The information in this bulletin applies to the academic year 2019-2020 and is accurate and current, to the greatest extent possible, as of September 2019. The university reserves the right to change programs of study, academic requirements, teaching staff, the calendar, and other matters described herein without prior notice, in accordance with established procedures.

Duke University does not tolerate discrimination or harassment of any kind. Duke University has designated the Vice President for Institutional Equity as the individual responsible for the coordination and administration of its nondiscrimination and harassment policies generally. The Office for Institutional Equity is located in Smith Warehouse, 114 S. Buchanan Blvd., Bay 8, Durham, NC 27708, (919) 684-8222, oie-help@duke.edu. Sexual harassment and sexual misconduct are forms of sex discrimination and prohibited by the university. Duke University has designated Jayne Grandes as its director of Title IX compliance and Age Discrimination Act coordinator. She is also with the Office for Institutional Equity and can be contacted at (919) 660-5766 or jayne.grandes@duke.edu.

Questions or comments about discrimination, harassment, domestic violence, dating violence, and stalking can be directed to the Office for Institutional Equity, (919) 684-8222. Additional information, including the complete text of the discrimination grievance procedure and the harassment policy and appropriate complaint procedures, may be found by contacting the Office for Institutional Equity or visiting its website at https://oie.duke.edu/. Questions or comments about sex-based and sexual harassment and misconduct, domestic violence, dating violence, and stalking committed by a student may also be directed to Victoria Krebs, Associate Dean of Students in the Office of Student Conduct, at (919) 684-7336 or victoria.krebs@duke.edu. Additional information, including the complete text of the policy and complaint procedure for such misconduct, may be found at https://studentaffairs.duke.edu/conduct/z-policies/student-sexual-misconduct-policy-dukes-commitment-title-ix.

Duke University recognizes and utilizes electronic mail as a medium for official communications. The university provides all students with email accounts as well as access to email services from public clusters if students do not have personal computers of their own. All students are expected to access their email accounts on a regular basis to check for and respond as necessary to such communications.

Information that the university is required to make available under the federal Clery Act is available by visiting the Records Division, Duke University Police Department, 502 Oregon Street, Durham, NC 27708, or by calling (919) 684-4602. See https://police.duke.edu/news-stats/clery for more details.

The Family Educational Rights & Privacy Act (FERPA), 20 USC § 1232g; 34 CFR Part 99, is a federal law that guides the release of students’ education records, of which disciplinary records are a part. For additional information about FERPA, see https://www.ed.gov/policy/gen/guid/fpco/ferpa/index.html.

Duke University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award baccalaureate, master’s, doctorate, and professional degrees. Contact the Commission on Colleges at 1866 Southern Lane, Decatur, GA 30033-4097 or call (404) 679-4500 for questions about the accreditation of Duke University.

This publication is available in alternative format on request. Please call (919) 684-2813.

September 2019
The Mission of Duke University

James B. Duke's founding indenture of Duke University directed the members of the university to "provide real leadership in the educational world" by choosing individuals of "outstanding character, ability and vision" to serve as its officers, trustees and faculty; by carefully selecting students of "character, determination and application;" and by pursuing those areas of teaching and scholarship that would "most help to develop our resources, increase our wisdom, and promote human happiness."

To these ends, the mission of Duke University is to provide a superior liberal education to undergraduate students, attending not only to their intellectual growth but also to their development as adults committed to high ethical standards and full participation as leaders in their communities; to prepare future members of the learned professions for lives of skilled and ethical service by providing excellent graduate and professional education; to advance the frontiers of knowledge and contribute boldly to the international community of scholarship; to promote an intellectual environment built on a commitment to free and open inquiry; to help those who suffer, cure disease and promote health, through sophisticated medical research and thoughtful patient care; to provide wide-ranging educational opportunities, on and beyond our campuses, for traditional students, active professionals and life-long learners using the power of information technologies; and to promote a deep appreciation for the range of human difference and potential, a sense of the obligations and rewards of citizenship, and a commitment to learning, freedom and truth.

By pursuing these objectives with vision and integrity, Duke University seeks to engage the mind, elevate the spirit, and stimulate the best effort of all who are associated with the university; to contribute in diverse ways to the local community, the state, the nation and the world; and to attain and maintain a place of real leadership in all that we do.

— Adopted by the Board of Trustees on February 23, 2001
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# 2019-2020 Academic Calendar

## Summer 2019

**Duke University Marine Laboratory**

<table>
<thead>
<tr>
<th>February</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>18 M</td>
<td>Registration begins for all summer sessions</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>May</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13 M</td>
<td>Term 1 classes begin; class meeting schedule begins</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drop/Add continues</td>
<td></td>
</tr>
<tr>
<td>15 W</td>
<td>Drop/Add for Term 1 ends</td>
<td></td>
</tr>
<tr>
<td>27 M</td>
<td>Memorial Day holiday. No classes are held</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>June</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14 F</td>
<td>Term 1 classes end</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>July</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8 M</td>
<td>Term 2 classes begin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drop/Add continues</td>
<td></td>
</tr>
<tr>
<td>10 W</td>
<td>Drop/Add for Term 2 ends</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>August</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9 Th</td>
<td>Term 2 classes end</td>
<td></td>
</tr>
</tbody>
</table>

## Fall 2019

<table>
<thead>
<tr>
<th>August</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>19 T</td>
<td>New graduate student orientation begins</td>
<td></td>
</tr>
<tr>
<td>21 W</td>
<td>4:00 PM. Convocation for new graduate and professional school students</td>
<td></td>
</tr>
<tr>
<td>26 M</td>
<td>8:30 AM. Fall semester classes begin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drop/Add continues</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>September</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2 M</td>
<td>Labor Day. Classes in session</td>
<td></td>
</tr>
<tr>
<td>6 F</td>
<td>Drop/Add ends</td>
<td></td>
</tr>
<tr>
<td>26/27 Th/F</td>
<td>5:30 PM. Founders' Day Convocation</td>
<td></td>
</tr>
<tr>
<td>29 Su</td>
<td>Founders' Day</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>October</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4 F</td>
<td>7:30 PM. Fall break begins</td>
<td></td>
</tr>
<tr>
<td>9 W</td>
<td>8:30 AM. Classes resume</td>
<td></td>
</tr>
<tr>
<td>21 M</td>
<td>Bookbagging begins for Spring 2020</td>
<td></td>
</tr>
<tr>
<td>30 W</td>
<td>Registration begins for Spring 2020</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>November</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11 M</td>
<td>Registration ends for Spring 2020</td>
<td></td>
</tr>
<tr>
<td>12 T</td>
<td>Drop/Add begins for Spring 2020</td>
<td></td>
</tr>
<tr>
<td>26 T</td>
<td>10:30 PM. Thanksgiving recess begins. Graduate classes end</td>
<td></td>
</tr>
<tr>
<td>27-Dec. 10 W-T</td>
<td>Graduate reading period</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>December</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11 W</td>
<td>9:00 AM. Final examinations begin</td>
<td></td>
</tr>
<tr>
<td>16 M</td>
<td>10:00 PM. Final examinations end</td>
<td></td>
</tr>
</tbody>
</table>
# 2019-2020 Academic Calendar

## Spring 2020

### January

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>W</td>
<td>8:30 AM. Spring semester begins. The Monday class meeting schedule is in effect on this day; regular class meeting schedule begins on Thursday, January 9; classes meeting in a W/F meeting pattern begin January 10. Drop/Add continues.</td>
</tr>
<tr>
<td>9</td>
<td>Th</td>
<td>Regular class meeting schedule begins.</td>
</tr>
<tr>
<td>20</td>
<td>M</td>
<td>Martin Luther King, Jr. Day holiday. Classes are rescheduled on Wednesday, January 8.</td>
</tr>
<tr>
<td>22</td>
<td>W</td>
<td>Drop/Add ends.</td>
</tr>
</tbody>
</table>

### February

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>M</td>
<td>Registration begins for Summer 2020.</td>
</tr>
</tbody>
</table>

### March

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>F</td>
<td>7:00 PM. Spring recess begins.</td>
</tr>
<tr>
<td>16</td>
<td>W</td>
<td>8:30 AM. Classes resume.</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
<td>Bookbagging begins for Fall 2020.</td>
</tr>
</tbody>
</table>

### April

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>W</td>
<td>Registration begins for Fall 2020; Summer 2020 registration continues.</td>
</tr>
<tr>
<td>9</td>
<td>Th</td>
<td>Registration ends for Fall 2020; Summer 2020 registration continues.</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>Drop/Add begins for Fall 2020.</td>
</tr>
<tr>
<td>15</td>
<td>W</td>
<td>Graduate classes end.</td>
</tr>
<tr>
<td>16-26</td>
<td>Th-Su</td>
<td>Graduate reading period.</td>
</tr>
<tr>
<td>27</td>
<td>M</td>
<td>9:00 AM. Final examinations begin.</td>
</tr>
</tbody>
</table>

### May

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Sa</td>
<td>10:00 PM. Final examinations end.</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>Commencement begins.</td>
</tr>
<tr>
<td>10</td>
<td>Su</td>
<td>Graduation exercises; conferring of degrees.</td>
</tr>
</tbody>
</table>

## Summer 2020

### Duke University Marine Laboratory

#### February

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>M</td>
<td>Registration begins for all summer sessions.</td>
</tr>
</tbody>
</table>

#### May

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>W</td>
<td>Term 1 classes begin; class meeting schedule begins. Drop/Add continues.</td>
</tr>
<tr>
<td>15</td>
<td>F</td>
<td>Drop/Add for Term 1 ends.</td>
</tr>
<tr>
<td>25</td>
<td>M</td>
<td>Memorial Day holiday. No classes are held.</td>
</tr>
</tbody>
</table>

#### June

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>F</td>
<td>Term 1 classes end.</td>
</tr>
<tr>
<td>29</td>
<td>M</td>
<td>Term 2 classes begin; Drop/Add continues.</td>
</tr>
</tbody>
</table>

#### July

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>W</td>
<td>Drop/Add for Term 2 ends.</td>
</tr>
</tbody>
</table>

#### August

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Th</td>
<td>Term 2 classes end.</td>
</tr>
</tbody>
</table>

*The dates on this calendar are subject to change.

Past, current, and future academic calendars can be found at [https://registrar.duke.edu/calendars-key-dates/academic-calendar](https://registrar.duke.edu/calendars-key-dates/academic-calendar).*
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University Administration

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Gary G. Bennett, PhD, Vice Provost for Undergraduate Education
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Lawrence Carin, PhD, Vice Provost for Research
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Deborah Jakubs, PhD, University Librarian and Vice Provost
Scott Lindroth, PhD, Vice Provost for the Arts

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Kevin Smith, MS, Assistant Dean, Information Technology
Cynthia A. Peters, BA, Assistant Dean, Student Services
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A. Brad Murray, PhD, Professor and Director of Graduate Studies (EOS)
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Prasad Kasibhatla, PhD, Professor and Director of Undergraduate Studies (ENV)
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Sara Childs, MEM, Duke Forest Resource Manager

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Shannon Lyons, MEM’04, Chesapeake Bay Foundation (Ex-Officio)
Tim Profeta, MEM’97, L’97, Nicholas Institute for Environmental Policy Solutions, Durham, NC (Ex-Officio)
William K. Reilly, Aqua International Partners, LP, San Francisco, CA (Ex-Officio)

Alumni Council, Nicholas School of the Environment
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Shannon Lyons, MEM’04, SouthWings, Inc., Annapolis, MD (Past President)
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Lauren Campbell, MEM’11, Federal Energy Regulatory Commission, Washington, DC
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Laura Marie Davis, MEM’17, EarthShare North Carolina, Durham, NC
Romi Gottfrid, MEM’97, New York, NY
Kira Jacobs, MEM’97, US Environmental Protection Agency, Boston, MA
Ga-Young Park, MEM’05, Cyclone Energy Group, Chicago, IL
**Introduction**

Headquartered in the heart of the Duke University campus, the Nicholas School of the Environment strives for a new paradigm, one that views and attempts to understand the earth and the environment—including humans—as an integrated whole. Addressing problems as well as identifying solutions, the Nicholas School mission is to create knowledge and global leaders of consequence for a sustainable future.

To achieve this vision, the Nicholas School has assembled a unique and talented faculty of more than 150 world-class researchers and educators with expertise spanning forty-five core focal areas in the physical, life, and social sciences. Individually, Nicholas School faculty are leaders in their fields; collectively, they form a community of shared purpose and passion, each steeped and actively engaged in their respective disciplines but also committed to the multi- and interdisciplinary lines of inquiry and collaborations that are at the core of many environmental challenges.

We strive to fulfill our school’s mission by:

- **Creating knowledge** through basic and applied multidisciplinary research designed to expand our understanding of the Earth and its environment;
- **Creating global leaders of consequence** through:
  - an undergraduate academic program designed to spread understanding of the Earth and the environmental ethic to a new cadre of Duke graduates, and prepare them for careers or advanced studies in many in-demand fields;
  - a professional master’s program that combines the specificity of an MS and the practical nature of an MBA or MPP to train a new breed of environmental professionals with in-demand skills needed to devise and implement effective environmental policies and practices in the private, public and nonprofit sectors; and
  - a PhD program dedicated to adding to a new generation of world-class scientists, researchers, and educators in the environment;
- **Forging a sustainable future** by strategically focusing our intellectual resources and capital to address the most challenging environmental issues confronting society on five fronts:
  - energy and resources;
  - climate and impacts;
  - environmental health;
  - ocean and coastal systems; and
  - aquatic and terrestrial systems.

In addition, the following three themes cut across all of the above: governance; economy and policy; data and technology; and our discovery mission in Earth and environmental applied and basic science.

Environmental issues affect us all. We all need to be part of the solution. At the Nicholas School, we believe lasting environmental change depends on embracing and encouraging the rich diversity of talent, perspectives and experiences brought to our field by faculty, staff, students, and alumni from all backgrounds.

The Nicholas School values its strong partnership with Duke’s Office of Institutional Equity and its support of the school’s efforts to create a community that recognizes and values the contributions and concerns of all its members, regardless of their race, ethnicity, national origin, religion, sexual orientation, gender identification, physical capabilities and other important characteristics of their identities. Through organizations such as DICE, BLS, Actionators, oStem, and others, the Nicholas School strives to foster a truly inclusive community committed to the mission of the school.

**Graduate Professional Degrees**

Most students entering the Nicholas School seek graduate professional degrees, preparing for careers as expert environmental problem-solvers after two years of study. The master of environmental management (MEM) degree trains students to understand the scientific basis of environmental problems, as well as the social, political, and economic factors that determine effective policy options for their solution with an eye toward forging a sustainable future. Mid-career environmental professionals can also earn the MEM degree through the Duke Environmental Leadership (DEL) Program (through a combination of traditional and distance-learning formats, students focus on environmental management and leadership development). The master of forestry (MF) degree develops experts in sustainable management of forested ecosystems. The Sanford School of Public Policy and the Nicholas School offer an international master of environmental policy (iMEP) degree through a program based at the Duke Kunshan University campus in Kunshan, China. Students enrolling at the Nicholas School also have the opportunity to seek concurrent degrees with The Fuqua School of Business (MBA), Duke Law School (JD), the Sanford School of Public Policy (MPP), the Pratt School of Engineering (MEMP), and the master of arts in teaching (MAT) through The Graduate School.

**Doctoral Degrees**

The traditional PhD, which is offered to Nicholas School students through The Graduate School, provides the opportunity for students to pursue in-depth interest in a more narrowly focused field in preparation for a career in teaching and/or research or in application-oriented settings. Doctoral students work with faculty in each of the Nicholas School’s three divisions: environmental sciences and policy, earth and ocean sciences, and marine science and conservation.

**Undergraduate Degrees**

The Nicholas School cooperates with the Trinity College of Arts & Sciences in awarding four undergraduate degrees: the AB in environmental sciences and policy, the BS in environmental sciences, and the BA and BS in earth and ocean science.
面临海洋生物和生物技术，海洋政策与管理。

环境科学与政策

该学院的化学、物理、社会科学工作致力于解决实际和基础环境问题。学院强调跨学科的方法，以解决环境问题。

海洋科学与保护

该学院的海洋科学与保护(MSC)致力于了解海洋环境系统的前沿。

位置

杜克大学坐落在北卡罗来纳州杜尔的263,000多人口的中央_phpometregion。位于杜克的阿巴拉契亚山脉距离杜尔大约100英里。

杜克大学马里恩实验室位于距离杜尔180英里东南方向的皮弗斯岛，紧邻历史悠久的皮弗斯岛和阿巴拉契亚山脉。

杜克大学成立于1938年，是环境科学与政策的高等教育和研究的先驱，也是美国第一所环境科学与政策的专业学校。学校的环境科学与政策课程得到了美国林学会的完全认可。
Piedmont North Carolina is characterized by a rolling, forested topography interspersed with small farms and rural communities in addition to the state’s largest cities. The climax forests of the piedmont are hardwoods; however, human disturbance has resulted in the establishment of many forests of native southern pines. To the west, the Appalachian Mountains contain magnificent hardwood forests, giving way to spruce-fir forests at higher elevations. The region hosts a large percentage of the rich biodiversity of the southeastern United States.

