least eleven credits from the list of electives, in consultation with the applied plant sciences director of graduate studies, to complete the 12-credit minimum. Electives will be chosen from courses on genetics and plant breeding; organismal biology; or cropping systems, communities, and commodities.
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 2018
- 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

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
Program Requirements
30 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.

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
Take the following courses:
- AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
- APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
- APSC 8270 - Graduate Seminar (2.0 cr)

Take one of the following courses:
- AGRO 5121 - Applied Experimental Design (4.0 cr)
- or BIOL 5272 - Applied Biostatistics (4.0 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 GIS 5555 - Basic Spatial Analysis (3.0 cr)
- or NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
- or PUBH 6450 - Biostatistics I (4.0 cr)
- or STAT 5021 - Statistical Analysis (4.0 cr)
- or STAT 5201 - 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)

Take one of the following courses. Consult with the advisor regarding number of credits to take if APSC 8280 is selected.
- APSC 8280 - Current Topics in Applied Plant Sciences (1.0 - 3.0 cr)
- or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

Take one of the following courses:
- GRAD 8101 - Teaching in Higher Education (3.0 cr)
- or CFAN 8101 - Professional Skills for Scientists (2.0 cr)

Electives
Select courses, in consultation with the advisor, to complete 30 course credits.

Thesis Credits
Take at least 24 doctoral thesis credits.
- APSC 8888 - Thesis Credit: Doctoral (1.0 - 24.0 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

Take two courses from the following list. Consult with advisor to determine number of credits to take if AGRO 5999 is selected.
- AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
- AGRO 4605 - Strategies for Agricultural Production and Management (3.0 cr)
- AGRO 5021 - Plant Breeding Principles (3.0 cr)
- AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
- AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
- APSC 8201 - Advanced Plant Breeding (3.0 cr)
- SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

Plant Biology

Take one of the following courses or another course selected in consultation with the advisor:
- PMB 5516 - Plant Cell Biology (3.0 cr)
- PMB 5412 - Plant Physiology (3.0 cr)

Ecology/Plant Pathology/Soil Science

Take at least one course from the following list:
- BIOL 5407 - Ecology (3.0 cr)
- EEB 4068 - Plant Physiological Ecology (3.0 cr)
- EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
- EEB 5609 - Ecosystem Ecology (3.0 cr)
- ESPM 5108 - Ecology of Managed Systems (4.0 cr)
- ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
- ESPM 5296 - GIS in Environmental Science and Management (4.0 cr)
- HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
- HORT 5071 - Ecological Restoration (4.0 cr)
- PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
- PLPA 5202 - Field Plant Pathology (2.0 cr)
- PLPA 5480 - Principles of Plant Pathology (3.0 cr)
- PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
- SOIL 4111W - Introduction to Precision Agriculture (3.0 cr)
- 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 at least one course from each area; four courses in total from Areas 1 and 2.

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)
- AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
- 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 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 Strategy (2.0 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 Medicinal Plants: Classification, Identification, and Application (3.0 cr)
or HORT 5012 - Common 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 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 8203 - Evolution of Crop Plants (3.0 cr)
or APSC 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 PMB 5412 - Plant Physiology (3.0 cr)
or PMB 5516 - Plant Cell Biology (3.0 cr)
or PMB 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

Take at least one course from the following:
AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)
or APSC 8201 - Advanced Plant Breeding (3.0 cr)

Genetics and Genomics

Take at least one course from the following:
AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
or EEB 5042 - Quantitative Genetics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
or HORT 5058 - Plant Cytogenetics (2.0 cr)
or HORT 5059 - Plant Cytogenetics Lab (1.0 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 and Cropping Systems
Consult with the advisor regarding number of credits to take if AGRO 5999 is selected.
AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
or HORT 5011 - Common Medicinal Plants: Classification, Identification, and Application (3.0 cr)
or HORT 5012 - Common Medicinal Plants: Growing and Processing (3.0 cr)
or HORT 5023 - Public Garden Management (2.0 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 5071 - Ecological Restoration (4.0 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)
or PMB 5601 - Topics in Plant Biochemistry (3.0 cr)

Biotechnology/Genetics/Genomics
GCD 4034 - Molecular Genetics and Genomics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
or HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (4.0 cr)
or HORT 5007 - Advanced Plant Propagation (3.0 cr)
or PLPA 5301 - Large Scale Omic Data in Plant Biology (3.0 cr)

Computational Biology/Bioinformatics
Consult with the advisor regarding number of credits to take if CSCI 5980 is selected.
BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
or CSCI 4041 - Algorithms and Data Structures (4.0 cr)
or CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
or CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
or CSCI 5980 - Special Topics in Computer Science (1.0 - 3.0 cr)

Evolution
EEB 5221 - Molecular Evolution (3.0 cr)

Physiology
PMB 5412 - Plant Physiology (3.0 cr)
or PMB 5516 - Plant Cell Biology (3.0 cr)

Pathology
PLPA 5202 - Field Plant Pathology (2.0 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 8103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 8104 - Plant Virology (2.0 cr)
or PLPA 8105 - Plant Bacteriology (2.0 cr)

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)
or AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or AGRO 8022 - Breeding for Quantitative Traits in Plants (3.0 cr)
or AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
or APSC 8201 - Advanced Plant Breeding (3.0 cr)
or EEB 5042 - Quantitative Genetics (3.0 cr)
or GCD 4034 - Molecular Genetics and Genomics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
or HORT 5058 - Plant Cytogenetics (2.0 cr)
or HORT 5059 - Plant Cytogenetics Lab (1.0 cr)
or PLPA 5301 - Large Scale Omic Data in Plant Biology (3.0 cr)

Organismal Biology
Take at least one course from the following:
HORT 5007 - Advanced Plant Propagation (3.0 cr)
or HORT 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)
or PMB 5412 - Plant Physiology (3.0 cr)
or PMB 5516 - Plant Cell Biology (3.0 cr)
or PMB 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 5560 - 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 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 2018
- 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

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
- 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

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 2018
- 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 2018
- 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 adviser 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 2018
- 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 three tracks, 1) conservation science or 2) fisheries and aquatic biology or 3) wildlife ecology & management. 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 for students 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 (4.0 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.

- 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 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)
- 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 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)
- **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)

### Wildlife Ecology and Management

The Wildlife Ecology and Management 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 ecology and management of both game and non-game wildlife species. 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 wildlife ecology & management.

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.

