The following are required:

1. three or more letters of recommendation regarding the student’s academic and professional promise;
2. a concise statement describing the student’s goals both within the program and in professional life;
3. a curriculum vitae.

Specific inquiries about the Ecology Program may be directed to the program chair. Applications received by December 15 will have preferred consideration for assistantships and fellowships for fall semester admission.

Degree Requirements

Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (http://gradschool.psu.edu/graduate-education-policies/)

A minimum of 30 credits at the 400, 500, 600, or 800 level is required, with at least 18 credits at the 500 and 600 level, combined. A minimum of six (6) thesis research credits (ECLGY 600 or ECLGY 610) must be taken in Ecology.

In addition to Graduate Council requirements, the instructional program includes:

- ECLGY 515 Advances in Ecology (3 cr.),
- two graduate courses in ecology selected from the following subdisciplines: Molecular, Physiological, Behavioral, and Evolutionary Ecology; Population and Community Ecology; Ecosystem, Landscape and Global Ecology. A list of courses that will satisfy this requirement is maintained by the graduate program office,
- a graduate (500 or 800 level) statistics course,
- two credits of colloquium (ECLGY 590),
- a minimum of six thesis credits (ECLGY 600 or ECLGY 610),
- breadth courses selected by the student in consultation with the research adviser and research committee,
- and a thesis research project directed by the student's adviser. The thesis must be accepted by the advisers and/or committee members, the head of the graduate program, and the Graduate School, and the student must pass a thesis defense.

Doctor of Philosophy (Ph.D.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (http://gradschool.psu.edu/graduate-education-policies/)

In addition to Graduate Council requirements, the instructional program includes:

- ECLGY 515 Advances in Ecology (3 cr.),
- ECLGY 510 Classical Ecology (2 cr.),
- two graduate courses in ecology selected from the following subdisciplines: Molecular, Physiological, Behavioral, and Evolutionary Ecology; Population and Community Ecology; Ecosystem, Landscape and Global Ecology. A list of courses that will satisfy this requirement is maintained by the graduate program office,
- two graduate (500 or 800 level) statistics courses, two graded credits plus two audit credits (4 credits total) of colloquium (ECLGY 590),
- breadth courses selected by the student in consultation with the research adviser and Ph.D. committee,
- one credit of Supervised Experience in College Teaching (ECLGY 602),
- a minimum of 15 thesis credits (ECLGY 600 or ECLGY 610),
- and a dissertation research project directed by the student's adviser.
English competence will be assessed and reported at the time of the qualifying examination and formally attested before the comprehensive examination is scheduled. The qualifying examination includes written and oral portions.

The Ph.D. committee is selected by the student and adviser and approved by the Program Chair and the Graduate School. The Ph.D. Committee must meet all Graduate Council Requirements (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-602-phd-committee-formation/). In addition, members of the Ecology faculty must comprise at least half of the committee. The committee has the responsibility for determining the course program and research acceptable in satisfying degree requirements. The committee will administer the comprehensive examination and final oral examination.

Doctoral students must pass a qualifying examination, a comprehensive examination, and a final oral examination (the dissertation defense). To earn the Ph.D. degree, doctoral students must also write a dissertation that is accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

**Options**

Four options for specialization are offered, for both the M.S. and the Ph.D.:

1. Conservation Biology
2. Microbial Ecology
3. Quantitative Ecology
4. Physiological Ecology

Students are not required to select an option. Each option entails extra course requirements plus a thesis directed by an ecology faculty member in the option.

When courses that fulfill option requirements appear on the list of approved subdiscipline courses, these courses may also be counted towards the subdiscipline graduate courses required for the Ecology major.

**Conservation Biology**

The Conservation Biology option is concerned with problems of maintaining the rapidly disappearing diversity of organisms and their habitats, and the global reservoir of genetic diversity that these organisms represent.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANTH 559</td>
<td>Human Ecology</td>
<td></td>
</tr>
<tr>
<td>BIOL 428</td>
<td>Population Genetics</td>
<td></td>
</tr>
<tr>
<td>GEOG 414</td>
<td>Principles and Applications in Landscape Ecology</td>
<td></td>
</tr>
<tr>
<td>WFS 430</td>
<td>Conservation Biology</td>
<td></td>
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</tbody>
</table>

In addition, two courses (at least 6 credits) are required from this list of Conservation Biology courses:

- ANTH 560 Ecology, Evolution, and Human Behavior
- BIOL 414 Taxonomy of Seed Plants
- BIOL 422 Advanced Genetics
- BIOL 427 Evolution
- BIOL 448 Ecology of Plant Reproduction