The coastal plain of North Carolina, well known for its agricultural production, is used extensively by many of the nation’s forest industries for plantations of native pines. Coastal wetlands and estuaries, now recognized as one of the nurseries of world fisheries, offer abundant and valuable natural resources. The barrier islands of North Carolina’s Outer Banks serve to protect these coastal waters. The rapidly increasing population and development in this region make proper management of its natural resources particularly important to the nation.

Because of the school’s central location near these regions of vital ecological importance and rapid human population growth, students are afforded the opportunity to study many current environmental problems in the field. Both the opportunity and the challenge exist to analyze these pressing problems and to develop sound approaches to their management.

History of Duke University

Duke University traces its roots to 1838 in nearby Randolph County, where local Methodist and Quaker communities joined forces to support a permanent school that they named Union Institute. After a brief period as Normal College (1851-59), the school changed its name to Trinity College in 1859 and became a liberal arts college affiliated with the Methodist Church. The college moved to the growing city of Durham in 1892 when Washington Duke provided financial assistance and another local businessman, Julian S. Carr, donated land. In December 1924, the trustees graciously accepted the provisions of James B. Duke’s indenture creating the family philanthropic foundation, The Duke Endowment, which provided for the expansion of Trinity College into Duke University.

As a result of the Duke gift, Trinity underwent both academic and physical expansion. The original Durham campus became known as East Campus when it was rebuilt in stately Georgian architecture. West Campus, Gothic in style and dominated by the soaring tower of the Duke Chapel, opened in 1930. In 1972, the men’s and women’s colleges merged into the Trinity College of Arts & Sciences. Academic expansion of the university throughout its history has also included the establishment of graduate and professional schools. Duke now is composed of ten schools, including The Graduate School, Duke Divinity School, the School of Medicine, the School of Nursing, the School of Law, the Pratt School of Engineering, The Fuqua School of Business, the Nicholas School of the Environment, and the Sanford School of Public Policy, along with international outposts, including one in Kunshan, China.

Today, Duke embraces a diverse community of learners, including approximately 7,000 undergraduates and 8,900 graduate and professional students from a multiplicity of backgrounds. For more historical information, visit https://library.duke.edu/rubenstein/uarchives.

Facilities

The Nicholas School of the Environment is headquartered in Grainger Hall at 9 Circuit Drive located on Duke’s West Campus and linked by a walkway to the A Wing of the Levine Science Research Center (LSRC), its former home. The 70,000-square-foot, five-story glass-and-concrete platinum LEED-certified building incorporates state-of-the-art green features and technologies inside and out. The hall houses five classrooms, a 105-seat auditorium, forty-five private offices, seventy-two open office spaces, a thirty-two-seat computer lab, an outdoor courtyard, and an environmental art gallery, as well as conference rooms, shared workrooms, and common areas. Green features range from rooftop solar panels and innovative climate control and water systems, to special windows that moderate light and heat, to an organic orchard and sustainably designed landscaping.

The divisions of Earth and Ocean Sciences (EOS) and Environmental Sciences and Policy (ESP) are housed across both Grainger Hall and the LSRC. EOS maintains state-of-the art facilities for geochemical analysis and climate modeling studies. ESP hosts extensive research facilities focusing on environmental health, including a new research laboratory in "environmental exposomics," an emerging scientific field that assesses the cumulative effects of environmental contaminants on human health. The LSRC A wing also houses Nicholas School student services.

Duke University Marine Laboratory is home to the third division of the Nicholas School, the Marine Science and Conservation division. Situated on Pivers Island on the coast of North Carolina, the Marine Lab is Duke’s coastal campus. Its facilities are described in detail later in this chapter.

Duke Forest

The Duke Forest comprises more than 7,000 acres of land in Alamance, Durham, and Orange counties and has been managed for teaching and research purposes since the early 1930s. A variety of ecosystems, forest cover types, plant species, soils, topography, and past land use conditions are represented within its boundaries. In terms of size, diversity, accessibility, and accumulated long-term data, the Duke Forest is a resource for studies related to forest ecosystems and the environment that is unmatched by any other university.

Academic use of the Duke Forest ranges from class instruction to long-term research projects and includes studies on vegetation composition, landscape ecology, remote sensing, invertebrate zoology, atmospheric science, and global climate change. A large volume of information is available to support teaching and research efforts including data on soils, topography, and forest inventory, as well as historic and current management records.

In addition to leading educational tours and field laboratory exercises, Duke Forest Staff are available to assist faculty, students, teachers, and researchers in project development—from site selection and logistics to utility hook-ups and stand management. To initiate or lead academic activities in the Duke Forest, please contact the Office of the Duke Forest at dukeforest@duke.edu. More information can also be found online at https://dukeforest.duke.edu/.
Duke University Marine Laboratory

General Information

The Duke University Marine Laboratory is a campus of Duke University and a unit within the Nicholas School of the Environment. The Division of Marine Science and Conservation (MSC) strives to be at the forefront of understanding marine environmental systems, their conservation, and their governance through leadership in research, training, and communication.

The Marine Laboratory campus serves year-round resident Duke faculty in the Division of Marine Science and Conservation who, together with research and administrative staff, provide training, educational, and research opportunities to about 2,500 people annually. Duke academic programs served by the Marine Laboratory campus include undergraduate students, graduate degree students, and doctoral students. Students and post-graduates from other colleges may enroll for one or more semesters or summer sessions. Visiting student groups use the Laboratory’s dormitory and laboratory facilities and scientists come from North America and across the globe to conduct research on the campus. A weekly seminar/lecture series features distinguished scientific speakers from across the nation and abroad.

Location and Natural Environment

The Marine Lab is situated on Pivers Island, near the historic town of Beaufort. Beaufort is the third-oldest town in North Carolina and is surrounded by fishing, agricultural, and leisure-tourism communities. The area is well known for its historic and scenic attractions as well as being a seaside resort. Cape Lookout National Seashore and the Rachel Carson Estuarine Research Reserve are within easy boating distance.

The laboratory is within range of both temperate and tropical species of marine biota. The edge of the Gulf Stream oscillates between thirty and forty miles offshore, with reefs on the wide continental shelf and habitat for marine vertebrates. The coastal region of North Carolina is a system of barrier islands, sounds, and estuaries rich in flora and fauna, and other diverse habitats, including rivers, creeks, mud flats, sand beaches, dunes, marshes, peat bogs, cypress swamps, bird islands, and coastal forests. It is a haven for both nature lovers and those interested in the pursuit of marine science.

Two other university laboratories, federal and state laboratories, plus a museum, and an aquarium in the Beaufort-Morehead City area collectively house one of the highest concentrations of marine scientists in the nation. These are the University of North Carolina’s Institute of Marine Sciences (IMS), the North Carolina University’s Center for Marine Science and Technology (CMAST), the North Carolina State University Seafood Laboratory, the National Oceanic and Atmospheric Administration’s (NOAA) Beaufort Laboratory, the North Carolina Divisions of Marine Fisheries and Coastal Management, the North Carolina Maritime Museum, and the North Carolina Aquarium at Pine Knoll Shores. This concentration of marine scientists provides a critical mass for the pursuit of science, conservation, and education.

Teaching and Research Facilities

The Marine Lab campus features dormitories, a dining hall, a student center, classrooms, laboratories, and research buildings. The Marguerite Kent Repass Ocean Conservation Center, the Marine Lab’s first LEED-certified building and Duke University’s second building
to receive a rating of LEED Platinum. The Orrin Pilkey Research Laboratory was dedicated in 2014 and provides the Marine Lab with a state-of-the-art space for studying molecular biology, genomics, marine microbes, and community ecology. The Pilkey Laboratory includes a conference room and a teaching lab where faculty and students can apply advanced genetic tools and techniques toward understanding marine systems and marine ecosystems. The Pilkey Laboratory was designed with sensitivity to the changing coastal environment-including site design utilizing prevailing winds and sunlight, geothermal heating and cooling systems, and recycled and regional materials—and is LEED Gold certified.

In addition to modern analytical facilities, the Marine Lab operates a variety of seawater systems and tanks for experimental work. The Marine Lab maintains modern computer facilities and IT services, including state-of-the-art video conferencing facilities. The Pearse Memorial Library at the Marine Lab is a component of the Duke University Library System. Computer and library facilities are described in further detail in the sections highlighting the Computer and Library Resources of the Nicholas School and Duke University. The Marine Lab features a new, fully equipped and state-of-the-art shared-use Marine Conservation Molecular Facility in the Bookhout Research Laboratory. This laboratory enables a range of genetic studies from genomics to populations genetics and forensics. In 2015, the Marine Lab opened the Marine Robotics and Remote Sensing Lab led by faculty member Dave Johnston. The new facility has enabled the Marine Lab to conduct cutting edge research around the globe, partner with other research facilities, and engage local school groups. The Marine Lab’s newest vessel, the R/V Shearwater will arrive in Fall 2019. The vessel will allow researchers and other institutions to conduct research along the Atlantic seaboard in a wide range of vital fields, including marine ecology and conservation, biological oceanography, and renewable ocean energy development. The mission of the vessel is research, education, and outreach. The lab also operates the R/V Richard T. Barber, a 30-foot aluminum vessel used mostly for nearshore and offshore faculty and student research; the R/V Kirby-Smith, a 28-foot Carolina Skiff with a capacity of eighteen passengers used mostly for student research and teaching; and a fleet of kayaks and canoes for research and teaching.

Computer Resources

The Nicholas School of the Environment’s Information Technology (IT) department provides IT support to students, faculty and staff in all divisions. Resources such as multipurpose classrooms, instructional and public computer labs, specialized software, data storage, scanners, and network printers are available at each location. The Nicholas School provides access to ArcGIS, ENVI, and Homer software, as well as software available through Duke’s Office of Information Technology, including Adobe Creative Cloud, NVivo, Matlab, Mathematics, Stata, and R. Windows laptops and tablets, conference phones, and digital projectors may be reserved for short-term loans.

The Nicholas School is unique with its daily interactions between the Durham campus and the Marine Lab campus in Beaufort. Therefore, video conferencing is a frequently employed tool, which enables faculty, staff, and students to remotely attend meetings and classes and collaborate effectively. The units range from ones that accommodate one or two people to full size technology enabled classrooms with multi-screen teleconferencing, which offer students global access to guest lecturers and professors.

Additional IT services used at the Nicholas School are provided by Duke support organizations, including the Office of Information Technology (OIT), Center for Instructional Technology (CIT), and Research Computing. Examples include: Physical and Virtual Computer Labs, Microsoft Office365 and Calendar, Sakai, Duke Capture, Duke Wiki, WordPress, site licensed software, and web conferencing. Duke also has a computer store located on West campus along with Duke Computer Repair only a couple of miles away.

For more information on resources for Duke students, see https://oit.duke.edu/.

Regional Resources

Research Triangle Park

Numerous industrial and governmental organizations have established research facilities in the Research Triangle Park, ten miles from the Duke campus. Government facilities include a major research laboratory of the Environmental Protection Agency, the Forestry Sciences Laboratory of the United States Forest Service, and the National Institute of Environmental Health Sciences (NIEHS). These laboratories provide opportunities for student research and internships in some of the nation’s most advanced research facilities.

Neighboring Universities

Through a reciprocal agreement, Duke students may supplement their education in forestry and the environmental sciences by taking courses in related fields at The University of North Carolina at Chapel Hill, North Carolina State University in Raleigh, and North Carolina Central University in Durham. Graduate students of Duke University and The University of North Carolina at Chapel Hill are granted library loan privileges in both universities.

Forest History Society

Founded in 1946, the Forest History Society is a nonprofit, nonadvocacy organization committed to balanced and objective investigations of human interaction with the forest environment. In 1984, it became affiliated with Duke University and moved its headquarters to Durham. The Forest History Society copublishes the quarterly journal Environmental History and maintains a large collection of archival materials, including records from the American Forestry Association, American Forest Institute, National Forest Products Association and the Society of American Foresters. These valuable resources and the services of the society’s reference staff are available to Nicholas School students. The society also provides the F. K. Weyerhaeuser Fellowship for a graduate student studying forest conservation history (see Financial Aid sections in chapters for professional degree and doctoral students in this bulletin) and cosponsors the Lynn W. Day Distinguished Lectureship in Forest & Conservation History with the Nicholas School and the Department of History. For more information, visit https://foresthistory.org/ or call (919) 682-9319.
The Carolina Population Center

The Carolina Population Center is a community of outstanding scholars who promote population research and education at The University of North Carolina at Chapel Hill. The CPC offers classes and seminars and supports its own library as well as an online catalog of resources. The Nicholas School collaborates with the Carolina Population Center as a member of its Integrative Graduate Education and Research Training (IGERT) grant from the National Science Foundation. For more information, visit https://www.cpc.unc.edu/.

Center for Sustainable Enterprise

Based at the Kenan-Flagler School of Business at The University of North Carolina at Chapel Hill, the Center for Sustainable Enterprise has provided over a decade of vision and impact, creating leaders for the world they envision and using business to innovate for global change. The CSE world class curriculum fourteen sustainability-related classes this fall, real-world applications, and relevant research help students and companies succeed with sustainable strategies. Nicholas School students with interests in business and the environment, industrial ecology and sustainable business practices frequently enroll in courses offered by this center. For more information, visit https://cse.unc.edu/.

Organization for Tropical Studies at Duke

The Organization for Tropical Studies (OTS) is a nonprofit consortium that has grown to include sixty-three universities and research institutions from the United States, Latin America, and Australia. In the early 1960’s, scientists from US universities forged working relationships with colleagues at the Universidad de Costa Rica in the interest of strengthening education and research in tropical biology. Intense interest both in the United States and Costa Rica led to the founding of OTS in 1963. OTS was founded to provide leadership in education, research, and the responsible use of natural resources in the tropics. To address this mission, OTS conducts graduate and undergraduate study abroad programs, facilitates scientific research, participates in tropical forest conservation, maintains three biological stations in Costa Rica, and another in Kruger National Park, South Africa. For more information, visit https://tropicalstudies.org/.

Campus Resources

Libraries

Duke University Libraries, which rank among the top ten private research libraries in the United States, include the libraries of the Perkins Library System—Perkins Library, Bostock Library, the Rubenstein Rare Book and Manuscript Library, Lilly Library, the Music Library, and the Marine Lab Library—and the libraries affiliated with Duke Divinity School, The Fuqua School of Business, Duke Law School, and the Medical Center. Duke University Libraries also include the Library Service Center (LSC), an off campus, state-of-the-art high density repository designed to maintain optimal temperature and humidity levels that has the capacity to store fifteen million volumes. Library patrons can search more than seven million volumes in the collection, as well as more than two million electronic resources, and print articles on demand or download them to their computer or smartphone. Through a single interface, they can search the catalogs of Triangle Research Libraries Network partners (The University of North Carolina at Chapel Hill, North Carolina State University, and North Carolina Central University) and have a book from the combined collection of more than fifteen million volumes delivered within twenty-four hours to Durham facilities. They can ask a Duke librarian a question from anywhere in the world by email, phone, or IM. Last year, Duke University librarians made 1,000 presentations to more than 15,000 students and answered more than 31,000 research inquiries in person, by phone, live chat, or IM.

The Pearse Memorial Library on the Beaufort campus of Duke University’s Marine Laboratory is a satellite branch of Duke’s Perkins Library System. It provides access to print and electronic resources that support interdisciplinary education and research with a primary focus on the marine environment. The library subscribes to a limited number of print research journals, has access to the full complement of journals in electronic format, and maintains holdings of approximately 3,500 titles. The Pearse Library connects electronically to the Duke University Library’s online catalog, providing access to holdings information and full-text e-resources, as well as its robust collection of full-text and citation databases. Pearse Library actively participates in interlibrary loan and document delivery services in cooperation with regional and national academic institutions and research centers.

Student Life

Housing

Most undergraduates live in dormitories on the Duke campus, and first-year undergraduates are required to do so. Dormitories are also available and required for undergraduate students attending the Duke University Marine Laboratory; graduate degree students usually live off campus. On-campus housing for graduate students is extremely limited so most graduate students in the Nicholas School of the Environment live off-campus. Housing is plentiful and varied, both in Durham and in Beaufort. The perimeter of the West Campus is densely developed with apartment complexes, and the East Campus is adjacent to a neighborhood of large, early 20th-century homes, some of which have been converted to apartments. Free and frequent bus service is available between the two campuses and between Duke and The University of North Carolina at Chapel Hill.

The Duke Off-Campus Housing Service maintains listings of apartment openings, house rentals, and roommates wanted. The off-campus housing service does not rate the quality of apartments, houses or landlords, nor does it arrange viewings. Similarly, the Nicholas School maintains an electronic bulletin board where students may list apartments and seek housing or roommates. The Office of Student Services sends housing information to all entering professional degree students in the late spring.
Services for Students

Student Disability Access Office

Duke University and the Nicholas School of the Environment are committed to equality of educational opportunities for qualified students with disabilities. The Student Disability Access Office (SDAO) is charged with the responsibility of exploring possible coverage and reasonable accommodations for undergraduate, graduate, and professional students for purposes of the Americans with Disabilities Act (ADA) of 1990 and Section 504 of the Rehabilitation Act of 1973. The mission of the Student Disability Access Office (SDAO) is to provide and coordinate accommodations, support services, and auxiliary aids for qualified students with disabilities.