### Wildlife Ecology and Management - 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 5011 - Insect Structure and Function (4.0 cr)
• ENT 5041 - Insect Ecology (3.0 cr)
• EPSY 5243 - Principles and Methods of Evaluation (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)
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 2018
• 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: conssci@umn.edu
Website: http://www.conssci.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- 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 three tracks, conservation science track or fisheries and aquatic biology track or wildlife ecology and management 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
The preferred English language test is Test of English as Foreign Language (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 (4.0 cr)
• EPSY 8251 - Statistical Methods in Education I (3.0 cr)
• EPSY 8252 - 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 5810 - 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 credits 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 5327b - Trivialor Ecology (3.0 cr)
- EEB 5409 - Evolution (3.0 cr)
- EEB 5601 - Limnology (3.0 cr)
- EEB 5609 - Ecosystem Ecology (3.0 cr)
- ENT 4021 - Honey Bees and Insect Societies (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)
- 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)
- GEG 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)

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
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)
- 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)
- 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)
- LA 5202 - Landscape Analysis Workshop (1.0 cr)
- LA 5204 - Metropolitan Landscape Ecology (3.0 cr)
Wildlife Ecology and Management

The Wildlife Ecology and Management 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 the disciplines of social sciences, education, and economics. 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 wildlife ecology and management.

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.

Wildlife Ecology & Management - 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 credits 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)
• ENT 4021 - Honey Bees and Insect Societies (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)
• 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 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 2018
• 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.
GRE scores in Verbal Reasoning, Quantitative Reasoning, Analytical Writing are required.

Special Application Requirements:
Applicants must submit a complete set of official transcripts and a clearly written statement of career interests, goals, and objectives, and a diversity statement. 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 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:** 1-3 project reports as directed by the advisor and the advisory committee.

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 2.8 is required for students to remain in good standing.

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

Students must accumulate 2 written examination points.

**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)

**Plan Options**

**Plan A Requirements**

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

**Electives**
- Take at least 8 credits in consultation with the advisor. Elective courses can be taken from entomology or any University of Minnesota program. 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.

**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 1-6 credits of Independent Research (ENT 5910: Special Problems in Entomology)
  - ENT 5910 - Special Problems in Entomology (1.0 - 6.0 cr)

**Electives**
- Take at least 13-18 credits in consultation with the advisor and the advisory committee. Elective courses can be taken from entomology or any University of Minnesota program. 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.
Twin Cities Campus
Entomology Minor
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 2018
- 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 2018
- 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.
GRE scores for Verbal Reasoning, Quantitative Reasoning and Analytical Writing are required for admission.

Special Application Requirements:
Applicants must submit a complete set of official transcripts and a clearly written statement of career interests, goals, objectives and a diversity statement. 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).

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
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.
24 thesis credits are required.

**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:** 1-3 project reports as directed by the advisor and the advisory committee.

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 2.8 is required for students to remain in good standing.

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

Students must accumulate 3 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)

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

**Electives**
11 or more credits required.

Elective courses can be taken from entomology or any University of Minnesota program. 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, but only a maximum of 9 credits from the 4xxx level may be used.

**Thesis Credits**
24 credits required
- ENT 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)
Twin Cities Campus
Food Science M.S.
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/foodsciencegraduate/index.htm

- Program Type: Master's
- Requirements for this program are current for Fall 2018
- 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.

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
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 5131 - Food Quality for Graduate Credit (3.0 cr)
- or FSCN 5312 - Food Analysis (4.0 cr)
- or If FSCN 5122 is taken, FSCN 5123 must also be taken
  - FSCN 5122 - Food Fermentations and Biotechnology (2.0 cr)
  - FSCN 5123 - Molecular Biology for Applied Scientists (1.0 cr)

Food Science Elective

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

General Elective

Choose remaining credits in consultation with the adviser 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 2018
- 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 2018
- 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 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)
- **FSCN 5131 - Food Quality for Graduate Credit** (3.0 cr)

**Course Options**
Students must choose one of the following courses.
- **FSCN 5122 - Food Fermentations and Biotechnology** (2.0 cr)
- **FSCN 5312 - Food Analysis** (4.0 cr)