**Microbial Ecology**

The Microbial Ecology option addresses the structure, function, and interactions of microbial populations and communities, both within plants and animal hosts and in diverse environmental samples (soils, sediments, water).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICRB 401</td>
<td>Microbial Physiology and Structure</td>
<td></td>
</tr>
<tr>
<td>MICRB 416</td>
<td>Microbial Biotechnology</td>
<td></td>
</tr>
<tr>
<td>SOILS 512</td>
<td>Environmental Soil Microbiology</td>
<td></td>
</tr>
<tr>
<td>PPEM 440</td>
<td>Introduction to Microbiome Analysis</td>
<td></td>
</tr>
</tbody>
</table>

In addition, two courses (at least 6 credits) are required from this list of Microbial Ecology courses:

- BIOL/PPEM 425 Biology of Fungi
- BMB/MICRB 450 Microbial/Molecular Genetics
- CE 479 Environmental Microbiology for Engineers
- FDSC 526 Microbial Physiology of Foodborne Organisms
- GEOSC 409W Geomicrobiology
- GEOSC 502 Evolution of the Biosphere
- MCIBS 593 Molecular Biology Laboratory
- PATH 533 Molecular Genetics of Plant-Pathogen Interactions
- PPEM 454 Virus Ecology
- PPEM 456 Applied Microbial Ecology
- SOILS/CE 536 Topics in Biogeochemistry
  or GEOSC 536 Topics in Biogeochemistry

**Quantitative Ecology**

The Quantitative Ecology option includes mathematical and statistical modeling and applications of statistics to experimental design and data analysis.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 465</td>
<td>Network analysis of biological systems</td>
<td></td>
</tr>
<tr>
<td>BIOL 519</td>
<td>Ecological and Environmental Problem Solving</td>
<td></td>
</tr>
<tr>
<td>WFS 560</td>
<td>Population Estimation and Modeling</td>
<td></td>
</tr>
<tr>
<td>WFS 585</td>
<td>Applied Spatial Ecology</td>
<td></td>
</tr>
</tbody>
</table>

In addition, two courses (at least 6 credits) are required from this list of Quantitative Ecology courses:

- BIOL/STAT 555 Statistical Analysis of Genomics Data
- FOR 455 Remote Sensing and Spatial Data Handling
- GEOG 464 Advanced Spatial Analysis
The Physiological Ecology option is concerned primarily with the function and performance of organisms in their environment.

**Code** | **Title** | **Credits**
--- | --- | ---
| GEOG 465 | Advanced Geographic Information Systems Modeling | 
| GEOSC 450 | Risk Analysis in the Earth Sciences | 
| MATH 450 | Mathematical Modeling | 
| STAT 416 | Stochastic Modeling | 
| STAT 464 | Applied Nonparametric Statistics | 
| STAT 505 | Applied Multivariate Statistical Analysis | 
| STAT 508 | Applied Data Mining & Statistical Learning | 
| STAT 510 | Applied Time Series Analysis | 
| STAT 511 | Regression Analysis and Modeling | 
| STAT 512 | Design and Analysis of Experiments | 
| STAT 513 | Theory of Statistics I | 
| STAT 514 | Theory of Statistics II | 
| STAT 515 | Stochastic Processes and Monte Carlo Methods | 
| STAT 517 | Probability Theory | 
| STAT 551 | Linear Models I | 
| STAT 565 | Multivariate Analysis | 

**Physiological Ecology**

The Physiological Ecology option is concerned primarily with the function and performance of organisms in their environment.

**Select two required courses from the following list:**

- **BIOL 406** | Symbiosis |
- **BIOL 446** | Physiological Ecology |
- **HORT 445** | Plant Ecology |
- **PLBIO 514** | Modern Techniques and Concepts in Plant Ecophysiology |

In addition, two courses (at least 6 credits) are required from this list of Physiological Ecology courses:

- **AGRO 410W** | Physiology of Agricultural Crops |
- **AGRO 518** | Responses of Crop Plants to Environmental Stress |
- **BIOL 415** | Ecotoxicology |
- **BIOL 441** | Plant Physiology |
- **ENT 539** | Chemical Ecology of Insects |
- **PLBIO 512** |
- **PLBIO 513** |
- **PLBIO 515** |
- **PLBIO 516** |

**Dual-Titles**

**Dual-Title Ph.D. in Ecology and Biogeochemistry**

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200-gcac-208-dual-title-graduate-degree-programs/).

Graduate students with research and educational interests in biogeochemistry may apply to the Biogeochemistry dual-title degree program. Students must apply and be admitted to the graduate program in Ecology and The Graduate School before they can apply for admission to the dual-title degree program. After admission to the Ecology program, students must apply for admission to and meet the admissions requirements of the Biogeochemistry dual-title program.