Services and accommodations are provided to students with a variety of disabilities, including but not limited to attention deficit hyperactivity disorders, learning disabilities, psychological disabilities, or physical disabilities such as visual impairments, hearing impairments, chronic health disorders, and mobility impairments. Students who wish to be considered for reasonable accommodations at the Nicholas School must identify themselves to the Duke University Student Disability Access Office. A comprehensive website at https://access.duke.edu/students provides complete policy and procedural information for students requesting to be considered for reasonable accommodations.

For questions about documentation, eligibility, and accommodations, please contact the director of the Student Disability Access Office at 402 Oregon Street, Suite 102, Box 90142, Durham, NC 27708 or at (919) 668-1267. For information about specific Nicholas School program requirements, please contact Cynthia Peters, assistant dean, Student Services, Nicholas School of the Environment at Box 90330, Duke University, Durham, NC 27708 or at cynthia.peters@duke.edu at (919) 613-8071.

Communications

Upon entrance to the Nicholas School, each student is issued an email address. Email is recognized as an official means of communication within the university. Students are encouraged to check their Duke email frequently. While not official forms of communications, the school uses various social media as well as the school’s website to communicate announcements and other information relevant to students. Most faculty use Sakai to communicate information regarding their courses to the students enrolled in their courses.

Medical Care

The Duke Student Health Center, the primary care clinic for Duke students, is located in the new Student Wellness Center on Towerview Drive behind the Bryan University Center. The Duke Student Health Center is not a Walk-In Clinic and priority is given to students with scheduled appointments. For more information, visit https://studentaffairs.duke.edu/studenthealth. In addition to Student Health, the new building houses Counseling and Psychological Services and other services contributing to student wellness.

The student health fee is nonrefundable after the first day of classes. Students may be covered during the summer for an additional charge. Dependents and family members are not covered at any time.

The resources of the medical center are available to all students and their spouses and children. Charges for all services received from the medical center are the responsibility of the student, and students must carry health care insurance to cover these costs.

The university has a Student Medical Insurance Plan available for full-time students. Although participation in this plan is voluntary, the university expects all graduate students to be financially responsible for medical expenses above those covered by the student health service. Students who have medical insurance or wish to accept the financial responsibility for any medical expense may elect to join the Student Medical Insurance Plan by registering their insurance provider with the university online, through DukeHub. Each full-time student in residence must purchase Duke's student health insurance or indicate the alternative arrangement that is equal in coverage to Duke's plan. All F-1 and J-1 visa students must purchase the Duke plan.

The Student Medical Insurance Plan is in effect twenty-four hours a day during the twelve-month term of the policy. Students are covered on and off the campus, at home, while traveling, and during interim vacation periods. For additional fees, a student may obtain coverage for a spouse and children. The annual term of the policy begins on the opening day of classes each fall.

Coverage and services are subject to change as deemed necessary by the university.

Counseling and Psychological Services (CAPS)

CAPS provides a comprehensive range of counseling and psychological services to assist and promote the personal growth and development of Duke students. The professional staff is composed of clinical social workers, psychologists, and psychiatrists experienced in working with young adults. Among services provided are personal, social, and academic counseling. A number of short-term seminars or groups focusing on skills development and special interests such as coping with stress and tension, fostering assertiveness, enriching couples' communication, and dealing with separation and divorce are also offered.

A policy of strict confidentiality is maintained concerning each student's contact with the CAPS staff. Student health fees cover individual evaluation and brief counseling/therapy as well as skills development seminars. There are no additional charges to the student for these services.

Appointments may be made by calling (919) 660-1000 or visiting CAPS, Wellness Center, Towerview Drive. Walk-in appointments for first-time clients are available Monday through Friday between 9:00 AM and 3:00 PM during the academic year.

Career and Professional Development

The Nicholas School of the Environment operates its own Career and Professional Development Center (CPDC) for MEM, MF, and DEL-MEM students and alumni.

The professional staff in CPDC are leading career experts for the environmental and natural resource profession.

To help students maximize their career readiness, the center’s professional staff pledges to:

- Assist in developing a student’s personal career strategy;
- Help students refine and communicate career skills they possess and acquire new ones for career success;
- Assist in making connections with professionals and alumni in a student’s chosen field;
- Provide a variety of career experiences, tools, and resources.

For more information, visit https://nicholas.duke.edu/careers.
The University Career Center at Duke (https://studentaffairs.duke.edu/career) provides career services to Trinity College undergraduates and doctoral students in The Graduate School. The center’s goal is to assist with exploration of career options to post-graduation employment preparation and opportunities that match an individual’s special interests, training, and expertise gained from an undergraduate education or PhD credential. The Career Center has numerous services, resources, programs, and events to help students choose careers or further training and education.

International Advisor

The Duke University Visa Services Office handles governmental matters for students from abroad, including statements of attendance for home governments, issuance of United States immigration forms for reentry into the country after a temporary absence and required yearly extensions of time. Any new student who is not a citizen of the United States should report with passport to the international advisor immediately upon arrival. The Visa Services Office is located at Smith Warehouse, Bay 7, first floor.

Other Services

The Bryan Center houses an information desk, two drama theaters, a film theater, stores for books and supplies, meeting rooms, lounges, snack bars, and other facilities. A barbershop, hairdresser, postal services, and various bank ATMs are also located in the Bryan Center and in the nearby West Campus Union.

Student Activities and Organizations

Sports

Students are welcome to use recreational facilities such as the swimming pools, tennis courts, golf course, track, jogging course, handball and squash courts, gymnasiums, weight room, and playing fields. Intramural programs provide an opportunity to participate in informal and competitive physical activity. A variety of clubs for gymnastics, scuba diving, sailing, cycling, badminton, karate, rugby, soccer, and crew are also active. Students studying at the Duke Marine Laboratory in Beaufort, North Carolina will receive a free student membership to the local gym in Morehead City.

Cultural Activities

Concerts, recitals, lectures, plays, films, and dance programs are presented frequently on campus. Information on major events is available at Page Box Office or the Bryan Center information desk. The Nasher Museum of Art, located near West Campus, features an excellent permanent collection as well as popular visiting exhibitions.

Religious Services

Interdenominational services are conducted on Sunday mornings in Duke Chapel. Roman Catholic masses are offered daily on campus. Several Protestant denominations have student centers on campus. The Divinity School conducts other chapel services and religious and social activities. There is also a Hillel group that meets regularly, and the Freeman Center hosts Jewish student life activities. Duke is one of a very few academic institutions to have on staff a Muslim imam for the benefit of Muslim students.

Duke Environmental Law and Policy Forum (DELPF)

DELPF is a student-run publication, staffed by students from the Duke Law School, the Nicholas School and the Sanford School of Public Policy. New journal members, both JD and non-JD, are selected based upon their writing skills, research ability, and interest in both DELPF and environmental policy. The staff produce the biannual journal Duke Environmental Law and Policy Forum as an outlet for scholarly work in environmental law, policy, economics, and science. Recent issues of the journal have dealt with climate change, environmental justice, and land use.

Duke Environmental Leadership (DEL) Program

The Duke Environmental Leadership (DEL) Program at the Nicholas School of the Environment provides an online master’s degree and executive education courses to advance knowledge in environmental management topics. Residential MEM students have the opportunity to register for most DEL-MEM courses (900-999) during spring semesters. These courses are primarily held online and allow residential students the opportunity to study with mid-career environmental professionals in the DEL-MEM Program. Inquire about permission numbers and course logistics at nsoe-studentservices@duke.edu.

In addition, while executive education courses are intended for a professional audience, there are opportunities for students to participate in these offerings, per DEL policy guidelines and permission.

The DEL program offers paid student assistantships and/or work study opportunities for assisting in the social media and marketing projects, including graphic design work and possible video projects. Please contact the DEL office for more information and to volunteer with local schools at nsoe-studentservices@duke.edu.

Student Organizations

Nicholas School Chartered Groups

Nicholas School Student Council (NSSC) of the Nicholas School of the Environment is an advocate on behalf of professional students, representing the interests and concerns of these students to the Duke University and Nicholas School community. The NSSC is a group of elected and volunteer-appointed Masters of Environmental Management (MEM) and Masters of Forestry (MF) students that serves as an advisory body to the faculty and administration and provides a conduit between the student body, faculty, and administration. NSSC also coordinates the annual Earth Day and Field Day activities.

Nicholas PhD Advocacy Council (NPAC) is a group composed of peer-elected students from the Nicholas School-affiliated PhD programs (ENV, UPE, UPEP, MSC, TOX, EOS) which aims to represent and support the academic and professional interests of all Nicholas...
School-affiliated PhD students, while fostering a sense of community within the Nicholas School. NPAC aims to:
1. Strengthen professional and social relationships among students in Nicholas School-affiliated PhD programs (e.g., through professional development activities such as the Graduate Afternoon Seminar).
2. Advocate for the academic and professional interests of Nicholas School-affiliated PhD students.
3. Provide support to program administrators for PhD student needs (e.g., Nicholas School PhD student orientation).
4. Provide representation for Nicholas School-affiliated PhD students to other administrative and advocacy groups (e.g., Nicholas School faculty meetings, Duke Graduate and Professional Student Council).

**Social Groups**

**Diverse & Inclusive Community for the Environment (DICE)** fosters a welcoming community within the Nicholas School so that members of disenfranchised groups/communities will feel that they belong in the community. This means bridging gaps between peoples of various identities by both acknowledging their differences and also learning to recognize shared interests and experiences. DICE seeks to empower members of disenfranchised groups/communities to join the Nicholas School community. This means working with the Nicholas School administration and staff to increase the recruitment rates for students of different races, cultures, gender and sexual identities, levels of ability/disability, socioeconomic classes, countries of origin, religions, and ethnicities.

**Nicholas School Black & Latino Club (BLC)** is a student group providing a space to celebrate and educate the Nicholas School community on Black and Latino culture. It serves the needs of not only Black and Latino students but also any student, faculty, or staff member who wishes to engage in meaningful activities that build cultural, academic, and environmental awareness.

**Nicholas School Partners and Spouses (NicPartners)** exists to make students and their partners feel welcome at the Nicholas School and in the Duke community, to ease the transition process to Durham through social networking, to promote inclusion and diversity, and to strengthen the bond between families and the Nicholas School.

**Nicholas School Naturalists (NicNats)** is a natural history and outdoors club within the Nicholas School of Environment. Outdoor trips, which include hiking, backpacking, climbing, rafting, canoeing, birding, scuba diving, and more, are open to any graduate students within the Nicholas School.

**FOREM** is the official unofficial social organization of the Nicholas School. It is a social professional organization for all Nicholas School graduate students, faculty, and staff. The group’s purpose is to foster an environment in which students can balance their academic and social lives.

**Sustainable Oceans Alliance (SOA), Duke chapter,** strives to equip students who have a passion for ocean conservation with the tools to help make a change. Duke SOA aims to enhance the university’s ability to support the needs and interests of student who intend to pursue marine science and conservation, both educationally and professionally. SOA provides a forum for Duke students interested in marine science and conservation, education for the Duke community about opportunities in the marine sciences available at Duke and the Duke Marine Lab, and facilitation for those students wishing to study at the Duke Marine Lab.

**Environmental Internship Fund (EIF)** is an organization that raises money for summer internships. All the money goes directly back to students, with priority being given to those who help raise the funds.

**Nicholas School Energy Club (NSEC)** has a mission to educate Nicholas School students and the broader Duke community about energy issues and provide professional development opportunities in energy through networking events, field trips, socials, and conferences. NSEC coordinates activities with the Duke University Energy Initiative and partner energy clubs at the Fuqua School of Business and the Sanford School of Public Policy.

**Ocean Policy Working Group (OPWG)** is a graduate student organization that focuses on the political, economic, and cultural dimensions of human interactions with the ocean. The group brings together graduate and professional students from a variety of disciplinary backgrounds to consider the ways in which their areas of study influence perceptions of the ocean. In addition, the group’s biannual publication, *Upwelling*, is a great way for members, faculty, and alumni to showcase their policy work with the greater Duke community.

**Student Association for Geospatial Analysis (SAGA)** is a graduate student organization for students interested in developing and sharing skills related to geospatial analysis. The mission of SAGA is to provide the graduate students of Duke University with a resource to expand, explore, and build professional skills in the field of Geospatial Analysis. SAGA serves as an organization to inform students about emerging trends and techniques, as well as to develop skills not taught through Nicholas School curriculum.

**NSEC coordinates activities with the Duke University Energy Initiative and partner energy clubs at the Fuqua School of Business and the Sanford School of Public Policy.**
Duke Affiliates - Societies, Chapters, Clubs and Initiatives

African Environment Initiative (AEI) is a student organization with the goal of promoting greater interdisciplinary collaboration among the community of Duke researchers (from both the Nicholas School and other departments) working in Africa. The group seeks to act as liaisons between Nicholas School students and the diverse Africa-related programs (including the Duke Africa Initiative and the department of evolutionary anthropology) within Duke University.

Duke Chapter of American Fisheries Society (DukeFish) is the graduate student chapter of the American Fisheries Society (AFS) at Duke University. AFS is an international organization whose mission is to promote and improve the conservation and sustainability of fishery resources and aquatic ecosystems. It is the oldest and largest fisheries professional society, established in 1870. The group promotes sustainable fisheries and consumer practices by reaching out to our peers, community members, and local industries through education, outreach, and community participation.

Duke Conservation Society (DCS) is a student group focusing on contemporary conservation issues and solutions. The group covers a variety of fields and explores multiple forms of conservation including wildlife, land trusts, market-based, community-based, and policy-based among others. The group’s vision is to provide a resource for students and future conservationists in finding solutions to the natural world’s most pressing problems.

Duke Environmental Law and Policy Forum (DELPF) began in 1991 as an interdisciplinary magazine published annually. Since then, the Forum has grown into a traditional environmental law journal. DELPF has retained its interdisciplinary roots and presents scholarship that examines environmental issues by drawing on legal, scientific, economic, and public policy resources. DELPF’s affiliations with the Nicholas School for the Environment, the Sanford School of Public Policy, and the Law School render it uniquely positioned to adapt to the increasingly interdisciplinary nature of environmental law. DELPF is a student-run publication, with staff members from the Law School, the Nicholas School for the Environment, and the Sanford School of Public Policy. New journal members, both JD and non-JD, are selected based upon their writing skills, research ability, and interest in both DELPF and environmental policy.

Society of American Foresters (SAF), Duke Chapter, is the national scientific and educational organization representing the forestry profession. The Duke University Student SAF Chapter is a professional organization that facilitates student involvement in forestry at the local, regional, and national levels by promoting the forestry program at the Nicholas School, sustaining Duke’s relationship with other forestry schools, organizing both educational and community service events, and facilitating student attendance at SAF national conferences and meetings.

Duke Student Association of Wetland Scientists (SAWS) is a student-run organization dedicated to wetland ecology, restoration, and conservation at Duke University. The goal is to provide a meeting ground for graduate and non-graduate students interested in all aspects of wetlands. Activities include field trips, seminars, and volunteer events. The club works in coordination with the Duke University Wetlands Center.

Duke University Greening Initiative (DUGI) initiates and supports activities to help the Duke community move towards a more sustainable existence.

MEM/MBA Club is the home for concurrent MEM/MBA students and provides the key link between the Nicholas School and Fuqua School of Business. The club’s mission is to support students’ academic transition between two graduate programs, facilitate social cohesion, and encourage professional development through Duke’s unique hybrid education. The MEM/MBA program—both within Duke and externally through increased visibility and outreach to the Nicholas School of the Environment, The Fuqua School of Business, and the UNC Kenan-Flagler Business School—actively works with school administrations to streamline MEM/MBA academics and administrative processes.

Nicholas School Business and Environment Club - Net Impact (BEC-Net Impact) is the Nicholas School chapter of the national Net Impact organization. It is a networking and professional development club that connects Nicholas School students with environmental professionals in the private sector and provides access to resources for further business related education.

The Coastal Society (TCS) is an organization of private sector, academic, and government professionals and students. TCS is dedicated to actively addressing emerging coastal issues by fostering dialogue, forging partnerships, and promoting communication and education. The Duke University Student Chapter of TCS seeks to fulfill this mission of coastal stewardship through education and restoration.

Working Group on the Environment in Latin America (WGELA) is a collaborative effort between Duke University, the University of North Carolina, and North Carolina State University undergraduate and graduate students to promote a rich comprehension of environmental issues in Latin America through interdisciplinary collaboration. WGELA aims to foster a dialogue concerning critical environmental issues affecting Latin America. The group also seeks to improve the understanding of the social, historical, political, and cultural contexts in which these environmental issues are embedded, and build capacity among an interdisciplinary and cross-institutional group of individuals to address and conduct research on Latin American issues.
The Nicholas School of the Environment collaborates with the Trinity College of Arts & Sciences in awarding four undergraduate degrees: the bachelor of arts degree in environmental sciences and policy, the bachelor of science degree in environmental sciences, the bachelor of arts degree in earth and ocean sciences, and the bachelor of science degree in earth and ocean sciences.