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

**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**

**Thesis Credits**
Food Science PhD students must take 24 thesis credits.
- **FSCN 8888 - Thesis Credit: Doctoral** (1.0 - 24.0 cr)
Twin Cities Campus
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 2018
• 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 CHEM 1061 - Chemical Principles I [PHYS] (3.0 cr)
CHEM 1062 - Chemical Principles II [PHYS] (3.0 cr)
or BIOL 1009 - General Biology [BIOL] (4.0 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 5480 - Special Topics in Land and Atmospheric Science (1.0 - 4.0 cr)
- LAAS 5515 - Soil Formation: Earth Surface Processes and Biogeochemistry (3.0 cr)
- LAAS 8195 - Research Problems in Soils (1.0 - 5.0 cr)
- AGRO 5121 - Applied Experimental Design (4.0 cr)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGRO 5321</td>
<td>Ecology of Agricultural Systems</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>BBE 5535</td>
<td>Assessment and Diagnosis of Impaired Waters</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>BBE 5608</td>
<td>Environmental and Industrial Microbiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 4502</td>
<td>Water and Wastewater Treatment</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 4562</td>
<td>Environmental Remediation Technologies</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 5180</td>
<td>Special Topics</td>
<td>1.0 - 4.0 cr</td>
</tr>
<tr>
<td>CEGE 5511</td>
<td>Urban Hydrology and Water Quality</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 5541</td>
<td>Environmental Water Chemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 5542</td>
<td>Experimental Methods in Environmental Engineering</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 5543</td>
<td>Introductory Environmental Fluid Mechanics</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 5551</td>
<td>Environmental Microbiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8501</td>
<td>Environmental Fluid Mechanics I</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8502</td>
<td>Environmental Fluid Mechanics II</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8503</td>
<td>Environmental Mass Transport</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8506</td>
<td>Stochastic Hydrology</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8521</td>
<td>The Atmospheric Boundary Layer</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8541</td>
<td>Aquatic Chemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8542</td>
<td>Chemistry of Organic Pollutants in Environmental Systems</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8551</td>
<td>Environmental Microbiology: Molecular Theory and Methods</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8561</td>
<td>Analysis and Modeling of Aquatic Environments I</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8562</td>
<td>Analysis and Modeling of Aquatic Environments II</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8572</td>
<td>Computational Environmental Fluid Dynamics</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>EEB 4068</td>
<td>Plant Physiological Ecology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EEB 4611</td>
<td>Biogeochemical Processes</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EEB 5053</td>
<td>Ecology: Theory and Concepts</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>EEB 5601</td>
<td>Limnology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EEB 5605</td>
<td>Limnology Laboratory</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>ESCI 5102</td>
<td>Climate Change and Human History</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 5205</td>
<td>Fluid Mechanics in Earth and Environmental Sciences</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 5351</td>
<td>Geochemical Modeling of Aqueous Systems</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 5402</td>
<td>Science and Politics of Global Warming</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 8401</td>
<td>Aqueous Environmental Geochemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 8402</td>
<td>Biogeochemical Cycles in the Ocean</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 8801</td>
<td>Geomicrobiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5061</td>
<td>Water Quality and Natural Resources</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5111</td>
<td>Hydrology and Water Quality Field Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5245</td>
<td>Sustainable Land Use Planning and Policy</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5402</td>
<td>Biometeorology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5601</td>
<td>Principles of Waste Management</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 5114</td>
<td>Hydrology and Watershed Management</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 5131</td>
<td>Geographical Information Systems (GIS) for Natural Resources</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>FNRM 5153</td>
<td>Forest Hydrology &amp; Watershed Biogeochemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 5262</td>
<td>Remote Sensing and Geospatial Analysis of Natural Resources</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FW 8459</td>
<td>Stream and River Ecology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEOG 5401</td>
<td>Geography of Environmental Systems and Global Change</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>GEOG 5426</td>
<td>Climatic Variations</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEOG 5531</td>
<td>Numerical Spatial Analysis</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>GEOG 5562</td>
<td>GIS Development Practicum</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEOG 5839</td>
<td>Introduction to Dendrochronology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEOG 8270</td>
<td>Seminar: Climatology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GIS 5555</td>
<td>Basic Spatial Analysis</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PMB 4111</td>
<td>Microbial Physiology and Diversity</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PMB 5412</td>
<td>Plant Physiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PLPA 8103</td>
<td>Plant-Microbe Interactions</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6100</td>
<td>Topics: Environmental Health</td>
<td>1.0 - 4.0 cr</td>
</tr>
<tr>
<td>PUBH 6190</td>
<td>Environmental Chemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6191</td>
<td>Air Pollution</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>SAGR 8010</td>
<td>Colloquium in Sustainable Agriculture</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>SOIL 5232</td>
<td>Vadose Zone Hydrology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>SOIL 5555</td>
<td>Wetland Soils</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>SOIL 5611</td>
<td>Soil Biology and Fertility</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>SOIL 8252</td>
<td>Advanced Soil Physics</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>SOIL 8510</td>
<td>Advanced Topics in Pedology</td>
<td>2.0 - 4.0 cr</td>
</tr>
<tr>
<td>SOIL 8541</td>
<td>Aquatic and Soil Chemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>STAT 5021</td>
<td>Statistical Analysis</td>
<td>4.0 cr</td>
</tr>
</tbody>
</table>
- STAT 5302 - Applied Regression Analysis (4.0 cr)
- STAT 5303 - Designing Experiments (4.0 cr)
- WRS 5101 - Water Policy (3.0 cr)

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: kjarcho@umn.edu
Website: http://www.laas.umn.edu

- Program Type: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- 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 MS 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 5621** - Soil and Environmental Genomics (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 5621** - Soil and Environmental Genomics (3.0 cr)
- **LAAS 8128** - Land and Atmospheric Science Seminar (1.5 cr)
Twin Cities Campus
Land and Atmospheric Science Ph.D.

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: laas@umn.edu
Website: http://www.laas.umn.edu

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- 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)
- or MATH 2243 - Linear Algebra and Differential Equations (4.0 cr)
- PHYS 1101W - Introductory College Physics I [PHYS, WI] (4.0 cr)
- or PHYS 1102W - Introductory College Physics II [PHYS, WI] (4.0 cr)
- or ESPM 3131 - Environmental Physics (3.0 cr)
- or CHEM 1061 - Chemical Principles I [PHYS] (3.0 cr)
- CHEM 1062 - Chemical Principles II [PHYS] (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 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
• 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 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 5480 - Special Topics in Land and Atmospheric Science (1.0 - 4.0 cr)
• LAAS 5515 - Soil Formation: Earth Surface Processes and Biogeochemistry (3.0 cr)
• LAAS 8195 - Research Problems in Soils (1.0 - 5.0 cr)
• AGRO 5121 - Applied Experimental Design (4.0 cr)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGRO 5321</td>
<td>Ecology of Agricultural Systems</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>BBE 5535</td>
<td>Assessment and Diagnosis of Impaired Waters</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>BBE 5608</td>
<td>Environmental and Industrial Microbiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 4502</td>
<td>Water and Wastewater Treatment</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 4562</td>
<td>Environmental Remediation Technologies</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 5180</td>
<td>Special Topics</td>
<td>1.0 - 4.0 cr</td>
</tr>
<tr>
<td>CEGE 5511</td>
<td>Urban Hydrology and Water Quality</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 5541</td>
<td>Environmental Water Chemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 5542</td>
<td>Experimental Methods in Environmental Engineering</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 5543</td>
<td>Introductory Environmental Fluid Mechanics</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 5551</td>
<td>Environmental Microbiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8501</td>
<td>Environmental Fluid Mechanics I</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8502</td>
<td>Environmental Fluid Mechanics II</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8503</td>
<td>Environmental Mass Transport</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8506</td>
<td>Stochastic Hydrology</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8521</td>
<td>The Atmospheric Boundary Layer</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8541</td>
<td>Aquatic Chemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8542</td>
<td>Chemistry of Organic Pollutants in Environmental Systems</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8551</td>
<td>Environmental Microbiology: Molecular Theory and Methods</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>CEGE 8561</td>
<td>Analysis and Modeling of Aquatic Environments I</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8562</td>
<td>Analysis and Modeling of Aquatic Environments II</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>CEGE 8572</td>
<td>Computational Environmental Fluid Dynamics</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>EEB 4068</td>
<td>Plant Physiological Ecology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EEB 4611</td>
<td>Biogeochemical Processes</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EEB 5053</td>
<td>Ecology: Theory and Concepts</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>EEB 5601</td>
<td>Limnology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EEB 5605</td>
<td>Limnology Laboratory</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>ESCI 5102</td>
<td>Climate Change and Human History</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 5205</td>
<td>Fluid Mechanics in Earth and Environmental Sciences</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 5351</td>
<td>Geochemical Modeling of Aqueous Systems</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 5402</td>
<td>Science and Politics of Global Warming</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 8401</td>
<td>Aqueous Environmental Geochemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 8402</td>
<td>Biogeochemical Cycles in the Ocean</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESCI 8801</td>
<td>Geomicrobiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESM 5061</td>
<td>Water Quality and Natural Resources</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESM 5111</td>
<td>Hydrology and Water Quality Field Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESM 5245</td>
<td>Sustainable Land Use Planning and Policy</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESM 5402</td>
<td>Biometeorology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESM 5601</td>
<td>Principles of Waste Management</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNMR 5114</td>
<td>Hydrology and Watershed Management</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNMR 5131</td>
<td>Geographical Information Systems (GIS) for Natural Resources</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>FNRM 5153</td>
<td>Forest Hydrology &amp; Watershed Biogeochemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 5262</td>
<td>Remote Sensing and Geospatial Analysis of Natural Resources</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FW 8459</td>
<td>Stream and River Ecology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEOG 5401</td>
<td>Geography of Environmental Systems and Global Change</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>GEOG 5426</td>
<td>Climatic Variations</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEOG 5531</td>
<td>Numerical Spatial Analysis</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>GEOG 5562</td>
<td>GIS Development Practicum</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEOG 5839</td>
<td>Introduction to Dendrochronology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEOG 8270</td>
<td>Seminar: Climatology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GIS 5555</td>
<td>Basic Spatial Analysis</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PMB 4111</td>
<td>Microbial Physiology and Diversity</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PMB 5412</td>
<td>Plant Physiology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PLPA 8103</td>
<td>Plant-Microbe Interactions</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6100</td>
<td>Topics: Environmental Health</td>
<td>1.0 - 4.0 cr</td>
</tr>
<tr>
<td>PUBH 6190</td>
<td>Environmental Chemistry</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 6191</td>
<td>Air Pollution</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>SAQR 8010</td>
<td>Colloquium in Sustainable Agriculture</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>SOIL 5232</td>
<td>Vadose Zone Hydrology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>SOIL 5555</td>
<td>Wetland Soils</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>SOIL 5611</td>
<td>Soil Biology and Fertility</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>SOIL 8252</td>
<td>Advanced Soil Physics</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>SOIL 8510</td>
<td>Advanced Topics in Pedology</td>
<td>2.0 - 4.0 cr</td>
</tr>
<tr>
<td>STAT 5021</td>
<td>Statistical Analysis</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>STAT 5302</td>
<td>Applied Regression Analysis</td>
<td>4.0 cr</td>
</tr>
</tbody>
</table>
•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 2018
- 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; or 7) paper science and engineering.