Refer to the Admission Requirements section of the Biogeochemistry Bulletin page (http://bulletins.psu.edu/graduate/programs/majors/biogeochemistry/). Once a student has been admitted to the dual-title degree in Biogeochemistry, they must pass a qualifying examination that incorporates knowledge of the discipline of biogeochemistry.

It is preferred that students take a joint Ecology / Biogeochemistry qualifying examination incorporating knowledge of both the ecology and biogeochemistry disciplines. When a joint qualifying examination is administered, the qualifying examination committee will be composed of Graduate Faculty from Ecology and must include at least one Graduate Faculty member from the Biogeochemistry program.

Ecology graduate students who have already passed their qualifying examination will take a second qualifying examination focused solely on the discipline of biogeochemistry. When the Biogeochemistry qualifying examination is administered separately, faculty members who hold appointments in the Biogeochemistry Graduate Faculty may serve in administering the Biogeochemistry qualifying exam.

In either case, all qualifying examinations must be complete no later than the end of the fourth semester (not counting summer semesters) of entry into the Ecology program.

To qualify for the Biogeochemistry dual-title degree, students must satisfy the degree requirements for the Ph.D. in Ecology, listed in the Degree Requirements section. In addition, students must complete the degree requirements for the dual-title in Biogeochemistry, listed on the Biogeochemistry Bulletin page (http://bulletins.psu.edu/graduate/programs/majors/biogeochemistry/). Some courses may satisfy both the Ecology program requirements and those of the Biogeochemistry dual-title program.

In addition to the general Graduate Council requirements for Ph.D. committees (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600-gcac-602-phd-committee-formation/), the Ph.D. committee of an Ecology and Biogeochemistry dual-title Ph.D. student must include at least one member of the Biogeochemistry Graduate Faculty. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in Biogeochemistry, the member of the committee representing Biogeochemistry must be appointed as co-chair. The Biogeochemistry representative on the student’s Ph.D. committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students in the dual-title program are required to write and orally defend a dissertation on a topic that is approved in advance by their Ph.D. committee and reflects their original research and education in Ecology and Biogeochemistry. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School.

**Dual-Title M.S. and Ph.D. in Ecology and International Agriculture and Development**

Requirements listed here are in addition to requirements listed in GCAC-208 Dual-Title Graduate Degree Programs (http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-200-gcac-208-dual-title-graduate-degree-programs/).

Graduate students with research and educational interests in international agriculture and development may apply to the International
Agriculture and Development (INTAD) dual-title degree program. Students must apply and be admitted to the graduate program in Ecology and The Graduate School before they can apply for admission to the INTAD dual-title degree program. After admission to their primary program, students must apply for admission to and meet the admissions requirements of INTAD dual-title program. Refer to the Admission Requirements section of the INTAD Bulletin page (https://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/).

Degree Requirements for dual-title M.S.
To qualify for the INTAD dual-title degree, students must satisfy the requirements of the Ecology M.S. program. In addition, they must satisfy the INTAD program requirements for the dual-title M.S. degree. Refer to the M.S. Degree Requirements section of the INTAD Bulletin page (https://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/). Some courses may satisfy both the Ecology program requirements and those of the INTAD dual-title program.

The Ecology program requires students pursuing a M.S. degree to produce a master’s thesis. Therefore, in addition to the 12 credits specified in the degree requirements, dual-title students must write the thesis on a topic that reflects their education and interest in both Ecology and INTAD. At least 6 thesis research credits (ECLGY 600 or ECLGY 610) must be taken in Ecology.

All members of the student’s committee for the dual-title M.S. degree will be members of the Graduate Faculty. The committee must include at least one Graduate Faculty member from INTAD. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role.

Degree Requirements for the Dual-Title Ph.D.
To qualify for the INTAD dual-title degree, students must satisfy the requirements of the Ecology Ph.D. program. In addition, they must satisfy the INTAD program requirements for the dual-title Ph.D. degree. Refer to the Ph.D. Degree Requirements section of the INTAD Bulletin page (https://bulletins.psu.edu/graduate/programs/majors/international-agriculture-development/). Some courses may satisfy both the Ecology program requirements and those of the INTAD dual-title program.

Qualifying Examination
It is preferred that students in the dual-title program take a single qualifying examination, containing elements of both Ecology and INTAD. However, in cases when students matriculate into a dual-title after they have already completed the Ecology qualifying exam, a second qualifying exam may be taken for the dual title, according to policy GCAC-604 (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-604-qualifying-exam/) and the guidelines of the dual-title degree program. Whether taken as a combined exam in ECLGY and INTAD or as a second, separate exam for INTAD, the qualifying examination committee for the dual-title Ph.D. degree must include at least one Graduate Faculty member from the INTAD program. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role.