In addition, minors are offered in both environmental sciences and policy and earth and ocean sciences. Courses for the majors and minors are taught by Nicholas School faculty and professors in cooperating departments and schools within Duke University. Information about these majors and minors is available through the undergraduate office in A106 LSRC (undergrad@nicholas.duke.edu) or through the program website, https://nicholas.duke.edu/academics/undergraduate-programs.

All applications for undergraduate studies at Duke University are submitted to the Office of Undergraduate Admissions, and admission is offered by Trinity College of Arts & Sciences or the Pratt School of Engineering. All applicants should contact the Office of Undergraduate Admissions or visit their website at https://admissions.duke.edu/.

Environmental Sciences and Policy (ENVIRON)

Prasad Kasibhatla, Director of Undergraduate Studies

Two majors are offered within the program, leading either to the bachelor of arts degree or the bachelor of science degree within Trinity College of Arts & Sciences. A concentration in marine science and conservation for majors and a minor in environmental sciences and policy are also offered.

Environmental Sciences and Policy (AB Degree)

The undergraduate major in environmental sciences and policy is offered as a bachelor of arts degree to students interested in the interdisciplinary study of environmental issues. The major draws from the breadth of perspectives from humanities, science and policy, while engaging students in an in-depth study in natural or social sciences. This major is designed for students with career objectives such as environmental law, policy, science, management, or planning that require in-depth understanding of environmental issues that cross disciplinary boundaries. The prerequisites for the AB degree stress a firm foundation in basic natural, environmental, and social science areas. The gateway course focuses on local, regional, and global case studies taught by interdisciplinary teams of faculty.

Students are required to participate in a relevant field experience or internship and many students choose to fulfill this requirement through study abroad, a semester at the Marine Lab, or the Stanback Internship Program. The program encourages all students to pursue independent research with Nicholas School faculty members.

Corequisites

The courses listed below or their equivalents (for example, Advanced Placement credit) are required. Approval to substitute courses taken at other universities must be obtained from the director of undergraduate studies in the department offering the course. Some of these courses are prerequisite to some upper-level courses in this major.

- Environment 102 (Introduction to Environmental Sciences and Policy)
- Biology 201L, 202L, or 203L (Gateway to Biology)
- Chemistry 101L or 110L (Advanced General Chemistry)
- Economics: Economics 101 (Economic Principles) or Political Science 145 (Introduction to Political Economy)
- Mathematics 111L (Introductory Calculus) or equivalent (e.g., Mathematics 105L and 106L)
- Statistical Science: Statistical Science 101, 102, 111, or 130; or Biology 304; or Sociology 333

Major Requirements

- Gateway Course: Environment 201 (Integrating Environmental Sciences and Policy)
- Topical Areas: One course in each of the following areas, chosen from a list of approved courses:
  - Environmental Humanities
  - Environmental Sciences
  - Environmental Policy
- Area of Specialization: Three courses in one of the following areas, one of these courses must be at the 500 level or above:
  - Environmental Social Sciences
  - Environmental Natural Sciences
- Capstone: Environment 495 (Senior Capstone Course). Participating in Graduation with Distinction (GWD) can fulfill this requirement.
- Field Experience or Internship: Students will complete a field experience or internship relevant to their major. The Duke Career Center maintains information on available internships. Field experiences may include a semester or summer session at the Duke University Marine Laboratory or participation in field-oriented study abroad programs. For a complete list of elective courses go to https://nicholas.duke.edu/academics/courses.

Environmental Sciences (BS Degree)

The undergraduate major in environmental sciences is offered as a bachelor of science degree to students interested in a scientific perspective on environmental issues. The major is designed to expose students to the breadth of environmental sciences, while engaging students to develop depth in a focus area. This major is designed for students with career objectives in environmental sciences, industry, or management that require a strong scientific background, or for students intending to pursue graduate degrees in environmental sciences. The major also merges well with premedical requirements. The
prerequisites for the BS degree stress a firm foundation in the physical and life sciences and mathematics. The gateway course focuses on local, regional, and global case studies taught by interdisciplinary teams of faculty. The major requirements include six core courses selected from five categories (environmental health, ecology, environmental physical sciences, environmental social science and environmental tools and skills). Students choose a focus area, in consultation with their major advisor, that can be incorporated into core course choices or include additional courses. Students are required to participate in a relevant field experience or internship and many students choose to fulfill this requirement through study abroad, a semester at the Marine Lab, or the Stanback Internship Program. The program encourages all students to pursue independent research with Nicholas School faculty members.

Corequisites
The courses listed below or their equivalents (for example, Advanced Placement credit) are required. Approval to substitute courses taken at other universities must be obtained from the director of undergraduate studies in the department offering the course. Some of these courses are prerequisites to upper-level courses in this major.

- Environment 102 (Introduction to Environmental Sciences and Policy)
- Biology 201L, 202L, or 203L (Gateway to Biology)
- Chemistry 101DL (Advanced General Chemistry) and either Chemistry 210DL or 210DL
- Physics 141L (Introductory Physics)
- Mathematics 111L and 112L (Introductory Calculus)

Major Requirements
- **Gateway Course:** Environment 201 (Integrating Environmental Sciences and Policy)
- **Six Core Courses,** at least one from each category, chosen from a list or approved courses:
  - Environmental Health
  - Ecology
  - Environmental Physical Sciences
  - Environmental Social Sciences
  - Environmental Tools/Skills
- **Focused Study Area:** Students are required to choose a focus area and take three courses, one at the 500 level. One of these courses can overlap the core courses or be taken in addition to the core courses. Focus areas will be chosen under the direction of the student’s major advisor and will be approved by the director of undergraduate studies upon successful submission of a short essay outlining the focus area and justifying the chosen courses.

**AB Degree with Concentration in Marine Science and Conservation (MSC)**

The Environmental Sciences and Policy Program also offers an AB degree with concentration in marine science and conservation. The prerequisite and gateway courses are the same as the AB degree in environmental sciences and policy. Students must choose at least one course in each of three topical areas (environmental humanities, marine conservation, and marine science) and must choose three courses in an area of specialization (marine science or marine conservation), including at least one independent study. Lists of courses satisfying the topical areas are maintained on the Duke Marine Lab website (https://nicholas.duke.edu/marinelab). Courses satisfying the area of specialization will be chosen in consultation with a major advisor and/or the Marine Lab director of undergraduate studies. Students seeking an AB degree with a concentration in marine science and conservation are required to spend at least one semester at the Marine Lab.

**BS Degree with Concentration in Marine Science and Conservation (MSC)**

The Environmental Sciences and Policy Program also offers a BS degree with concentration in marine science and conservation. The prerequisite and gateway courses are the same as the BS degree in environmental sciences and policy. Students must choose at least six courses in each of five core areas (marine ecology, conservation, organismal: structure/function, marine processes, and marine tools/skills). In addition, students must specialize in an area by completing three courses in that area, including at least one independent study. Lists of courses satisfying the topical areas are maintained on the Duke Marine Lab website (https://nicholas.duke.edu/marinelab). Courses satisfying the area of specialization will be chosen in consultation with a major advisor and/or the Marine Lab director of undergraduate studies. Students seeking a BS degree with a concentration in marine science and conservation are required to spend at least one semester at the Marine Lab.

**Minor in Environmental Sciences and Policy**

**Requirements:** Five courses: two core courses (Environment 102 and Environment 201); the remaining three courses selected from 200-level or above environment courses, which may include one substitution of a course in another department. Students with Advanced Placement credit must select an additional environment course in place of Environment 102 to equal five courses.

**Advising in Environmental Sciences and Policy**

Advisors are assigned based on students’ general areas of interest. Students present a proposed plan of study to their advisors that explains the rationale for their chosen area of concentration within their focused study. The program encourages close relationships between faculty and students with convergent interests.

**Graduation with Distinction**

The Environmental Sciences and Policy and Environmental Sciences programs both offer a Graduation with Distinction option. Interested students with a 3.0 grade point average overall and 3.2 grade point average in the environmental sciences/policy major should apply by the beginning of their senior year. The application should include a written request to the director of undergraduate studies.
describing the proposed research project, and identifying a primary faculty advisor who has agreed to supervise the research. Students are required to take one independent research study as part of the Graduation with Distinction process. Students will write a substantial paper describing their completed research, which is evaluated by the faculty advisor, and will make an oral presentation to students and faculty of the program before the end of classes of the student’s final semester. For additional information and an application form, contact the director of undergraduate programs or visit https://nicholas.duke.edu/academics/undergraduate-programs/graduation-distinction.

Earth and Ocean Sciences (EOS)

Emily Klein, Director of Undergraduate Studies; Alexander Glass, Co-Director of Undergraduate Studies

The Division of Earth and Ocean Sciences offers introductory and advanced courses in climatology, coastal processes, environmental geology, hydrology, geochemistry, geomorphology, oceanography, paleontology, petrology, marine geology, and energy. A bachelor of science degree is offered for those students wishing to pursue further studies in the earth and ocean sciences, and for those who intend to work professionally in earth sciences. A bachelor of arts degree is offered for those students who wish to understand more fully local and global environmental issues.

The majors are administered by the Nicholas School of the Environment. Additional information about the division can be found on the divisional website at https://nicholas.duke.edu/academics/undergraduate-programs/earth-ocean-sciences.

For the AB Degree

The AB degree in earth and ocean sciences is designed as a flexible major for those students interested in how the earth, atmosphere, and oceans work. The major is intended to provide a general knowledge of scientific issues that shape and control the environment in which humans live.

Corequisites

- Mathematics 105L and 106L, Mathematics 111, or Mathematics 122
- One course from two of the following subject areas (no more than one course per subject area):
  - Biology: Biology 201, 202, or 206
  - Chemistry: Chemistry 101DL or 110DL
  - Physics: Physics 141L or equivalent

Major Requirements

- Earth and Ocean Sciences 101 or 102
- Six earth and ocean sciences courses, of which five must be at or above the 200 level
- Three additional 200-level or higher courses in either earth and ocean sciences or related fields (biology, chemistry, environment, evolutionary anthropology, mathematics, physics, or statistical science), as approved by the director of undergraduate studies

For the BS Degree

The BS degree provides a background for subsequent graduate work for those who wish to follow an academic or professional career track in the earth and ocean sciences.

Prerequisites

- Earth and Ocean Sciences 101 and 102
- Chemistry 101DL and either Chemistry 210DL or 201DL, or equivalents
- Mathematics 111L and 112L
- Physics 141L
- Biology 202L

Major Requirements

- Four of the following five courses: Earth and Ocean Sciences 201L, 202, 203S, 204L, and 365
- Five additional earth and ocean sciences courses at the 200 level, including one field-oriented class. Up to two courses from a related field (biology, environment, evolutionary anthropology, mathematics, physics, or statistical science) may be substituted with the approval of the director of undergraduate studies.

Ocean Science

An exciting area in earth and ocean sciences is the study of the ocean realm. Majors in earth and ocean sciences may fulfill elective requirements with courses in marine science by studying at the Duke University Marine Laboratory on the coast in Beaufort, North Carolina, which often include fieldwork excursions to other areas of the world (e.g., Hawaii, Trinidad, Singapore). Approved courses include: marine ecology; biological oceanography; analysis of ocean ecosystems; marine invertebrate zoology (see full course listings at https://nicholas.duke.edu/marinelab/academics/courses). Students typically also perform a research independent study project on a topic of interest supervised by a faculty member of the Marine Lab.

Graduation with Distinction

The Division of Earth and Ocean Sciences through Trinity College offers Graduation with Distinction through successful completion of a student research project. A candidate for Graduation with Distinction in the Division of Earth and Ocean Sciences must have a divisional grade point average of 3.2 at the beginning of the project to qualify for nomination. The student will apply for consideration for Graduation with Distinction by the beginning of his or her senior academic year by submitting an application to the director of undergraduate studies...
The Marine Science and Conservation Leadership Program is rooted in marine science and conservation, but includes studies in a variety of disciplines—biology, earth and ocean sciences, economics, engineering, environmental sciences and policy, markets and management studies, philosophy, political science, public policy, religion, and theater studies. The introductory course on environmental sciences and policy introduces students to the integration of natural and social sciences and a means of evaluating an environmental issue and developing an effective solution. A capstone course is required of all students during the spring semester of their senior year.

Certificate Requirements

The certificate requirements are: 1) a total of six courses: one introductory course (Environment 102 or Environment 201 with permission, for students who place out of Environment 102), one leadership, ethics, management, or communication course, two marine science courses (one natural science and one social science), one marine conservation course, and one capstone course taken during spring of the senior year; 2) no more than three courses may originate in a single department; and 3) no more than two courses that are counted toward the marine science and conservation leadership certificate may also satisfy the requirements of any major, minor, or other certificate program. Appropriate courses may come from the list included on the certificate’s website, https://nicholas.duke.edu/academics/certificate-programs/marine-science-conservation-leadership-certificate, or may include other courses as approved by the director. Acceptance into the certificate program does not guarantee enrollment in electives, with the exception of the Capstone Course.

Program Enrollment

All students are eligible to enroll in the program. Enrollment must be done via the Marine Lab website at https://nicholas.duke.edu/marinelab/academics/undergraduate/enrollment.

Energy and the Environment

Emily M. Klein and Josiah Knight, Co-Directors

A certificate, but not a major, is available in this program.

The certificate in energy and the environment is designed to provide Duke undergraduates with an understanding of the breadth of issues that confront society in its need for clean, affordable, and reliable energy. An expertise in energy will expand the students’ career options in the private, nonprofit, government, and academic sectors. In addition to integrative core and capstone courses, the certificate will expose students to the three key disciplines in the study of energy and the environment: markets and policy; environmental impacts and resources; and energy technology. The goal of the certificate is to develop innovative thinkers and leaders who understand the energy system as a whole and the important interconnections among policy, markets, technology, and the environment. Energy use is a multifaceted problem, which draws upon the perspectives and expertise of a variety of disciplines. The certificate in energy and the environment is therefore similarly interdisciplinary.

Beyond traditional coursework, the certificate in energy and the environment will offer a variety of activities intended to provide students with a real-world perspective and hands-on experiences. These include field trips, guest speakers such as visiting executives and practitioners, research opportunities, and internships. Additional information may be obtained from the Undergraduate Programs Office for the Nicholas School and at https://nicholas.duke.edu/academics/certificate-programs/certificate-energy-environment.
Course of Study  
The certificate requires a total of six courses, no more than three of which may originate in a single department. No more than two courses counted toward the certificate in energy and the environment may also satisfy the requirements of any major, minor, or other certificate program. Advanced Placement credit may not fulfill certificate requirements.

Energy use is a multifaceted problem, which draws upon the perspectives and expertise of a variety of disciplines. The certificate in energy and the environment is therefore similarly interdisciplinary.

Certificate Requirements

• **Introductory Course:** Earth and Ocean Sciences/Environment/Energy 231 (Energy and the Environment)

• **Four Elective Courses:** Approved courses are listed below. One course in each of the following three areas plus one additional course from any area:
  - Markets and Policy
  - Environment
  - Energy Science and Technology

• **One Capstone Project Course (choose one):**
  - Energy 395/396 (Connections in Energy: Projects): Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore, and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the nonprofit sector. A team’s work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Instructor consent required.
  - Environment 452L (for Trinity students)/Engineering 424L (for Pratt students) (Energy and Environment Design): Teams of students explore the feasibility of a new or modified energy resource, technology, or approach. An integrative design course addressing both creative and practical aspects of the design of systems related to energy and the environment. With prior approval of the certificate codirector, this course may serve as the capstone project course if taken during the student’s junior or senior year. Alternatively, students may take the following as their fourth elective course for the certificate.

Electives

Four elective courses are required, with one from each area (markets and policy, environment, and energy science and technology) and one additional course from any of the three areas. These electives can be chosen from the list below. The most up-to-date version of the list can be found on the program’s website at [https://nicholas.duke.edu/academics/certificate-programs/certificate-energy-environment](https://nicholas.duke.edu/academics/certificate-programs/certificate-energy-environment).

**Markets and Policy**

Civil and Environmental Engineering  
315. Engineering Sustainable Design and the Global Community  
Economics  
325S. Economic Analysis of Current Energy Issues  
431S. Research Methods: Energy Markets/Environmental Impacts  
439. Economics of the Environment  

Environment  
212. United States Environmental Policy  
343S. Energy Futures and Environmental Justice  
390A. Environmental Conservation in Southeast Asia  
390A. Urban Tropical Ecology in Singapore  
577. Environmental Politics  
583S. Energy and US National Security  

German  
364S. Green Germany: World Leader in Environmental Policy  

Political Science  
145. Introduction to Political Economy  
344. Environmental Politics in the United States  
549S. Collective Action, Property Rights, and the Environment  

**Environment**

Chemistry  
91. Chemistry, Technology, and Society  
Civil and Environmental Engineering  
169K. Intro to Environmental Engineering and Science  
461L. Chemical Principles in Environmental Engineering  
462L. Biological Principles in Environmental Engineering  

Earth and Ocean Sciences  
202. Ocean and Atmosphere Dynamics  
351S. Global Environmental Change  
355. Global Warming  
364S. Changing Oceans  
511. The Climate System  
514. Energy and Ecology  
544S. Geoenengineering  

Environment  
102. Introduction to Environmental Sciences and Policy  
245. The Theory and Practice of Sustainability
Energy Science and Technology

Note: in selecting the elective course in energy science and technology, it is important to consider which course will provide optimal preparation for the student's capstone project course. Students should discuss their selection of this elective with a co-director of the program.