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 MS 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 Natural Resources Seminar course. Course was listed as FNRM 8107 prior to spring 2017, and NR 8107 in all future semesters.

**NR 8107 - Seminar: Natural Resources Science and Management (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 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 [inactive] (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 - Economic 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 Management Planning (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)
- FW 8200 - Seminar (1.0 - 4.0 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)
- NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
- NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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)
• 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 - Analysis of Categorical Data (3.0 cr)
• STAT 5501 - Time Series Analysis (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 for International Students (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 - India (3.0 - 9.0 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)
- ECON 8106 - Macroeconomic Theory (2.0 cr)
- EEB 5609 - Ecosystem Ecology (3.0 cr)
- EEB 8200 - Sustainability Science Distributed Graduate Seminar (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 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 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESPM 5061 - Water Quality and Natural Resources (3.0 cr)
- ESPM 5071 - Ecological Restoration (4.0 cr)
- ESPM 5101 (Inactive) (3.0 cr)
- ESPM 5108 - Ecology of Managed Systems (4.0 cr)
- ESPM 5111 - Hydrology and Water Quality Field Methods (3.0 cr)
- ESPM 5102 - 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 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
- ESPM 5251 - Natural Resources in Sustainable International Development (3.0 cr)
- ESPM 5256 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
- ESPM 5261 - Economics and Natural Resources Management (4.0 cr)
- ESPM 5602 - Regulations and Corporate Environmental Management (3.0 cr)
- ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
- ESPM 5604 - Environmental Management Systems and Strategy (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 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 5264 - Advanced Forest Management Planning (3.0 cr)
- FNRM 5411 - Managing Forest Ecosystems: Silviculture (3.0 cr)
- FNRM 5412 - Advanced Remote Sensing and Geospatial Analysis (3.0 cr)
- FNRM 5421 - Managing Forest Ecosystems: Silviculture Lab (1.0 cr)
- FNRM 5431 - Timber Harvesting and Road Planning (2.0 cr)
- FNRM 5471 - Forest Management Planning (3.0 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 - 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 5003 - Human Dimensions of Biological Conservation (3.0 cr)
- FW 8200 - Seminar (1.0 - 4.0 cr)
- FW 8494 - Research in Wildlife (1.0 - 4.0 cr)
- GEOG 5561 - Principles of Geographic Information Science (4.0 cr)
- GEOG 8101 - Proseminar: Nature and Society (3.0 cr)
- GIS 5555 - Basic Spatial Analysis (3.0 cr)
- GIS 5571 - ArcGIS I (3.0 cr)
- GIS 5572 - ArcGIS II (3.0 cr)
- 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)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 cr)
• OLPD 5081 - 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 - Microeconomics for Policy Analysis (3.0 cr)
• PA 5022 - Applications of Economics for Policy Analysis (1.5 - 3.0 cr)
• PA 5031 - Statistics for Public Affairs (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 Systems and Policy (3.0 cr)
• PA 5722 - Economics of Natural Resource and Environmental 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 for International Students (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 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
- ESCI 4702 - General Hydrogeology (4.0 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 Measuring 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)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 cr)
• OLDP 5061 - Ethnographic Research Methods (3.0 cr)
• OLDP 5528 - Focus Group Interviewing Research Methods (1.0 - 3.0 cr)
• PA 5002 - Introduction to Policy Analysis (1.5 cr)
• PA 5031 - Statistics for Public Affairs (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 5022 - Introduction to Policy Analysis (1.5 cr)
• STAT 5301 - Designing Experiments (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 for International Students (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 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)
- **BBE 5402** - Bio-based Products Engineering Lab II (1.0 cr)
- **BBE 5403** - Bio-based Products Engineering Lab I (1.0 cr)
- **BBE 5404** - Biopolymers and Biocomposites Engineering (3.0 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 8266** - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- **ESP 5211** - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
- **ESP 5242** - Methods for Environmental and Natural Resource Policy Analysis (3.0 cr)
- **ESP 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)
- **NR 5021** - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
- **NR 8100** - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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)
• SSM 5414 - Advanced Residential Building Science (4.0 cr)
• SSM 5416 - Building Testing & Diagnostics (2.0 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 for International Students (3.0 cr)