Committee Composition
In addition to the general Graduate Council requirements for Ph.D. committees (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-602-phd-committee-formation/), the Ph.D. committee of an Ecology and INTAD dual-title Ph.D. student must include at least one member of the INTAD Graduate Faculty. Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role. If the chair of the Ph.D. committee is not also a member of the Graduate Faculty in INTAD, the member of the committee representing INTAD must be appointed as co-chair.

Comprehensive Exam
At the end of their course work, students must pass a comprehensive examination that follows the guidelines established by the Ecology program and reflects both the Ecology program and the INTAD dual-title degree curriculum. International agriculture must be one of the key areas of the exam and the INTAD representative on the student’s Ph.D. committee must have input into the development of and participate in the evaluation of the comprehensive examination.

Dissertation and Dissertation Defense
Doctoral students enrolled in the dual-title degree program are required to write and orally defend a dissertation on a topic that reflects their original research and education in both Ecology and INTAD. The dissertation should contribute to the body of knowledge in international agriculture. A public oral presentation of the dissertation is required. The dissertation must be accepted by the Ph.D. committee, the head of the graduate program, and the Graduate School, and the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree.

Minor
A graduate minor is available in any approved graduate major or dual-title program. The default requirements for a graduate minor are stated in Graduate Council policies listed under GCAC-600 Research Degree Policies (http://gradschool.psu.edu/graduate-education-policies/) and GCAC-700 Professional Degree Policies (http://gradschool.psu.edu/graduate-education-policies/), depending on the type of degree the student is pursuing:

- GCAC-611 Minor - Research Doctorate (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-611-minor-research-doctorate/)
- GCAC-641 Minor - Research Master’s (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-641-minor-research-masters/)
- GCAC-709 Minor - Professional Doctorate (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-700/gcac-709-professional-doctoral-minor/)
- GCAC-741 Minor - Professional Master’s (https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-700/gcac-741-masters-minor-professional/)

Student Aid
Graduate assistantships available to students in this program and other forms of student aid are described in the Tuition & Funding (http://gradschool.psu.edu/graduate-funding/) section of The Graduate School’s website. Students on graduate assistantships must adhere to the course load limits (http://gradschool.psu.edu/graduate-education-policies/gsad/gsad-900/gsad-901-graduate-assistants/) set by The Graduate School.

Courses
Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not. A graduate student may register for or audit these courses in order to make up
deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Ecology (ECLGY) Course List (https://bulletins.psu.edu/university-course-descriptions/graduate/eclgy/)

**Learning outcomes**

**Master of Science (M.S.)**

1. **Know:** demonstrate knowledge of core principles and primary literature in their specialty area including comprehension of methods, results, and data analysis in the specialty area.

2. **Apply/Create:** demonstrate ability to design and carry out a major research project in the discipline, including synthesis of previous work in the field, and assembling findings into a written work.

3. **Think:** demonstrate ability to critically analyze work by others in their specialty area.

4. **Communicate:** demonstrate ability to convey scientific ideas and results in clear, concise and original writing as well as in formal oral presentations.

5. **Professional Practice:** demonstrate comprehension of and commitment to ethical standards in the discipline.

**Doctor of Philosophy (Ph.D.)**

1. **Know:** demonstrate knowledge of core principles and primary literature in their specialty area including comprehension of methods, results, and data analysis in the specialty area.

2. **Apply/Create:** demonstrate ability to design and carry out a major research project in the discipline, including synthesis of previous work in the field, and assembling new findings into a written work that advances understanding in the field.

3. **Think:** demonstrate ability to critically analyze work by others in their specialty area.

4. **Communicate:** demonstrate ability to convey scientific ideas and results in clear, concise and original writing as well as in formal oral presentations.

5. **Professional Practice:** demonstrate comprehension of and commitment to ethical standards in the discipline.

6. **Teach:** demonstrate the ability to teach key concepts of the discipline to students.

**Contact**

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<thead>
<tr>
<th>Campus</th>
<th>University Park</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate Program Head</td>
<td>Jason Philip Kaye</td>
</tr>
<tr>
<td>Director of Graduate Studies (DGS) or Professor-in-Charge (PIC)</td>
<td>Jared Gregory Ali</td>
</tr>
<tr>
<td>Program Contact</td>
<td>Jean Elizabeth Shaw Pierce</td>
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<tr>
<td></td>
<td>101 Life Sciences Bldg</td>
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<td></td>
<td>University Park PA 16802</td>
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<td></td>
<td><a href="mailto:jep32@psu.edu">jep32@psu.edu</a></td>
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<tr>
<td></td>
<td>(814) 867-0371</td>
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<tr>
<td>Program Website</td>
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