Chemistry
590. Special Topics in Chemistry

Electrical & Computer Engineering
496.01. Solar Cells
496.07. Introduction to Electrical Energy Conversion

Energy
310. Introduction to Energy Generation, Delivery, Conversion and Efficiency

Energy Engineering
490. Special Topics in Energy Engineering

Environment
630. Transportation and Energy
631. Energy Technology and Impact on the Environment

Mechanical Engineering and Materials Science
461. Energy Engineering and the Environment
490. Special Topics in Mechanical Engineering

Physics
137S. Energy in the 21st Century and Beyond

Sustainability Engagement

Charlotte Clark, Director

A certificate, but not a major, is available in this program.

The certificate in sustainability engagement is a customizable program for undergraduates designed to facilitate learning and research that confronts the interconnections between environmental, economic, and social aspects of sustainability. Through the sustainability engagement certificate, students will achieve a strong interdisciplinary understanding of sustainability by completing courses and experiences around a theme of their choosing. Students will have the opportunity to engage with faculty from every corner of campus and professionals across the globe. The expertise cultivated in the program will prepare students to join a multisectoral vanguard of professionals achieving a more sustainable future.

For more information see https://nicholas.duke.edu/academics/certificate-programs/certificate-sustainability-engagement.

Study at the Duke University Marine Laboratory

All undergraduate students at Duke, no matter what their major, have the opportunity to study at the Duke University Marine Laboratory in Beaufort, North Carolina. Academic programs include a fall semester, a spring semester and two five-week summer terms. The fall and spring semesters include Beaufort Signature Travel Courses with extended field trips to Puerto Rico or Ascension Island, Bahamas; the Gulf of California; and Panama. The academic programs integrate classroom lectures and laboratories with direct field and shipboard experiences. For more information, visit the Duke Marine Lab website at https://nicholas.duke.edu/marinelab.

A semester or summer term of coursework at the Marine Lab is a core requirement of the BS major in biology with a concentration in marine biology. For more information see https://biology.duke.edu/undergrad/requirements/concentrations/marine.html.

Financial Aid

The Duke Undergraduate Financial Aid Office handles all financial aid matters, and the Bulletin of Undergraduate Instruction includes information about scholarships available to Duke undergraduates as well as loans and tuition payment plans.

Marine Lab Scholarships

The following scholarships are available to undergraduates wishing to study at the Duke University Marine Laboratory.

Summer Tuition Scholarships

Duke Marine Lab Summer Tuition Scholarships are available to all students enrolled in marine science summer courses. The criteria used in review of scholarship applicants are academic excellence, scope of preparation, professional goals, and need. A student may receive only one summer tuition scholarship per summer. The precondition for review of a scholarship application is admission to a specific summer course. Admission to courses does not automatically imply award of a scholarship; separate reviews are conducted. Please contact the Duke Marine Lab Enrollment Office at ml_enrollment@nicholas.duke.edu to apply for a summer tuition scholarship. Applicants are required to submit a letter of recommendation from academic faculty and a brief statement of purpose, i.e., the reason for taking the particular course and demonstrate a need for the scholarship. Details are available online at https://nicholas.duke.edu/marinelab/academics/undergraduate/scholarships-financial-aid. Deadline is April 1.

Bookhout Research Scholarship

The Bookhout Research Scholarship is offered for students interested in research related to the invertebrate zoology of marine animals. Support includes a full tuition scholarship to take Research Independent Study during Summer Term 1 or Summer Term 2. A student may receive only one summer tuition scholarship per summer. The only requirement for the research project is that it involves some aspect of the biology of invertebrate animals. The scholarship recipients will be assigned to a faculty sponsor based upon their stated interests or the
recipients may request a specific faculty advisor. Details are available at https://nicholas.duke.edu/marinelab/academics/undergraduate/scholarships-financial-aid. Deadline is April 1.

Undergraduate Scholarships in Marine Science

Two scholarships are available during fall semester for non-Duke undergraduates covering tuition and fees, room and board, books, travel to Beaufort, and full support for participation in one Beaufort Signature Travel Course. Undergraduate scholars will enroll in Duke courses taught in Beaufort, where there is emphasis on the biology and physiology of marine organisms, marine molecular biology, marine policy, and coastal socio-ecological issues. Eligible students must be currently enrolled as a sophomore, junior, or senior in college (non-Duke) and be a US citizen or hold a permanent resident visa. Other factors considered in the evaluation process include whether an applicant identifies with a group that is racially/ethnically underrepresented in marine science; has demonstrated interest in marine science and its impact on society; anticipates pursuing a PhD in marine science; and submits a compelling personal statement and strong letters of recommendation. Details are available at https://nicholas.duke.edu/marinelab/academics/undergraduate/scholarships-financial-aid.

The Stanback Conservation Internship Program

The Nicholas School offers paid summer conservation internship opportunities to any currently enrolled Duke undergraduate student through the Stanback Conservation Internship Program. Made possible by the support of Mr. and Mrs. Fred Stanback, the program provides students with significant work experience in grassroots conservation, advocacy, applied resource management, or environmental policy. More information is available at https://nicholas.duke.edu/careers/students/stanback-fellowship-program.

Academic Recognition

The Sara LaBoskey Award is given annually by the Nicholas School to a graduating senior in environmental science/policy in recognition of personal integrity and academic excellence. The award was established by Vicki and Peter LaBoskey in memory of their daughter, Sara LaBoskey.

The Thomas V. Laska Memorial Award is given annually by the Division of Earth and Ocean Sciences of the Nicholas School to a graduating senior in recognition of outstanding achievement and promise for future success in earth and ocean sciences. The award was established by Andrew J. and Vera Laska in memory of their son, Thomas Vaclav Laska.
The Nicholas School of the Environment offers three professional graduate degrees—the master of environmental management, the master of forestry, and the international master of environmental policy—all of which prepare students for careers in a wide variety of employment settings, including government agencies, private industry, consulting, nonprofit organizations, and international organizations.

### The Distinction between Professional and Doctoral Degrees

Professional graduate programs such as the master of environmental management (MEM) (including the Duke Environmental Leadership Program), master of forestry (MF), and international master of environmental policy (iMEP) differ from traditional MS/PhD programs both in terms of the career goals of students and in terms of curricula. The MEM, MF, and iMEP equip graduates to begin or advance in a professional career related to environmental policy and management. Most MEM, MF, and iMEP graduates hold management and staff positions in which they are expected to compile, analyze, and interpret natural and social science data and then use the data to formulate a plan for action.

The MEM, MF, and iMEP curriculum reflects these employment goals. Coursework provides a strong scientific and analytical foundation for management-oriented decision making. A master’s project supplements the coursework by allowing students to demonstrate their organizational and analytical skills in solving an environmental management problem in their areas of specialization.

Although the MEM, MF, and iMEP degrees are not designed as precursors to the PhD, students who later choose to enter PhD programs are well prepared and suffer no disadvantage from taking a professional master’s degree first.

Students desiring to concentrate their study and research within a well-defined subject area and planning for careers primarily in university teaching and research are encouraged to pursue the doctoral (PhD) degree. Most Nicholas School faculty train doctoral students at Duke. Prospective PhD students should consult the chapter in this bulletin on doctoral degrees as well as the bulletin of The Graduate School of Duke University (https://registrar.duke.edu/university-bulletins/graduate-school). For more detailed information, visit The Graduate School website at https://gradschool.duke.edu.

### Professional Master’s Degrees

The master of environmental management degree is designed to help students develop the professional management skills required to confront challenges at the intersection of the natural environment and society. MEM degree candidates choose one of these programs of study:

- Business and Environment
- Coastal Environmental Management
- Ecosystem Science and Conservation
- Ecotoxicology and Environmental Health
- Energy and Environment
- Environmental Economics and Policy
- Water Resources Management

Students pursuing the master of forestry (MF) focus their studies on sustainable forest management. The MF is accredited by the Society of American Foresters.

The Nicholas School of the Environment and the Sanford School of Public Policy collaborate to offer a two-year international Master of Environmental Policy (iMEP) Program based at the Duke Kunshan University campus in Kunshan, China. Duke Kunshan's iMEP Program prepares its graduates to meet the pressing environmental and economic challenges facing the international community through effective policy solutions by drawing from an array of disciplines.

The Duke Environmental Leadership (DEL) Program also offers a master of environmental management degree for mid-career environmental professionals (DEL-MEM). This program is primarily taught via a combination of distance and place-based, in-person learning. It requires students to attend five place-based sessions over the course of study. Applicants for the DEL-MEM Program must have a minimum of five years of relevant professional environmentally-related experience. Students who successfully complete the DEL-MEM Program are awarded the master of environmental management degree. Specific program requirements can be found below.

### Program Requirements

Each of the Nicholas School's professional programs requires the completion of 48.0 course credits (please see the section on Special Tracks for Practicing Professionals – Duke Environmental Leadership—Master of Environmental Management below for specific program requirements related to the master of environmental management degree offered through the Duke Environmental Leadership Program). These units are distributed among a set of courses required by each program listed above: core courses, quantitative courses, electives, tools, a master’s project, and seminars relevant to the program's objectives. More specific information about requirements for any one of the programs may be obtained from the Office of Student Services.

Courses below the 500 level may not be applied toward the required credits needed for a post-baccalaureate degree. Students wishing to take courses below the 500 level may do so but these courses do not count toward the degree nor can they be used to fulfill program requirements. Students must be enrolled in a full course load (at least 9.0 course credits for on-campus students) before adding a course below the 500 level. Students who choose to take a course below 500 may do so for a grade in order to demonstrate to a potential employer the extent of their knowledge acquired in a particular course, but the course will not count toward program or degree requirements.
Prerequisites

All programs require a semester each of college calculus and applied statistics as prerequisites. Most programs require additional prerequisites, as described later in this chapter. Any course submitted in fulfillment of a prerequisite must be taken for graded credit, a final grade of at least a B- must be earned and the course must be submitted on an official transcript from the accredited institution where the course was taken.

Major (Core) Courses

Each program requires a series of core courses that provide essential background training relevant to the program’s objectives, as outlined in the program descriptions below. All students are required to complete successfully the one credit 800-level ENVIRON course in communications and writing a master’s project during the program.

Quantitative and Analytical Courses

All programs require 6.0 to 12.0 course credits stressing quantitative and analytical methods.

Elective Courses

Elective courses are available to give the student flexibility in developing his or her course of study. Most programs use some of these courses to add depth to the major area of study or to develop a second area of expertise. Students who select the Environmental Economics and Policy Program must use at least three of their elective courses to broaden their understanding of environmental science.

Master's Project

A master’s project constituting 4.0 to 6.0 course credits is required. These projects take the form of individual or small-group analysis of a problem in natural resource management, offering alternative solutions for better management of the environment. Many master’s projects are conducted for a client. The results of the master’s project are presented orally in a symposium held near the end of each semester and in a written document that is presented to the student’s advisor before graduation and uploaded into a world-wide searchable database.

Seminars

All students are required to participate in seminars in their program area each semester that results in a total of one unit of credit at the end of their program. These seminars prepare students for the master’s project and other activities.

Certificates

Certificate programs allow students to achieve an area of special expertise by completing a series of courses and projects. At present, the Nicholas School offers certificates in geospatial analysis, environmental entrepreneurship and innovation, climate change science and applications, and in community-based environmental management. In addition, Nicholas School students sometimes complete certificate programs in other schools or departments, such as the International Development Policy certificate offered by the Sanford School of Public Policy or the Latin American and Caribbean Studies certificate through the Duke Center for Latin American and Caribbean Studies.

Experiential Learning

The professional Master of Environmental Management (MEM), Master of Forestry (MF) and Duke Environmental Leadership (DEL-MEM) programs are applied and experiential in nature. As such, many courses will include field and/or travel activities that carry inherent risks. Such field and/or travel activities are an important component of the educational experience. Activities may include day or overnight trips to sites—such as forests, streams, mountains, beaches, coastal areas, islands, the ocean, urban or rural environments—to learn about and enjoy the outdoor world or to gain valuable practical, job-related experiences related to the student’s education. A description of the courses with travel components can be found at https://nicholas.duke.edu/academics/courses/travel-courses or https://nicholas.duke.edu/marinelab/academics/courses/travel-courses-marine-lab. The university registrar is in the process of updating field and/or travel requirements in DukeHub. As this is a work in progress, students are encouraged to review the websites above for more details. Faculty will also provide information to students about field components for their courses during class. Participation for some courses is mandatory for course credit and will be noted in the syllabus or course description. Students should ensure they have a solid understanding of course expectations, risks and additional costs associated with travel and/or fieldwork before the end of the Drop/Add period so that they have time to consider the risks and take appropriate action as needed.

Professional Skills Development

A modest matching fund is available to help students defray the cost of skills training offered outside the school, such as the certificate in nonprofit management offered by the Duke Continuing Studies department.

Professional Programs

Business and Environment

The Business and Environment (BE) Program provides students with training on the challenges that private sector organizations face in engaging with the natural environment. Students learn about business organization, the fundamentals of finance, and how multinational firms and small and medium enterprises address environmental, economic, and social sustainability imperatives. The BE curriculum enables students to customize their educational experience to meet their interests and career goals, whether they involve a focus on supply chains, natural resource finance, compliance, consulting, strategy or product innovation.
Students take a series of required and elective courses to gain foundations to incorporate analytical tools to evaluate environmental and economic trade-offs of both organizational and technological innovations. Students also gain hands-on experience through client-based consulting projects. These projects leverage tools such as financial, strategic and life-cycle analysis in preparation for a career focused on the unique role businesses play with respect to the environment.

Prerequisites: calculus, statistics, and microeconomics (or general economics that focuses on microeconomics rather than macroeconomics) required.

For more detailed information about this program, including specific prerequisites and degree requirements, see https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/business-environment.

**Coastal Environmental Management**

The Coastal Environmental Management (CEM) Program provides a scientifically rigorous understanding of global, national, and local physical and biological coastal environments and processes and the human behaviors and policies that affect, and are affected by, those environments and processes. The specific aim of the program is to train scientifically informed professionals to fill coastal policy and management, research or advocacy positions in federal, state, and local agencies, industry, consulting firms, and nonprofit organizations. The program also provides a firm foundation for future PhD studies.

The first year of the program is spent on the Durham campus fulfilling the required courses in areas such as natural resource economics, general environmental policy, ecology, oceanoography, and methodological skills. The second year is usually spent in residence at the Marine Lab in Beaufort, taking courses in the natural, social, and policy sciences specific to the coastal and marine environment, and focusing on the production of the master’s project. The Marine Lab provides an ideal setting for the study of natural and social scientific phenomena associated with coastal and marine environments, and for interaction with coastal and marine constituencies and policymakers in the application of science to policy. Potential opportunities for participation in the policymaking process are emphasized throughout the program.

**Prerequisites:** calculus, statistics, introductory microeconomics (or general economics that focuses on microeconomics rather than macroeconomics) required.

For more detailed information about this program, including specific prerequisites and degree requirements, visit https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/coastal-environmental-management.

**Ecosystem Science and Conservation**

The Nicholas School offers one overarching ecological program, Ecosystem Science and Conservation (ESC), that focuses on the natural science, policy, and management issues that relate to the stewardship of natural resources. Conservation and ecosystem science are becoming ever more integrated as conservation planning moves to increasingly larger scales and addresses a wider range of resources, from biodiversity to watershed function. For curriculum planning purposes, the program is defined to provide a diversity of alternative perspectives on natural resource ecology and management. The defining feature of the program is a two-dimensional structure, consisting of a focal concentration area and an approach. The concentration defines a topical area or disciplinary specialization. The approach defines a methodological perspective and tool kit. In combination, these choices define a career track and a planning matrix for coursework and research experience for the MEM degree.

**Prerequisites:** calculus, statistics, and principles of ecology required; and, for some course work, introductory microeconomics (or general economics that focuses on microeconomics rather than macroeconomics); while not a program requirement, some ESC students choose to take the economics courses (ENVIRON 520 and 521) for which microeconomics is a required prerequisite.

For more detailed information about this program, including specific prerequisites and degree requirements, see https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/ecosystem-science-conservation.