Degree Plan Options

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

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, WI] (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 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
• ESPM 5071 - Ecological Restoration (4.0 cr)
• ESPM 5101 (inactive) (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)
• ESPM 5104 - Forest Ecology (4.0 cr)
• ESPM 5114 - Hydrology and Watershed Management (3.0 cr)
• ESPM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
• ESPM 5153 - Forest Hydrology & Watershed Biogeochemistry (3.0 cr)
• ESPM 5203 - Forest Fire and Disturbance Ecology (3.0 cr)
• ESPM 5204 - Landscape Ecology and Management (3.0 cr)
• ESPM 5205 - Productivity and Ecology of Forest Soils (3.0 cr)
• ESPM 5218 - Measuring and Modeling Forests (3.0 cr)
• ESPM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
• ESPM 5264 - Advanced Forest Management Planning (3.0 cr)
• ESPM 5411 - Managing Forest Ecosystems: Silviculture (3.0 cr)
• ESPM 5413 - Managing Forest Ecosystems: Silviculture Lab (1.0 cr)
• ESPM 5501 - Urban Forest Management: Managing Green Spaces for People (3.0 cr)
• ESPM 8101 - Research Problems: Physiological Ecology (1.0 - 5.0 cr)
• ESPM 8102 - Research Problems: Forest-Tree Genetics (1.0 - 5.0 cr)
• ESPM 8103 - Research Problems: Forest Hydrology (1.0 - 5.0 cr)
• ESPM 8104 - Research Problems: Forest Ecology (1.0 - 5.0 cr)
• ESPM 8105 - Research Problems: Silviculture (1.0 - 5.0 cr)
• ESPM 8106 - Research Problems: Urban Forestry--Biology and Management (1.0 - 5.0 cr)
• ESPM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)
• ESPM 8202 - Research Problems: Forest Biometry and Measurements (1.0 - 5.0 cr)
• ESPM 8203 - Research Problems: Forest Recreation (1.0 - 5.0 cr)
• ESPM 8205 - Research Problems: Spatial Data Analysis (1.0 - 5.0 cr)
• ESPM 8206 - Research Problems: Forest Management (1.0 - 5.0 cr)
• ESPM 8207 - Economic Analysis of Natural Resource Projects (2.0 cr)
• ESPM 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 8200 - Seminar (1.0 - 4.0 cr)
• FW 8452 - Conservation Biology (3.0 cr)
• GEOL 5426 - Climatic Variations (3.0 cr)
• GEOL 5839 - Introduction to Dendrochronology (3.0 cr)
• GEOL 8260 - Seminar: Physical Geography (2.0 cr)
• GIS 5555 - Basic Spatial Analysis (3.0 cr)
• HORT 5071 - Ecological Restoration (4.0 cr)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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 for International Students (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 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 (3.0 cr)
• BBE 5401 - Bioproducts Separation and Purification Processes (3.0 cr)
• BBE 5402 - Bio-based Products Engineering Lab II (1.0 cr)
• BBE 5403 - Bio-based Products Engineering Lab I (1.0 cr)
• BBE 5404 - Biopolymers and Biocomposites Engineering (3.0 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)
• 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)
• 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 5266 - 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 8201 - Research Problems: Urban Forestry-Biology and Management (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)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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 6126 - 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 for International Students (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 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESPM 5202 - Environmental Conflict Management, Leadership, and Planning (3.0 cr)
- ESPM 5241 - 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 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 - Research Problems: Economic Analysis of Natural Resource Projects (2.0 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)
- NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
- NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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 for International Students (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 2018
- 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.

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 2018
- 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; or 7) paper science and engineering.

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.

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 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 Natural Resources Seminar course. Course was listed as FNRM 8107 prior to spring 2017, and NR 8107 in all future semesters.

NR 8107 - Seminar: Natural Resources Science and Management (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)
- 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)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPSY 5221</td>
<td>Principles of Educational and Psychological Measurement</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EPSY 5244</td>
<td>Survey Design, Sampling, and Implementation</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EPSY 5247</td>
<td>Qualitative Methods in Educational Psychology</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EPSY 5261</td>
<td>Introductory Statistical Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EPSY 5262</td>
<td>Intermediate Statistical Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EPSY 8266</td>
<td>Statistical Analysis Using Structural Equation Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5031</td>
<td>Applied Global Positioning Systems for Geographic Information Systems</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EPSY 5071</td>
<td>Ecological Restoration</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>ESPM 5101</td>
<td>(Inactive)</td>
<td>(3.0 cr)</td>
</tr>
<tr>
<td>ESPM 5111</td>
<td>Hydrology and Water Quality Field Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5211</td>
<td>Survey, Measurement, and Modeling for Environmental Analysis</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EPSM 5242</td>
<td>Methods for Environmental and Natural Resource Policy Analysis</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5261</td>
<td>Economics and Natural Resources Management</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>ESPM 5295</td>
<td>GIS in Environmental Science and Management</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>ESPM 5603</td>
<td>Environmental Life Cycle Analysis</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>EPSM 5114</td>
<td>Hydrology and Watershed Management</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>ESPM 5131</td>
<td>Geographical Information Systems (GIS) for Natural Resources</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>ESPM 5218</td>
<td>Measuring and Modeling Forests</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 5228</td>
<td>Advanced Topics in Assessment and Modeling of Forests</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 5262</td>
<td>Remote Sensing and Geospatial Analysis of Natural Resources and Environment</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 5412</td>
<td>Advanced Remote Sensing and Geospatial Analysis</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 5471</td>
<td>Forest Management Planning</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>FNRM 8101</td>
<td>Research Problems: Physiological Ecology</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8102</td>
<td>Research Problems: Forest-Tree Genetics</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8103</td>
<td>Research Problems: Forest Hydrology</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8104</td>
<td>Research Problems: Forest Ecology</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8105</td>
<td>Research Problems: Silviculture</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8106</td>
<td>Research Problems: Urban Forestry--Biology and Management</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8201</td>
<td>Research Problems: Forest Economics</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8202</td>
<td>Research Problems: Forest Biometry and Measurements</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8203</td>
<td>Research Problems: Forest Recreation</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8204</td>
<td>Research Problems: Forest Policy</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8205</td>
<td>Research Problems: Spatial Data Analysis</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8206</td>
<td>Research Problems: Forest Management</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FNRM 8207</td>
<td>Economic Analysis of Natural Resource Projects</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>FNRM 8208</td>
<td>Research Problems: Environmental Learning and Leadership</td>
<td>1.0 - 5.0 cr</td>
</tr>
<tr>
<td>FW 8200</td>
<td>Seminar</td>
<td>1.0 - 4.0 cr</td>
</tr>
<tr>
<td>GEG 5531</td>
<td>Numerical Spatial Analysis</td>
<td>4.0 cr</td>
</tr>
<tr>
<td>GEG 5562</td>
<td>GIS Development Practicum</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GEG 8260</td>
<td>Seminar: Physical Geography</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>GIS 5555</td>
<td>Basic Spatial Analysis</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GIS 5571</td>
<td>ArcGIS I</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GIS 5572</td>
<td>ArcGIS II</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GIS 5575</td>
<td>Practical Surveying for GIS</td>
<td>2.0 cr</td>
</tr>
<tr>
<td>GIS 5577</td>
<td>Spatial Database Design and Administration</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GIS 5578</td>
<td>GIS Programming</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GRAD 8101</td>
<td>Teaching in Higher Education</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>GRAD 8200</td>
<td>Teaching and Learning Topics in Higher Education</td>
<td>1.0 cr</td>
</tr>
<tr>
<td>NR 5021</td>
<td>Statistics for Agricultural and Natural Resource Professionals</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>NR 8100</td>
<td>Topics in Natural Resources Science and Management</td>
<td>1.0 - 2.0 cr</td>
</tr>
<tr>
<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>
</tr>
<tr>
<td>PA 5031</td>
<td>Statistics for Public Affairs</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>
</tr>
<tr>
<td>PA 5920</td>
<td>Skills Workshop</td>
<td>0.5 - 4.0 cr</td>
</tr>
<tr>
<td>POL 8126</td>
<td>Qualitative Methods</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 7250</td>
<td>Designing and Conducting Focus Group Interviews</td>
<td>1.0 cr</td>
</tr>
<tr>
<td>PUBH 7407</td>
<td>Analysis of Categorical Data</td>
<td>3.0 cr</td>
</tr>
<tr>
<td>PUBH 8472</td>
<td>Spatial Biostatistics</td>
<td>3.0 cr</td>
</tr>
<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>
</tr>
<tr>
<td>SOIL 5555</td>
<td>Wetland Soils</td>
<td>3.0 cr</td>
</tr>
</tbody>
</table>
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:

• 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 - Analysis of Categorical Data (3.0 cr)
• STAT 5511 - Time Series Analysis (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 for International Students (3.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
• ESPM 5071 - Ecological Restoration (4.0 cr)
• ESPM 5101 (Inactive) (3.0 cr)
• ESPM 5108 - Ecology of Managed Systems (4.0 cr)
• ESPM 5111 - Hydrology and Water Quality Field 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 5241 - Natural Resource and Environmental Policy (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 5256 - Natural Resource Law and the Management of Public Lands and Waters (3.0 cr)
• ESPM 5261 - Economics and Natural Resources Management (4.0 cr)
• ESPM 5602 - Regulations and Corporate Environmental Management (3.0 cr)
• ESPM 5603 - Environmental Life Cycle Analysis (3.0 cr)
• ESPM 5604 - Environmental Management Systems and Strategy (3.0 cr)
• ESPM 5611 - Environmental Interpretation (3.0 cr)
• FNRM 5101 - Park and Protected Area Tourism (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 5264 - Advanced Forest Management Planning (3.0 cr)
• FNRM 5411 - Managing Forest Ecosystems: Silviculture (3.0 cr)
• FNRM 5412 - Advanced Remote Sensing and Geospatial Analysis (3.0 cr)
• FNRM 5413 - Managing Forest Ecosystems: Silviculture Lab (1.0 cr)
• FNRM 5431 - Timber Harvesting and Road Planning (2.0 cr)
• FNRM 5471 - Forest Management Planning (3.0 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–Biology and Management (1.0 - 5.0 cr)
• FNRM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)
• FNRM 8221 - 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 5003 - Human Dimensions of Biological Conservation (3.0 cr)
• FW 8200 - Seminar (1.0 - 4.0 cr)
• FW 8494 - Research in Wildlife (1.0 - 4.0 cr)
• GEOG 5561 - Principles of Geographic Information Science (4.0 cr)
• GEOG 8101 - Proseminar: Nature and Society (3.0 cr)
• GIS 5555 - Basic Spatial Analysis (3.0 cr)
• GIS 5571 - ArcGIS I (3.0 cr)
• GIS 5572 - ArcGIS II (3.0 cr)
• GRAD 8101 - Teaching in Higher Education (3.0 cr)
• GRAD 8200 - Teaching and Learning Topics in Higher Education (1.0 cr)
• 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)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8100 - Topics in Natural Resources Science and Management (1.0 - 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)
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. Students must enroll in at least 94 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 8013 - Parameter Estimation in Biosystems and Agricultural Engineering (3.0 cr)
- CEGE 8513 - Hydrologic Modeling of Small Watersheds (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 5266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESCI 4401 - Aqueous Environmental Geochemistry (3.0 cr)
- ESCI 4702 - General Hydrogeology (4.0 cr)
- ESCI 4703 - Glacial Geology (4.0 cr)
- ESCI 5205 - Fluid Mechanics in Earth and Environmental Sciences (3.0 cr)
- ESPM 5061 - Contaminant Hydrology (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 5261 - Economics and Natural Resources Management (4.0 cr)
- ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
- ESPM 5402 - Contaminant Hydrology (3.0 cr)
- ESPM 5555 - Contaminant Hydrology (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)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
• GIS 5577 - Spatial Database Design and Administration (3.0 cr)
• GRAD 8101 - Teaching in Higher Education (3.0 cr)
• GRAD 8200 - Teaching and Learning Topics in Higher Education (1.0 cr)
• LAAS 5311 - Soil Chemistry and Mineralogy (3.0 cr)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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 5402 - Bio-based Products Engineering Lab II (1.0 cr)
• STAT 5403 - Bio-based Products Engineering Lab I (1.0 cr)
• STAT 5404 - Biopolymers and Biocomposites Engineering (3.0 cr)
• STAT 5601 - Nonparametric Methods (3.0 cr)
• STAT 5602 - Applied Statistical Methods 2: Design of Experiments and Mixed Effects Modeling (3.0 cr)
• STAT 5603 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)
• STAT 5604 - Statistical Methods 4: Advanced Statistical Computing (3.0 cr)
• WRIT 5051 - Graduate Research Writing for International Students (3.0 cr)
• WRS 5101 - Water Policy (3.0 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)
• BBE 5402 - Bio-based Products Engineering Lab II (1.0 cr)
• BBE 5403 - Bio-based Products Engineering Lab I (1.0 cr)
• BBE 5404 - Biopolymers and Biocomposites Engineering (3.0 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 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 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)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8103 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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)
• SSM 5414 - Advanced Residential Building Science (4.0 cr)
• SSM 5416 - Building Testing & Diagnostics (2.0 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 for International Students (3.0 cr)
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 5621 - 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 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 8266 - Statistical Analysis Using Structural Equation Methods (3.0 cr)
- ESPM 5071 - Ecological Restoration (4.0 cr)
- ESPM 5101 - (Inactive) (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)
- 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--Biologie and Management (1.0 - 5.0 cr)
- FNRM 8201 - Research Problems: Forest Economics (1.0 - 5.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
• 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 - Research Problems: 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 8200 - Seminar (1.0 - 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)
• GRAD 8101 - Teaching in Higher Education (3.0 cr)
• GRAD 8200 - Teaching and Learning Topics in Higher Education (1.0 cr)
• HORT 5071 - Ecological Restoration (4.0 cr)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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)
• 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 for International Students (3.0 cr)