**Ecotoxicology and Environmental Health**

The Program in Ecotoxicology and Environmental Health (EEH) emphasizes interactions among human/environmental health and ecological processes. The concentration is concerned with the fates, effects, and risks of pollutants to natural ecosystems and human users of those systems both within the United States and internationally. A multidisciplinary program, EEH incorporates the concepts, information bases, and methodologies of toxicology, environmental chemistry, risk assessment, and ecology. This program stresses risk assessment attendant to actions/processes that affect human/environmental health and provides a scientific approach to environmental management. By instilling in the student a science-based approach combining integrated assessment for humans, biota, and natural resources, EEH seeks to produce scientists and environmental managers with a solid foundation in the principles underlying pollutant fates and impacts on ecology and environmental health, as well as a firm grasp of state-of-the-art approaches for evaluating specific instances of environmental contamination and for making management decisions based upon quantitative analysis.

**Prerequisites:** calculus, statistics, and chemistry required; organic chemistry and ecology recommended.

For more detailed information about this program, including specific prerequisites and degree requirements, see https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/ecotoxicology-environmental-health.

**Energy and Environment**

The Energy and Environment (EE) Program aims to provide students with the skills and knowledge necessary to effectively address energy and environmental challenges. Over the course of the program, students will gain a broad perspective on the current energy system and future alternatives; a fundamental understanding of science and technology as it relates to energy and environment; background in the economics, policy and business of energy; first-hand exposure to the energy sector and energy leaders; critical skills in data analysis and modeling; and experience with communication, facilitation, project management, and teamwork.

Energy use is one of the most complex and multi-faceted problems influencing the future of the environment. Students wishing to complete the energy and environment concentration will need to complete coursework that addresses energy across multiple disciplines, covering science and technology, economics, business, policy, and law. The concentration is organized along four broad themes: science and
technology, markets and policy, tools, and energy electives. The curriculum requires students to take a core course, courses in science and technology; markets and policy; tools; energy and general electives; and the master’s seminar and project.  

**Prerequisites:** calculus, statistics, and introductory microeconomics (or general economics that focuses on microeconomics rather than macroeconomics) required.

For more detailed information about this program, including specific prerequisites and degree requirements, see [https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/energy-environment](https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/energy-environment).

Environmental Economics and Policy

The Environmental Economics and Policy (EEP) Program is designed to train decision-makers, those who offer them expert advice, and those who try to influence policy through the political process. The program emphasizes the basic methods needed for analyzing how households and businesses react to existing and proposed environmental and resource policies. The program is highly analytical and is oriented toward the analysis of contemporary national and international environmental problems.

Understanding the effects of markets and institutions on people and the environment requires mastery of three broad areas of knowledge: the basic sciences pertaining to a natural resource or an environmental phenomenon; the relevant disciplines in the social sciences; and the quantitative and qualitative tools required for using knowledge from the physical, biological, and social sciences to arrive at informed decisions. Students choose one of three areas of emphasis: environmental policy analysis, environmental and resource economics, or business and the environment. Four major elective courses and three quantitative courses support the area of emphasis. Three science courses develop a resource area for applying social science analysis, e.g., conservation or water resources.

**Prerequisites:** calculus, statistics, and microeconomics (or general economics that focuses on microeconomics rather than macroeconomics) required.

For more detailed information about this program, including specific prerequisites and degree requirements, see [https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/environmental-economics-policy](https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/environmental-economics-policy).

Global Environmental Change

Students wishing to increase their expertise in climate change may pursue a newly designed certificate in Climate Change Science and Applications to complement their primary concentration. Students who enrolled as GEC students in Fall 2018 may continue in this program area; no new students will be admitted for Fall 2019 and later.

Water Resources Management

The Program in Water Resources Management (WRM) enables students to understand the physical, chemical, and biological processes—as well as the social contexts—affecting freshwater environments. The program concentrates on problems that span the natural divisions of the biosphere, soil, plants, lakes, watersheds, groundwater, and the atmosphere, and teaches quantitative techniques, including measurement and modeling methods used by environmental managers.

The core coursework and training in the WRM Program cover basic physical, chemical, and biological processes relevant to hydrologic sciences, methods of quantitative and statistical analysis, and methods of management and decision-making. Quantitative analysis techniques include mathematical and statistical methods, probabilistic and deterministic models, spatial analysis and modeling, and optimization and simulation methods. Methods for assessing human beliefs, attitudes and behavior, including survey design and analysis, and qualitative methods for analyzing documents and interview transcripts are also useful for water resources management.

Graduates of the program will acquire the skills required to practice as analysts, consultants, regulators, or entrepreneurs concerned with the management and protection of water resources. These employers include government agencies, public utilities, consulting firms, fuel and resource extraction companies, and hydrologic, atmospheric, or environmental research centers, and not-for-profit organizations. Within the WRM Program, students can use their course selection to develop expertise toward a career in: Water Science, Water Management, and International Water.

**Prerequisites:** calculus and statistics required; microeconomics (not required for WRM but required for ENVIRON 520: Resource and Environmental Economics, a popular course for WRM students); introductory physics and chemistry recommended.

For more detailed information about this program, including specific prerequisites and degree requirements, see [https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/water-resources-management](https://nicholas.duke.edu/academics/masters-programs/master-environmental-management/water-resources-management).

Master of Forestry

The Master of Forestry degree integrates forest ecology and management within an educational program that emphasizes related environmental fields. The program builds knowledge in basic forest ecology and ecological management of forests for a variety of uses, including nontraditional forest products and conservation. This distinctive approach is brought about by coordinating a core set of forestry courses in sampling, measurement, dendrology, silviculture and ecology—combined with electives in resource-oriented courses (such as soils, hydrology, air quality, water quality, biological conservation, and physiology); statistical analysis and modeling; and resource economics and policy. The Duke Forest serves as an outdoor laboratory in many of these courses.

The focus of the Master of Forestry is problem solving in complex ecological and management systems. Within the program, students may acquire skills that qualify them for positions in industry, conservation organizations, government agencies, nonprofit organizations, and other groups involved with the use and conservation of forests. The MF Program is accredited by the Society of American Foresters, which is recognized by the Council on Higher Education Accreditation as the specialized accrediting body for forestry educational programs in the United States. Students can develop additional credentials for employment by concurrently completing the MF degree and a master of environmental management degree in the Nicholas School of the Environment or other concurrent degree programs (i.e., business, law, or public policy) at Duke, as described in the section that follows.

**Prerequisites:** statistics, calculus, principles of ecology, and microeconomics (or general economics that focuses on microeconomics rather than macroeconomics) required.
Duke Environmental Leadership Master of Environmental Management

The Duke Environmental Leadership Master of Environmental Management (DEL-MEM) focuses on leadership and is designed for mid-career professionals. The DEL-MEM Program's unique combination online and place-based format makes it feasible for professionals to pursue the degree while working full-time and maintaining a commitment to job and family.

The DEL-MEM is a two-year, four-semester, thirty-course-credit program designed for mid-career professionals with a minimum of five years of environmentally-related experience. The DEL-MEM focuses on interdisciplinary and global themes, strategic approaches to environmental management, communication, and effective leadership. The DEL-MEM degree is offered primarily via distance-learning technologies, and is complemented with five short place-based sessions.

Program Format

The DEL-MEM combines distance-learning courses and short, intensive on-campus sessions. The five required on-campus sessions give participants an opportunity to experience the campus environment, meet fellow MEM students, interact directly with faculty, and participate in leadership development activities. Including orientation, students are required to come to the Duke campus five times during their studies. One of these sessions includes the hallmark DC Leadership Module in which students convene in Washington, DC, and meet with prominent leaders in all sectors. Between campus visits, and to complement the face-to-face sessions, students complete individual and group coursework online through web-conferences, discussion boards, Skype, email, and other advanced interactive technologies.

Prerequisites. Five years of professional environmentally-related experience is a prerequisite for the program. No specific courses are required to apply.

Major (Core) Courses. Core courses are offered in ecosystems science and management, making environmental decisions, economics of environmental management, environmental law and policy, and program management for environmental professionals. Other required components include: five place-based intensive sessions (varying from three to six days), a professional writing skills course for first-year students, and a master’s project.

Elective Courses. Elective courses, developed around more specialized themes, are offered in the spring semesters and alternate each year. Independent studies and projects and one-credit intensive short courses may also be taken.

Master’s Project. A master’s project constituting 4.0 course credits is required. These projects take the form of individual or small-group analysis of a problem in natural resource management, offering alternative solutions for better management of the environment. A project related to the student's current employment is recommended, but not required. The results of the master’s project are presented orally on campus and in a written document that is approved by the student's advisor before graduation.

DEL-MEM students have the option to complete a capstone project as an alternative to the traditional master’s project. Students will propose a Capstone Pathway and provide a detailed explanation why this choice meets their master’s project goals. A final leadership capstone project will integrate all DEL leadership sessions, particularly the DC leadership seminar, capstone courses, and interviews. The capstone project is not limited to an academic paper. An interview protocol will be developed to ensure thoughtful conversations around issues of leadership in which the student has an interest. The capstone must be a rigorous experience, integrating coursework, outreach, and reflection.

For more details on curriculum requirements, see https://nicholas.duke.edu/academics/masters-programs/duke-environmental-leadership-master-environmental-management.

Contact Information

For more information about the DEL-MEM Program, contact admissions@nicholas.duke.edu or (919) 613-8070 or visit https://nicholas.duke.edu/academics/masters-programs/duke-environmental-leadership-master-environmental-management.

International Master of Environmental Policy

The Sanford School of Public Policy and the Nicholas School offer a two-year International Master of Environmental Policy (iMEP) Program based at the Duke Kunshan University campus in Kunshan, China. The iMEP Program offers a highly analytical and multidisciplinary master’s degree based on the Duke Master of Public Policy (MPP) and Master of Environmental Management (MEM) programs. With an emphasis on both international and Chinese experience and contexts, the iMEP combines a world-class faculty, a cutting-edge research center, an innovative curriculum, and unparalleled career opportunities.

Duke Kunshan University’s iMEP Program prepares its graduates to meet the pressing environmental and economic challenges facing the international community through effective policy solutions by drawing from an array of disciplines. The core curriculum combines economics, science, law and governance, policy, and program evaluation. The program is four semesters and includes sixteen courses for a total of 48.0 graduate course credits. The program allows Duke Kunshan University students to spend their third semester at Duke. In their second year, iMEP students complete a client-based or quantitative research master’s project in partnership with an academic advisor.

The iMEP Program simultaneously creates a one-semester study away opportunity for Sanford MPP/MIDP and NSOE MEM/MF students, who may travel to Duke Kunshan University in their third semester. Duke and Duke Kunshan faculty may participate in a similar exchange.

International Master of Environmental Policy (iMEP), Duke Kunshan University Faculty

Junjie Zhang: Director, Associate Professor
PhD (Environmental and Resource Economics), Duke University, 2008

John Ji: Associate Director, Assistant Professor
ScD (Environmental Health), Harvard University, 2013

Jackson Ewing: Faculty Lead, Associate Professor, Sanford School; Senior Fellow, Nicholas Institute for Environmental Policy Solutions, Duke University
PhD (Environmental Security), Bond University (Australia), 2010
Binbin Li: Assistant Professor  
PhD (Conservation Biology), Duke University, 2017

Kathinka Fürst: Assistant Adjunct Professor, Associate Director, Environmental Research Center  
PhD (Environmental Governance), University of Amsterdam, 2016

Moon Joon Kim: Visiting Assistant Professor  
PhD (Economics), North Carolina State University, 2017

Coraline Goron: Assistant Professor  
PhD (Political Science), Université Libre de Bruxelles, 2017

Program Requirements

The curriculum for the iMEP degree consists of sixteen courses (48.0 course credits) spread out over two years.

Core Courses: Students are required to take seven core courses (21.0 course credits) so as to ensure quality and consistency in the degree.

Electives: There is some flexibility with the seven elective courses (21.0 course credits) so as to allow students to pursue particular environmental policy and resource issues as well as enhance their methodological skills.

The curriculum includes:
- Two-week Boot Camp the summer prior to first semester;
- Seven core courses (21.0 course credits);
- Seven elective courses (21.0 course credits);
- Two MP courses (6.0 course credits); and
- Summer internship between first and second year.

Prerequisites: The program includes a statistics and economics prerequisite. Students are required to take two examinations prior to enrollment to ensure that they have the appropriate skills in statistics and economics. If the student does not pass the examination, they will take an online class prior to enrollment and take refresher courses during the two-week Boot Camp the summer before their first semester.

This program also administers an English reading and writing examination prior to enrollment. Because iMEP is an English-only program, students will be screened for language before they can enroll. Students who need additional support in writing will be required to enroll in one of the English-language courses offered through the writing program at Duke Kunshan University (in addition to their 48.0 course credits).

Language and Culture Center Courses

For students whose native language is not Chinese, the Language and Culture Center at Duke Kunshan University provides different levels of Chinese courses. Chinese coursework is entirely optional, does not confer credit, and must be taken in addition to the required coursework. In addition to a weekly introductory course for graduate students, independent language study with a support coach is available for students with some previous Chinese experience.

Withdrawal from a Course

If a course must be dropped after the official Drop/Add period ends for a given semester, the student must formally withdraw from the course by contacting Duke Kunshan University registrar Lingling Wang (lingling.wang@dku.edu.cn). All withdrawals will be noted on the student’s record with a grade of W (withdrew from course).

Master’s Project Capstone

The master’s project (MP) is a 15-25 page single-spaced paper, policy memo, or journal article required of all masters students in the iMEP Program. Two types of projects are possible: a project for an actual client that involves a variety of methodological approaches (Client-based), or a project based on quantitative methods that may or may not have an actual client (research-based). Hybrids of these projects are also possible. Students are encouraged to build their projects from their summer internships where possible and to deepen their policy-area expertise by taking appropriate elective courses.

Research-Based Projects. This type of MP closely resembles a thesis. Research MPs follow the standard format for scientific research—abstract, introduction, methods, results, and discussion—and introduce a brand new idea or theory, and may involve original field data collection. Working with the MP advisor, the student needs to follow scientific methods in their topic area. The research topic must be relevant to environmental policy, and involve rigorous quantitative and/or qualitative methodology. If analysis involves using data with human subjects, then students may need the Duke Kunshan University IRB to review and approve their protocol. Research MPs should be of publishable quality, although they do not need to be published.

Client-Based Projects. This type of MP is designed to help a client decide what to do about an environmental policy problem. The purpose is to recommend a specific course of action. The project could follow from the summer internship, or an organization that the student would like to work with in the future. The student will conduct initial research into a general policy problem, then conduct relevant research to identify the specific policy problem. To be approved as an MP topic, the client must have a significant policy problem posed in the form of “What should the client do?” Students are encouraged to turn their MP into a case study for teaching purposes.

Grading of the MP. The MP committee consists of the MP advisor and a rotating group of faculty in the iMEP Program. The committee shall discuss the MP and form a consensus on one of the following marks: pass or fail.

For more detailed information about this program, see https://nicholas.duke.edu/academics/masters-programs/international-master-environmental-policy.

Concurrent Degrees

The most current information on all concurrent degree programs can be found at https://nicholas.duke.edu/academics/masters-programs/concurrent-degree-programs. In general, the Nicholas School works with the partner school to coordinate enrollments between the two schools. Students must apply to and be admitted by each school, and each school makes its own admission decisions. Typically, each school agrees to reduce by one semester the number of credits a student must earn, and the student agrees to tie the two degrees together.
so that the student may not earn one degree without the other.

Financial aid for concurrent degree students will be adjusted to take into account the reduction in required semesters of enrollment and credits needed. Students pursuing or interested in pursuing a concurrent degree should consult with the financial aid counselor for the Nicholas School for details particular to their specific concurrent degree program.

**Master of Environmental Management and Master of Forestry**

With careful planning of their curriculum, students can earn both the MEM and the MF degrees concurrently. The requirements for earning both degrees are as follows:

- The student must qualify for either the MEM or MF degree by earning 48.0 course credits under the requirements set forth in the previous section.
- For the second degree, the student must complete an additional 24.0 course credits of study that, in combination with courses taken for the first degree, meet the substance of the requirements for the second degree. Two additional semesters in residence are normally required, although, with careful planning, the student may complete both professional degrees in a total of five semesters.
- One master’s project should combine the two areas of study.

Determination of eligibility for the degrees will be made on an individual basis and will consider the educational background and objectives of the student.

**Master of Business Administration**

Students interested in a professional degree in environment and business at Duke have two options: 1) the master of environmental management (MEM) degree in the Business and the Environment Program of the Nicholas School described above or 2) concurrent master of environmental management/master of business administration degrees (MEM or MF + MBA) from the Nicholas School of the Environment and the Fuqua School of Business. At least three years of study are required to earn the combined degrees of master of environmental management/master of business administration or master of forestry/master of business administration. At least 36.0 course credits within the Nicholas School are required to receive the MEM or MF degree; these include four to six course credits for the master’s project. A typical program sequence would involve spending the first year in the Nicholas School followed by a year in The Fuqua School of Business, and concluding with the final year of combined work in both schools.

These concurrent degrees stress analytical reasoning and management science, while providing the student with knowledge of current problems in the natural resources, energy systems, and sustainable business practices. The study of managerial, resource and energy economics, organization theory and management, strategy and, natural resource management, the legal environment, and the public policy aspects of resource industries form a substantial component of each degree.

Because of the academic demands of these degrees, those entering without the necessary analytical skills or life science background may be required to take additional work beyond that specified.

Students who wish to undertake both the master of environmental management or master of forestry and master of business administration degrees must apply and be admitted by both the Nicholas School and the Fuqua School of Business. The Nicholas School will accept official GMAT scores from concurrent degree applicants who are applying as concurrent degree students. Students electing to pursue the MEM or MF concurrently with the MBA must complete the requirements for both degrees before either degree will be awarded.

For information on the master of business administration degree, the prospective student should write to The Fuqua School of Business, Admissions Office, Duke University, Box 90104, Durham, NC 27708-0104, or visit https://www.fuqua.duke.edu. The concurrent MEM/MBA is also an option at the Nicholas School and the Kenan-Flagler School of Business at the University of North Carolina-Chapel Hill. The application and admissions processes are completely separate; applicants must meet Nicholas School requirements as well as requirements stated by Kenan-Flagler. The sequence of enrollment between the two schools differs slightly as well. Students considering pursuing the concurrent MEM/MBA at UNC should consult with a member of the Student Services team for additional details.

Detailed information on the MEM/MBA Program and requirements can be found at https://nicholas.duke.edu/academics/masters-programs/concurrent-degree-programs.

**Master of Public Policy**

Students interested in a professional degree in environmental policy at Duke have three options: 1) the master of environmental management (MEM) degree in the Environmental Economics and Policy Program of the Nicholas School, described above; 2) a master of public policy (MPP) degree from the Sanford School of Public Policy; or 3) concurrent MEM/MPP degrees from the Nicholas School and the Sanford School. Doctoral candidates in the Nicholas School are also eligible to undertake the master of public policy.

The concurrent MEM/MPP degree provides training in the politics and economics of resource and environmental policymaking. Emphasis is placed on understanding the social and political forces involved, developing facility with quantitative and logical methods of forecasting and evaluating policy consequences. Knowledge of the uses and limitations of policy analysis and an awareness of the ethical dimensions of policy choice are also stressed.

The concurrent degree takes three years to complete. Typically, the first year is devoted to study in the Sanford School of Public Policy, the second year is spent in the Nicholas School of the Environment and the third year combines work in both the Nicholas School and the Sanford School. At least 36.0 course credits within the Nicholas School are required to earn the MEM or MF degree. A summer internship with a resource or environmental agency, or with a related legislative, judicial, or interest group, is required for the policy degree. Students in this concurrent degree program have the option of doing two separate master’s projects (MP), or one combined MP. Concurrent degree students working in a group MP in the Nicholas School must choose the two-MP option. Students electing to pursue the MEM concurrently with the MPP must complete requirements for both degrees before either degree will be awarded.

Students must apply to and be accepted by both the Nicholas School of the Environment and the Sanford School of Public Policy. For detailed information on the public policy degree, write to the Director of Graduate Studies, Sanford School of Public Policy, Duke University, Box 90243, Durham, NC 27708-0243, or visit the Sanford School of Public Policy website at https://sanford.duke.edu.
Juris Doctor in Environmental Law and Juris Doctor/MA Option

Environmental and natural resource issues increasingly require legal and regulatory knowledge for resolution. There is a growing demand for resource managers and scientists who have legal credentials; similarly, attorneys are facing more situations in which knowledge of natural resources and the environmental sciences is critical to the resolution of disputes. To satisfy these demands, the Nicholas School of the Environment and the Duke University School of Law have developed a cooperative arrangement to allow pursuit of concurrent master of environmental management (or master of forestry) and juris doctor degrees.

For students in the concurrent MEM (or MF)/JD Program, the Nicholas School requires 36.0 course credits, including a master’s project. The School of Law requires 84.0 course credits in law, 12.0 course credits of which may be satisfied through courses taken in the Nicholas School.

Typically, a student will complete the first year of study in the Duke Law School and the second in the Nicholas School. During the third and fourth years, the student will take a combination of courses in both schools. Students electing to pursue the MEM concurrently with the JD must complete requirements for both degrees before either degree will be awarded.

MEM/JD candidates must apply to and be accepted by both the Nicholas School of the Environment and the Duke Law School. For information on the law degree, prospective students should write to the Duke University School of Law, Admissions Office, Duke University, Box 90393, Durham, NC 27708-0393, https://law.duke.edu.

Additionally, the Duke University School of Law offers a unique program whereby students enrolled in the Duke Law School may concurrently pursue a master of arts degree in a variety of subject areas, including environmental studies. Students who intend to focus their careers on law but who wish to supplement their legal education with continuing study of the environment may find this program of interest. Students pursuing the MA are governed by the regulations of The Graduate School but take their coursework alongside professional degree students.

Applications to this program must file an application with the Duke Law School at https://law.duke.edu/admis. The application is also reviewed by faculty in the Nicholas School, and admission is offered by the Duke Law School and The Graduate School.

The JD/MA Program requires that students begin their studies in the summer and continue through the following six academic semesters. During that time students will earn 30.0 course credits in The Graduate School, of which twenty-four must be graded, and 72.0 course credits in the Duke Law School. MA students complete an oral comprehensive examination in the Nicholas School but are not required to complete a master’s project. Further information is available from the Director of Graduate Studies of the Nicholas School.

Master of Arts in Teaching

Over the past several decades, international concern for protecting ecosystems has led to an increased need to educate citizens on the challenges facing the environment. Numerous education programs are now aimed at K-12 students as well as the general population. Environmental education is of increasing importance to those who prepare to teach, particularly in the sciences. Duke’s concurrent degree program between the Nicholas School of the Environment and The Graduate School allows students to meet this challenge by earning a master of environmental management (MEM) and a master of arts in teaching (MAT) degree.

In this concurrent degree program, to earn the MEM degree students must complete 36.0 course credits in the Nicholas School, including a master’s project. For the MAT degree, students will complete 30.0 course credits, including a full-year teaching internship and all requirements for the North Carolina teaching licensure in comprehensive science at the high school level. Competencies required by the state will be met through undergraduate courses taken prior to admission to Duke, science courses taken as part of the MAT or courses taken as part of the MEM.

Students will normally enroll in the MAT Program during the summer and then complete an academic year of student teaching and MAT coursework prior to enrolling in the MEM Program for three semesters. Students electing to pursue the MEM concurrently with the MAT must complete requirements for both degrees before either degree will be awarded.

Students must apply to and be accepted by both the Nicholas School of the Environment and The Graduate School of Duke University, citing the Master of Arts in Teaching Program. Students admitted to the MAT Program in comprehensive science must hold an undergraduate degree in one of the natural sciences with significant undergraduate preparation in biology and chemistry. Organic chemistry is required.

Questions concerning the MAT degree should be addressed to the Director of the Master of Arts in Teaching Program, Duke University, Box 90093, Durham, NC 27708-0933; (919) 684-4353, https://educationprogram.duke.edu/MAT.

Master of Engineering Management

Duke’s concurrent degree program between the Nicholas School of the Environment and the Pratt School of Engineering provides a broad perspective to blend the master of engineering management (MEMP) students’ engineering backgrounds and the master of environmental management (or master of forestry) students’ training in natural and social environmental sciences, resulting in graduates with a strong mix of technical and contextual knowledge and tools well suited to careers in several environmental sectors, particularly energy and environment, environmental health, and water resources. Students wishing to pursue the MEM in a concurrent arrangement with the MEMP should plan on two to three years of study.

Students must complete 36.0 course credits in the Nicholas School, including a master’s project. An additional 24.0 course credits must be taken in the Pratt School of Engineering, including a required summer internship.

Prior to enrolling in the fall, students fulfill their required engineering internship in the summer preceding the fall term. During the first year, courses are split evenly between engineering and environment with an emphasis on core engineering courses. The second year includes elective credits in the Pratt School of Engineering and key core courses in the Nicholas School. During the third year students will complete their master’s projects for the Nicholas School; they may be able to finish in one additional semester or may require the full year to complete remaining credits and the master’s project.

Students must apply to and be accepted by both the Nicholas School of the Environment and the Pratt School of Engineering. Students electing to pursue the MEM or MF concurrently with the MEMP must complete requirements for both degrees before either degree will be awarded. Questions concerning the MEMP should be addressed to the Master of Engineering Management Program, Duke University Pratt School of Engineering.
Concurrent Degrees with Other Universities

With the special permission of the education committee and the dean of the Nicholas School of the Environment, students are permitted, on an individual basis, to establish concurrent degree programs with certified graduate degree programs either within or outside of Duke University. In the past, students have designed such programs with law schools, business schools, and graduate engineering programs. As with the other concurrent degrees, the student must be enrolled in the master of environmental management or master of forestry degree program for at least 36.0 course credits and be in residence for three semesters.

To receive permission to pursue a specially designed concurrent degree, the student must show an official acceptance from another certified graduate degree program. For additional information concerning special concurrent degrees, applicants should consult the Nicholas School Office of Student Services.
Admissions

Requirements and Prerequisites

The Nicholas School of the Environment welcomes applications from domestic and international students of all backgrounds who seek an intellectually challenging education designed to prepare them for leadership in a wide variety of natural resource and environmental careers. Admission to the master of environmental management (MEM) and the master of forestry (MF) is open to students who hold a four-year equivalent bachelor’s degree from an accredited college or university. Admission as a nondegree student may also be granted under appropriate circumstances.

Students enrolled in the Duke Environmental Leadership Master of Environmental Management (DEL-MEM) Program are subject to all of the same requirements, responsibilities, and policies as set forth for residential MEM students, except where specifically differentiated (i.e., admissions requirements, credit requirements, program format, and curriculum requirements). Admission to the DEL-MEM is open to students who hold a bachelor’s degree from an accredited college or university and have a minimum of five years of postdegree environmentally related experience (professional or a significant commitment to the personal/volunteer work in related fields). The DEL-MEM Program is a thirty-course-credit, two-year, four-semester master of environmental management degree-granting program utilizing distance-learning technologies.

For information about the international master of environmental policy (IMEP), see page 61.

Prerequisites

All students admitted to the school are expected to have had the following (the DEL-MEM Program does not have any course prerequisite requirements; however, five years of postdegree environmentally related experience is required):

- some previous training in the natural sciences or the social sciences related to their area of interest in natural resources and environment;
- at least one college semester of calculus; and
- a college statistics course that includes descriptive statistics, probability distributions, hypothesis testing, confidence intervals, correlation, and simple linear regression.

Each program area requires additional courses or recommends additional preparation, as follows:

- **Business and Environment**: microeconomics (or general economics that focuses on microeconomics)
- **Coastal Environmental Management**: microeconomics (or general economics that focuses on microeconomics)
- **Ecosystem Science and Conservation**: principles of ecology; microeconomics (or general economics that focuses on microeconomics) is recommended
- **Ecotoxicology and Environmental Health**: chemistry; principles of ecology and organic chemistry recommended
- **Energy and Environment**: microeconomics (or general economics that focuses on microeconomics)
- **Environmental Economics and Policy**: microeconomics (or general economics that focuses on microeconomics)
- **Forest Resource Management**: microeconomics (or general economics that focuses on microeconomics); principles of ecology
- **Water Resources Management**: economics; chemistry, and physics recommended
- **Duke Environmental Leadership Program**: minimum of five years of postdegree environmentally related experience (professional or a significant commitment to the personal/volunteer work in related fields)

All courses taken to fulfill a prerequisite must be full-semester courses and must be taken for graded credit; a final grade of B- or better must be earned in the course. Official transcripts must be submitted to the Office of Student Services.

Although students lacking the level of preparation described above may be admitted, deficiencies should be made up prior to enrollment in the Nicholas School. It is especially important for concurrent degree students and students planning to study at the Duke University Marine Laboratory in their second year to complete all prerequisites prior to enrollment. A limited number of deficiencies may be made up during the first year of study; however, these courses will not count toward the 48.0 course credits required for the MEM or MF degree and could delay the student’s progress toward the degree.

Interviews

An interview with a member of the admissions committee is not required for admission to the on-campus MEM or MF programs, though meeting with an enrollment services team member may be helpful to the applicant. Consequently, those applicants who can visit the Nicholas School are encouraged to do so. The visit presents an excellent opportunity for the applicant to ask questions and gain insights about the school. Applicants are encouraged to allow sufficient time to visit classes, meet students and faculty, and tour the university.

In general, visits can be scheduled on weekdays throughout the academic year by completing the online visitation request form at least two weeks in advance of the desired visit. Although visits during the summer months are possible, they should be scheduled well in advance since no summer classes are taught at the Durham campus of the Nicholas School of the Environment, and faculty are frequently away from campus. Formal visitation programs are hosted by the Office of Student Services of the Nicholas School of the Environment on-campus in the fall semester and through virtual visitations conducted online.

Each year, representatives of the Nicholas School travel throughout the country to visit undergraduate schools, participate in graduate school fairs, and attend relevant professional conferences. Applicants interested in meeting with a representative of the school should email or call the Office of Student Services, or visit [https://nicholas.duke.edu/admissions/recruitment-admissions-events](https://nicholas.duke.edu/admissions/recruitment-admissions-events) for a schedule of recruiting events in their area.

In addition, it is sometimes possible to arrange a meeting with an alumnus, particularly where distance precludes travel to Durham. For further information or to arrange a school visit, applicants may contact the Office of Student Services.
Admissions Criteria

Admissions criteria for the Nicholas School of the Environment are designed to ensure that admitted students will perform well while they are at Duke and after they graduate. Academic performance as an undergraduate, scores on the Graduate Record Examination and work experience are the key factors considered in the application review process. However, letters of recommendation, the applicant’s personal statement, résumé, extracurricular activities and other information requested on the application also provide a basis for selection.

The Admissions and Awards Committee evaluates each candidate for his or her academic potential, professional promise and ability to benefit from and contribute to the goals of the school. Individuals with prior relevant work experience are especially encouraged to apply.

The admissions criteria for the DEL-MEM Program include a minimum of five years of postdegree environmentally related experience (professional or a significant commitment to the personal/volunteer work in related fields). Academic performance as an undergraduate, professional environmental work experience, leadership experience and/or potential, letters of recommendation, applicant essays, and an applicant interview (for DEL-MEM) are the primary factors considered in the application review process. Extracurricular activities and other information requested on the application also provide a basis for selection.

Application Procedures

Application for admission to the on-campus master of environmental management and the master of forestry degrees is made through the Office of Student Services of the Nicholas School of the Environment by submitting an electronic application. Upon matriculation, official transcripts should be sent to: Office of Student Services, Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708-0328.

For both the on-campus MEM or MF and for the DEL-MEM, the application deadline is January 17 preceding the fall in which admission is desired. Admission is offered for the fall term only. Applications received after the January 17 deadline are held until all on-time applications have been considered. Admissions decisions on late applications are made on an individual basis according to the availability of student spaces.

No applicant will be considered until the completed application form, personal statement, and all supporting documents described below are received by the Office of Student Services.

1. Application Form. The electronic application may be accessed through the Nicholas School website, https://nicholas.duke.edu/admissions. Both on-campus MEM and MF as well as DEL-MEM applicants should use the above link. Please note: applications to the PhD program are available through The Graduate School website. The Admissions and Awards Committee attaches considerable weight to the statement of educational objectives submitted by the applicant. This statement should reflect well-defined motivation to pursue graduate study.

2. Official Transcripts. One copy of the transcript from each undergraduate and graduate school attended should be uploaded electronically as part of the electronic application. Unofficial transcripts are acceptable for the application review process. Official transcripts showing awarding of the degree must be submitted by every matriculating student prior to enrollment. Paper transcripts may be sent to the Office of Student Services in sealed envelopes that have been signed across the flap by the registrar of the institution attended. If the original transcript is not in English, the applicant must also provide a certified English translation. If not included on the transcript, students must provide proof of the degree prior to enrollment. If the undergraduate institution uses an agent (e.g., SCRIP-SAFE International (or similar agent) for the delivery of official transcripts, the applicant may request that their registrar forward an official transcript to admissions@nicholas.duke.edu.


4. Graduate Record Examination (GRE) scores. Applicants for the on-campus MEM or MF degree programs must provide official scores on the general test (verbal, quantitative, and writing assessment) of the Graduate Record Examination. Subject tests are not required. The GRE is not required for applicants to the DEL-MEM degree program. For scores to be considered, the GRE must have been taken within five years of the date of application. Applicants are urged to take the exam at the earliest convenient date. Scores on tests taken later than December may not reach the school until after the January 17 deadline. Scores should be reported to Duke University code number 5156.

5. Application Fee. A nonrefundable application fee of $80 is required of all applicants. The fee is paid by credit card at the time of application. Application will not be processed until the required fee has been paid.

Application for admission to the DEL-MEM Program is made through the Office of Student Services by submitting an electronic application. All application requirements are outlined at https://nicholas.duke.edu/admissions/how-apply. Should it be necessary to submit supporting documents via paper, applicants should address their documents to Office of Student Services, Box 90328, Nicholas School of the Environment, Duke University, Durham, NC 27708.

DEL-MEM students are admitted for the fall term. The application deadline is January 17 preceding the fall in which admission is desired. The DEL-MEM Program has only one admission period. Applications received after the January 17 deadline are held until all on-time applications have been considered. Admissions decisions on late applications are made on a case-by-case basis.