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 (3.0 cr)
• BBE 5401 - Bioproducts Separation and Purification Processes (3.0 cr)
• BBE 5402 - Bio-based Products Engineering Lab II (1.0 cr)
• BBE 5403 - Bio-based Products Engineering Lab I (1.0 cr)
• BBE 5404 - Biopolymers and Biocomposites Engineering (3.0 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)
• 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)
• 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 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)
• NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
• NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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)
Recruitment 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.

Recruitment 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)
- EPSY 5241 - 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 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 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)
- 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)
- NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
- NR 8100 - Topics in Natural Resources Science and Management (1.0 - 2.0 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 - Statistics for Public Affairs (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 for International Students (3.0 cr)
Nutrition M.S.
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: Master's
- Requirements for this program are current for Fall 2018
- 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

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.
Information current as of August 31, 2018
- 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 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)
- NUTR 5624 - Nutrition and Genetics (2.0 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)

**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)
  - PUBH 6451 - Biostatistics II (4.0 cr)
  - PUBH 6414 - Biostatistical Literacy (3.0 cr)
  - 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)

**Additional Outside Coursework**
- Other courses may be from any field, but must be at the 5000 or 8000 level. Exceptions: 6000 level courses from Public Health (PUBH) are allowed.
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.

Integrated BS/MS-Nutrition
This sub-plan is limited to students completing the program under Plan B.

The Department of Food Science and Nutrition offers an integrated bachelor of science (BS) and master of science (MS) in nutrition. The integrated BS/MS program offers students the opportunity to earn both degrees in five years by working toward a master’s degree while simultaneously working toward their undergraduate degree. Nutrition undergraduate students in the DPD or nutrition studies sub-plans are welcome to apply to this program during their 3rd year of undergraduate study. During the 4th year, students take undergraduate and graduate courses concurrently and are advised by an undergraduate and graduate program advisor.

Students in this program will complete the 120 undergraduate credits required for a BS degree in nutrition by the end of the 4th year and must be awarded an undergraduate degree at the 4th year mark. During the 4th and 5th years, students will complete 30 graduate credits and a Plan B research project with a final oral defense as required for the nutrition MS degree. Students who satisfy the Didactic Program in Dietetics (DPD) verification requirements can begin the Emily Program Dietetic Internship in August following their 5th year. Students cannot double-count credits to meet credit requirements for both the undergraduate and graduate degrees.
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 2018
- 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. 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, 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)
Twin Cities Campus
Nutrition 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/nutrition/phd

- Program Type: Doctorate
- Requirements for this program are current for Fall 2018
- 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.

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
Program Requirements

14 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 3.00 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)
NUTR 5624 - Nutrition and Genetics (2.0 cr)

Advanced Topics Courses
All students must take Nutr 8620.
NUTR 8620 - Advances in Nutrition (2.0 cr)

Outside Coursework
All doctoral students must complete a minimum of 12 credits of outside coursework. Students must take one graduate level statistics course, one graduate level research methods course, and any other graduate level course to meet the 12 credit minimum.

Statistics Course
Take at least one statistics course from the following list. A different graduate level 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)
or NURS 8173 - Principles and Methods of Implementing Research (3.0 cr)
or PUBH 6341 - Epidemiologic Methods I (3.0 cr)
or PUBH 6617 - Practical Methods for Secondary Data Analysis (3.0 cr)
or PUBH 6803 - Conducting a Systematic Literature Review (3.0 cr)
or PUBH 6806 - Principles of Public Health Research (2.0 cr)

Additional Outside Coursework
Other courses may be from any field, but must be at the 5000 or 8000 level. Exceptions: 6000 level courses from Public Health are allowed.

Doctoral Thesis Credits
Take at least 24 credits of the following:
NUTR 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)
**Twin Cities Campus**  
**Plant Pathology M.S.**  
**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, 495 Borlaug Hall, 1991 Buford Circle, Saint Paul, MN 55108 (612-625-8200)  
Email: plpath@umn.edu  
Website: [http://plpa.cfans.umn.edu](http://plpa.cfans.umn.edu)

- Program Type: Master's  
- Requirements for this program are current for Fall 2018  
- Length of program in credits: 30  
- This program requires 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.

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.

Master's degree applicants must have a sound college background in the basic biological and physical sciences and mathematics.

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

© 2005 by the Regents of the University of Minnesota  
The University of Minnesota is an equal opportunity educator and employer.  
Information current as of August 31, 2018
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 24 major credits and 6 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.
- Take PLPA 5480 (3 credits), if an introductory plant pathology course has not previously been taken.

### Required Coursework

Take all of the following courses. Take PLPA 8005 (S-N grade basis) for 2 credits for completing a one-semester teaching experience. Consult with the advisor and director of graduate studies regarding the additional teaching methods seminar/workshop requirement. These credits count toward the major credit requirement.

- **PLPA 5480** - Principles of Plant Pathology (3.0 cr)
- **PLPA 8123** - Research Ethics in Plant and Environmental Sciences (0.5 cr)
- **PLPA 8200** - Seminar (1.0 cr)
- **PLPA 8005** - Supervised Classroom or Extension Teaching Experience (1.0 - 2.0 cr)
- **PLPA 8104** - Plant Virology (2.0 cr)
- **PLPA 8105** - Plant Bacteriology (2.0 cr)

### Plant Pathology Electives

Select at least 5 credits from the following course list in consultation with the director of graduate studies, advisor, and graduate advisory committee.

Take 5 or more credit(s) from the following:

- **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 cr)
- **PLPA 5301** - Large Scale Omic Data in Plant Biology (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)
Outside Coursework
Take at least 6 credits 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)
BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)

Thesis Credits or Capstone Project Credits
Plan A students must take 10 credits of PLPA 8777. Plan B students must take 10 credits of PLPA 8300.

Thesis Credits
Plan A students take 10 credits of PLPA 8777.
Take 10 or more credit(s) from the following:
• PLPA 8777 - Thesis Credits: Master's (1.0 - 18.0 cr)
or
Plan B students take 10 credits of PLPA 8300.
Take 10 or more credit(s) from the following:
• PLPA 8300 - Plant Pathology Project (1.0 - 6.0 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.

Molecular Plant Pathology
This sub-plan is limited to students completing the program under Plan A.

Students in the molecular plant pathology track complete specialized coursework that emphasizes molecular approaches to investigating plant diseases, increase their knowledge of basic science, and explore emerging strategies for disease control. Students in the molecular plant pathology track will learn about topics such as pathogen effectomics, plant phenomics, molecular plant/microbe interactions, and an ever-evolving array of molecular research techniques, strategies, and analytical approaches. At the same time, students will garner a comprehensive understanding of plant interactions with pathogenic and non-pathogenic microbes from a systems level, building a firm knowledge base of classical and contemporary plant pathology concepts. Students completing the molecular plant pathology track will be well positioned for research careers in molecular plant pathology in academia, industry, and government.

Take all of the following courses. Take PLPA 8005 (S-N grade basis) for 2 credits for completing a one-semester teaching experience. Consult with the advisor and director of graduate studies regarding the additional teaching methods seminar/workshop requirement. These credits count toward the major credit requirement.

Molecular Plant Pathology
Take 14 - 20 credit(s) from the following:

Required Coursework
Minimum of 14 credits in plant pathology required.
• PLPA 5480 - Principles of Plant Pathology (3.0 cr)
• PLPA 5300 - Current Topics in Molecular Plant Pathology (1.0 cr)
• PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
• PLPA 8200 - Seminar (1.0 cr)
• PLPA 8123 - Research Ethics in Plant and Environmental Sciences (0.5 cr)
• PLPA 8005 - Supervised Classroom or Extension Teaching Experience (1.0 - 2.0 cr)
• Outside Coursework
Take at least 6 course credits outside the major. Select courses in consultation with 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)
• BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
• EEB 5221 - Molecular Evolution (3.0 cr)
• GCD 5036 - Molecular Cell Biology (3.0 cr)

Plant Pathology Electives
Take elective credits from the following list, chosen in consultation with your advisor, director of graduate studies, and advisory committee to meet the 14-credit (Plan A) minimum major requirement.
Take at most 8 credit(s) from the following:
• 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 - Large Scale Omic Data in Plant Biology (3.0 cr)
• PLPA 8104 - Plant Virology (2.0 cr)
• PLPA 8105 - Plant Bacteriology (2.0 cr)
Twin Cities Campus

Plant Pathology Minor

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: Graduate minor related to major
- Requirements for this program are current for Fall 2018
- 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 cr)
- PLPA 5301 - Large Scale Omic Data in Plant Biology (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 cr)
- **PLPA 5301** - Large Scale Omic Data in Plant Biology (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](http://plpa.cfans.umn.edu)

- Program Type: Doctorate  
- Requirements for this program are current for Fall 2018  
- Length of program in credits: 56  
- 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

---

© 2005 by the Regents of the University of Minnesota  
The University of Minnesota is an equal opportunity educator and employer.  
Information current as of August 31, 2018
- 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
20 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 (13 credits)
All students take the following courses, if not completed previously. Take PLPA 8200 twice for a total of 2 credits. Take PLPA 8005 for 2 credits to fulfill the one-semester teaching experience requirement. Take GRAD 8101 concurrently with or after completing PLPA 8005.

- 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 8005 - Supervised Classroom or Extension Teaching Experience (1.0 - 2.0 cr)
- GRAD 8101 - Teaching in Higher Education (3.0 cr)

Electives (12 credits)
Take at least 12 credits, in consultation with the advisor, to complete the outside credit requirement.

- AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
- ANSC 5200 - Statistical Genetics and Genomics (4.0 cr)
- BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
- CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
- EEB 5221 - Molecular Evolution (3.0 cr)
- AGRO 5021 - Plant Breeding Principles (3.0 cr)
- GCD 5036 - Molecular Cell Biology (3.0 cr)
- GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
- MICA 8002 - Structure, Function, and Genetics of Bacteria and Viruses (4.0 cr)
- AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
BBE 5302 - Biodegradation of Bioproducts (3.0 cr)
PMB 5412 - Plant Physiology (3.0 cr)
CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)

**Thesis Credits**
Take at least 24 doctoral thesis credits.
PLPA 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

**Standard Program**

**Standard Program Courses (7 credits)**
Take the following courses:
PLPA 8104 - Plant Virology (2.0 cr)
PLPA 8105 - Plant Bacteriology (2.0 cr)
PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 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.

**Molecular Plant Pathology**
Students in the molecular plant pathology track complete specialized coursework that emphasizes molecular approaches to investigating plant diseases, increase their knowledge of basic science, and explore emerging strategies for disease control. Students in the Molecular Plant Pathology track will learn about topics such as pathogen effectomics, plant phenomics, molecular plant/microbe interactions, and an ever-evolving array of molecular research techniques, strategies, and analytical approaches. At the same time, students will garner a comprehensive understanding of plant interactions with pathogenic and non-pathogenic microbes from a systems level, building a firm knowledge base of classical and contemporary plant pathology concepts. Students completing the molecular plant pathology track will be well positioned for research careers in molecular plant pathology in academia, industry, and government.

**Molecular Plant Pathology Courses (7 credits)**
Take the following courses. Take PLPA 5300 twice for a total of 2 credits.
PLPA 5301 - Large Scale Omic Data in Plant Biology (3.0 cr)
PLPA 5300 - Current Topics in Molecular Plant Pathology (1.0 cr)

**Virology OR Bacteriology**
Take one of the following courses:
PLPA 8104 - Plant Virology (2.0 cr)
or 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: isgigert@umn.edu
Website: http://isg-igert.umn.edu

- Program Type: Graduate free-standing minor
- Requirements for this program are current for Fall 2018
- 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 2018
- 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 (MA and MS) 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. A unique component of the minor is an on-site internship with growers, grassroots organizations, or public agencies working in sustainable agriculture. 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.

Required Coursework (6 Credits)
All students pursuing the Sustainable Agriculture Systems minor must complete the following courses for a total of 6 credits. Take SAGR 8020 for 1 credit.
- 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)
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
Master’s-level Minor
The master's-level Sustainable Agriculture minor comprises the 6 required course credits noted above.

Doctoral
Doctoral-level Minor Electives (6 Credits)
In addition to the 6 required credits, select at least 6 credits in consultation with the Sustainable Agriculture Systems director of graduate studies to complete the 12-credit minimum.