No applicant will be considered until the completed application form, letters of recommendation, employer sponsor letter, and all related documents described are received by the Office of Student Services. International applicants to the DEL-MEM should review specific requirements and other information at https://nicholas.duke.edu/admissions/how-apply/international-student-applicants#del.
Additional Procedures for International Students

Each year the Nicholas School of the Environment welcomes a number of international students among its professional degree candidates, including the Duke Environmental Leadership program. Applicants from other countries must meet the same criteria as applicants from the United States, including a four-year bachelor’s degree or its equivalent. All academic transcripts and other documents in support of admission must be accompanied by an official translation if the original document is not in English. The nonrefundable application fee must accompany the application.

Test of English as a Foreign Language (TOEFL)

Applicants must have a fluent command of oral and written English. No allowance is made for language difficulty in arranging course schedules or in evaluating performance. If the native language is not English, the applicant must submit scores on the Test of English as a Foreign Language (TOEFL) to be considered for admission. All arrangements for taking the TOEFL must be made directly with the Educational Testing Service at [https://www.ets.org/toefl/](https://www.ets.org/toefl/). In cases in which an applicant’s TOEFL score is low, the applicant may be accepted on the provision that an intensive English language program is completed in the United States prior to enrollment. Official acceptable scores on the International English Language Testing System (IELTS) may be submitted in lieu of the TOEFL.

In addition to TOEFL scores, international applicants whose native language is not English may be interviewed remotely (Skype or WeChat) to evaluate English proficiency prior to acceptance in the program.

Proficiency exams in written and spoken English will be given to nonnative speakers during the week prior to orientation week. Students found to lack the proficiency in English needed to do well at Duke will be required to enroll in additional English language instruction. Students should be prepared to assume all costs for English language instruction and may need to reduce their course or research program while being tutored. If more than one English language course is required, MEM and MF students may count one English course toward their degree; otherwise, English language instruction does not count toward credit hours required for the MEM or MF degree. (This paragraph is not applicable to students in the DEL-MEM Program).

Proof of Funding

The visa-granting authority in the student’s country of origin, ordinarily the United States Embassy, requires proof that sufficient funds are available to the student to cover the expenses of all academic years of study before a visa can be granted. Foreign students are not eligible for federal and state loans, although they may qualify for certain educational loans through private United States agencies. Immigration laws might make it difficult for the foreign student to find summer employment and permanent employment in the United States after graduation. Merit-based financial assistance, if it is offered, is not sufficient to cover all of the costs associated with studying at the Nicholas School. International students should expect to demonstrate other sources of support in order to obtain a visa.

Specific information for international students in the DEL-MEM Program should review the requirements at [https://nicholas.duke.edu/admissions/how-apply/international-student-applicants#del](https://nicholas.duke.edu/admissions/how-apply/international-student-applicants#del).

Admission with Nondegree Status

Persons wishing to enter the Nicholas School of the Environment as nondegree students must submit a special application form requesting nondegree status along with an application fee of $25. The applicant must have completed a bachelor’s degree from an accredited college or university and must submit an official transcript of all previous coursework. Taking the Graduate Record Examination is not required, although GRE scores are helpful in the admissions process. The student must have one letter of recommendation; this letter should indicate why the applicant should be allowed to undertake nondegree study at Duke. The application itself requires a brief statement of purpose in which the applicant should state his or her reasons for such study at Duke.

Admission as a nondegree student does not guarantee future admission to the MEM or MF degree. Nondegree students who complete an application for the professional degree and are offered admission may transfer a limited number of appropriate credits from their nondegree status at Duke into the MEM or MF degree. The student’s program chair will determine which if any credits may be counted toward the degree. Applying credits taken as a nondegree student does not reduce the number of semesters required for the degree or the tuition required. Neither the on-campus nor the DEL-MEM Programs accept transfer credits from other institutions.

Offers of Admission

When admission is approved, the applicant will receive an offer of admission and an acceptance form. Offers of admission for the fall semester, including financial aid awards, are sent to accepted students in mid-March via email. A nonrefundable enrollment deposit is required with acceptance of the offer. The admission process is not complete until the acceptance form and the enrollment deposit have been submitted online. Failure to respond by the stated deadline may result in cancellation of acceptance.

Deferred Admission

Applicants are admitted only to the class for which they have applied and should not apply until they are prepared to undertake professional studies. Applicants with substantial reasons for deferring the start of graduate work must send a request to the Admissions and Awards Committee in care of the Office of Student Services as soon as possible after receiving an offer of admission. Offers of financial assistance are cancelled upon deferral of admission, and students must be reconsidered for financial aid with no guarantee of future aid.
**Financial Information**

**Tuition and Fees**

**Estimated Expenses for the Academic Year**

The following approximate costs, applicable in 2019-2020, are indicative of costs that can be expected by MEM and MF candidates; PhD students should consult the bulletin of The Graduate School for similar data. Students should expect that tuition and fees will increase annually; the amounts are determined by the school and the university and reviewed and approved by the Board of Trustees.

<table>
<thead>
<tr>
<th></th>
<th>On-Campus</th>
<th>DEL-MEM</th>
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</thead>
<tbody>
<tr>
<td>Tuition ($20,500 per semester)</td>
<td>$41,000</td>
<td>$41,000</td>
</tr>
<tr>
<td>Student health fee ($417 per semester)</td>
<td>$834</td>
<td></td>
</tr>
<tr>
<td>Graduate student activity fee ($18.50 per semester)</td>
<td>$37</td>
<td></td>
</tr>
<tr>
<td>Recreation fee ($158 per semester)</td>
<td>$316</td>
<td></td>
</tr>
<tr>
<td>Graduate student services fee ($10 per semester)</td>
<td>$20</td>
<td></td>
</tr>
<tr>
<td>Transcript fee (first semester only)</td>
<td>$40</td>
<td>$40</td>
</tr>
<tr>
<td>Housing</td>
<td>$9,280</td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>$3,423</td>
<td>$2,755</td>
</tr>
<tr>
<td>Books and supplies</td>
<td>$666</td>
<td>$300</td>
</tr>
<tr>
<td>Transportation</td>
<td>$1,850</td>
<td>$2,000</td>
</tr>
<tr>
<td>Motor vehicle registration and parking</td>
<td>$200-$1,257</td>
<td></td>
</tr>
</tbody>
</table>

In addition to these fixed expenses, the student may incur other expenses, which will depend to a large extent upon individual tastes and habits. All students are required to carry major health insurance either through Duke’s comprehensive medical insurance plan or by providing proof that other health insurance provides equal coverage. International students are required to purchase Duke’s student medical insurance plan. The average Duke Nicholas School student can plan on a budget in the range of $62,000 to $67,000 for the academic year. Students with spouses and children naturally will have higher expenses.

Specific tuition information for the Duke Environmental Leadership program can be found at [https://nicholas.duke.edu/admissions/tuition-fees](https://nicholas.duke.edu/admissions/tuition-fees).

**Flat-Rate Tuition**

Professional degree students in the Nicholas School pay a flat rate of tuition per semester (excluding the summer session) (see "Flat-Rate Tuition—Duke Environmental Leadership Program" below for the DEL-MEM Program). Students enrolled in the regular two-year MEM or MF degree program are required to pay the flat rate tuition for a minimum of four semesters. Students in concurrent degree programs at Duke pay a flat rate to the university throughout their concurrent degree program that is split proportionately between the two programs regardless of where the student is taking courses in a particular semester; the tuition rate for the Nicholas School is equivalent to three semesters. Students in the concurrent MEM/MF program must enroll full-time for at least five semesters and pay the flat-rate tuition for a minimum of five semesters.

The flat-rate tuition allows master of environmental management and master of forestry degree candidates to register for 9.0 or more course credits for a fixed tuition payment per semester. The normal full-time enrollment is expected to be 12.0 course credits per semester, although course credits may vary from 9.0 to 15.0 depending upon the student’s academic and assistantship requirements. Permission is required to register for fewer than 9.0 or more than 15.0 course credits in a semester.

If the student is permitted to be enrolled part time (fewer than 9.0 course credits), he or she will be charged per course credit ($1,860 per unit for the 2019-2020 academic year). Students who are approved for part-time enrollment status are not eligible for school or federal financial aid. The per credit rate is available to professional degree students only after the minimum number of semesters of tuition have been paid (three, four, or five semesters depending on the degree program/s).

Students who wish to earn additional credits during the summer will be charged at the part-time rate per course credit. Payment for summer session courses is in addition to the required four semesters at the flat tuition rate. Students who have completed the required semesters in residence and all course requirements except the master’s project will be charged a minimum registration fee ($400 for 2019-2020) each semester until the degree is completed. Students being paid for a summer internship may not receive academic credit in addition to the salary.

All students are expected to be registered in residence, to be approved for a leave of absence or to pay a minimum registration fee for each semester until their degree is completed.

**Flat-Rate Tuition—Duke Environmental Leadership Program**

Professional degree students in the Nicholas School DEL-MEM Program pay a flat rate of tuition per semester (excluding the summer session). Students in the two-year DEL-MEM Program will pay the flat-rate tuition for four semesters.

The DEL-MEM Program is a minimum thirty-course-credit program that must be completed in four semesters over two years. The flat-rate tuition allows master of environmental management degree candidates to register for courses for a fixed tuition payment per semester. To complete the DEL-MEM Program within the required amount of time, students typically take between 6.0 and 9.0 course credits per semester. Permission is required to register for fewer than 6.0 course credits or more than 9.0 course credits in a semester. Students must be enrolled with at least 6.0 course credits to be considered a full-time student and to receive federal financial aid, if eligible. Students registering for fewer than 6.0 course credits per semester are not eligible to receive federal financial aid.
Students who have completed the required four semesters and all course requirements, except the master’s project, will be charged a minimum registration fee ($400 for 2019-2020) each semester until the degree is completed.

All students are expected to be registered, to be approved for a leave of absence, or to pay a minimum registration fee for each semester until their degree is completed.

Payment of Accounts
Invoices for tuition, fees, and other charges are sent electronically by the Office of the Bursar and are payable by the invoice due date. As a part of the agreement of admission to Duke University, a student is required to pay all invoices as presented, unless other arrangements are made in advance. Students interested in arranging a payment plan should contact Tuition Management Services by calling (800) 722-4867 or visiting https://duke.afford.com/.

Late Payment Charge
If the total amount due on the student invoice is not received by the invoice due date, a penalty charge will be accrued from the billing date and applied to the past due balance. The past due balance is defined as the previous balance less any payments and credits received during the current month. Student loan payments already accepted and in process in the system will not cause a late payment charge.

Restrictions
If the total amount due on the student invoice is not received by the due date, the student will be considered in default and will not be allowed to register for classes, receive a copy of the academic transcript, have academic credits certified, be granted a leave of absence or receive a diploma at graduation. In addition, an individual in default may be subject to dismissal from the university.

Tuition Refund Policy
In case of withdrawal from the university, Title IV federal financial aid received by students enrolled for the first time at Duke will be refunded on a pro rata basis. The pro rata formula is calculated by multiplying the total school charges by the remaining fraction of the enrollment period for which the student has been charged, rounded downward to the nearest 10 percent, less any unpaid charges owed by the student. The pro rata refund policy does not apply to any student whose withdrawal occurs after the 60 percent point in the period of enrollment. Sample refund calculations are available from the Student Services office.

If the student receives federal financial aid but is not attending the university for the first time or if the student does not receive federal financial aid, tuition will be refunded or carried forward as a credit for later study according to the following schedule:

<table>
<thead>
<tr>
<th>Withdrawal</th>
<th>Refund</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before classes begin</td>
<td>full amount</td>
</tr>
<tr>
<td>During first or second week</td>
<td>80%</td>
</tr>
<tr>
<td>During third, fourth or fifth week</td>
<td>60%</td>
</tr>
<tr>
<td>During sixth week</td>
<td>20%</td>
</tr>
<tr>
<td>After sixth week</td>
<td>none</td>
</tr>
</tbody>
</table>

Late Registration
Students who register at a date later than that prescribed by the university must pay a late registration fee at the Office of the Bursar.

Audit Fee
Students registered for a full course load may audit courses without charge. Otherwise, audit fees are $620 per course credit.

Transcripts
Official transcripts are available upon request from the Duke University Office of the University Registrar. During their first semester in residence, students are charged a fee that covers all future requests for official transcripts. The Nicholas School of the Environment cannot issue official transcripts. For more information, visit https://registrar.duke.edu/student-records-resources/transcripts-and-verifications.

Parking
Students who wish to operate or park motor vehicles on campus must obtain a permit from the Parking and Transportation Office. Parking fees vary according to location and type of vehicle. Duke University has Enterprise CarShare service and offers carpool coordination for students, faculty, and staff to use as needed. There is not a fee for bicycle parking. Once bicycle commuters have registered with Parking and Transportation, two daily parking passes a month are provided at no cost to the rider.

Student Health Fee
All students are assessed a fee for the Student Health Service. This fee is distinct from health insurance and does not provide major medical coverage.

Medical Insurance
All on-campus students are billed for major medical/health insurance in the fall semester unless proof of other insurance is provided. Family plans are available through the university’s insurance vendor for an additional fee. All international students will be registered automatically for the Duke Student Medical Insurance policy. International students are required to carry health insurance for a spouse or children living in Durham.

Students enrolled in the DEL-MEM Program are exempt from the health insurance fee. However, DEL-MEM students opting to be enrolled in the Duke health insurance plan can do so by contacting the university’s insurance vendor.

Tuition and Fees for the Summer
Very few summer course offerings are available on the Durham campus of the Nicholas School. MEM and MF students who wish to take additional credits during the summer should expect to do so through other departments in the university or at the Duke University
Eligibility for Financial Assistance

A significant portion of the financial assistance for students in the Nicholas School of the Environment is provided by federal, Title IV funds. To qualify for such funding, usually in the form of loans, students must meet federal eligibility requirements including the maintenance of satisfactory academic progress (see "Satisfactory Academic Progress" on page 55). Professional degree students must meet satisfactory academic progress standards to maintain eligibility for Title IV funds.

Although professional degree students, including DEL-MEM students, have five years from the first date of matriculation in the school to complete their degree requirements, they are eligible for federal financial assistance for the equivalent of four full-time semesters only. Students who fail to meet the satisfactory academic progress requirements or need federal financial assistance for more than the equivalent of four semesters may appeal to the Admissions and Awards Committee.

Recreation Fee

A mandatory fee will be charged to all registered students for usage of campus recreational facilities. Students' spouses or domestic partners are eligible to use the facilities for an additional fee. Students enrolled in the DEL-MEM Program are not assessed this fee. Local DEL-MEM students wishing to use campus recreational facilities may do so for a fee.

Athletic Events

Students are admitted free of charge to most regularly scheduled university athletic events held on campus during the academic year, with the exception of basketball. Students who wish to attend home basketball games must enter the student ticket lottery and pay for tickets if selected.

Financial Assistance

Financial assistance in the form of merit-based scholarships, fellowships, or assistantships is available for qualified students. Funds to support these merit awards are limited. As a result, students must expect to have other financial resources. For many students, the federal loan programs provide a large portion of the funds necessary to cover the cost of attendance. Students in the DEL-MEM Program may also be eligible for limited financial support from the school.

All professional degree students who are US citizens or permanent residents must file the Free Application for Federal Student Aid (FAFSA) to be considered for student loans and work-study. A separate application must be filed for each academic year. Applicants may obtain a FAFSA online at https://fafsa.ed.gov. Professional degree applicants must also complete the financial aid section of the Application for Admission.

Scholarships and assistantships are granted from school funds, which are in limited supply. Consequently, only highly-qualified students can expect to receive awards. Scholarships and assistantships are awarded on the basis of demonstrated outstanding academic ability and a high degree of professional promise.

Fellowships are obtained from foundation grants, private industry, or individual donors. Donors of fellowship funds sometimes place restrictions on the use of the funds as well as on the amount of awards.

Research assistantships are obtained primarily from grant and contract funds awarded to various faculty in the school. University-funded assistantships may be available for students who have sufficient experience to contribute to one or more ongoing research or academic programs.

Pursuant to the Tax Reform Act of 1986, students performing any services (whether degree-related or not) required by their scholarship, fellowship, or assistantship must have income taxes withheld. However, if the student anticipates no tax liability at the end of the calendar year, or if the state or federal withholdings, or no taxes will be withheld. Income tax information is reported to the student by the university in January.

In all instances, admission to the Nicholas School is a prerequisite for the award of assistance in any form. If offered financial assistance, professional degree students normally will receive the award for two years of study; it is expected that they will complete their degree within this period of time. Students in concurrent degree programs receiving school-supported assistance, will receive the equivalent of three semesters of assistance, provided they remain in good standing. However, the school has the right to examine the progress of each student to determine eligibility for continuation of awards beyond the first year. Students not in good standing (with regard to academics or honor code) are not eligible for any new awards from the Nicholas School (e.g., scholarships, fellowships, recognitions without monetary component) whether academic performance is an eligibility criterion or not.

No student will receive financial aid while on probation unless an appeal is approved by the associate dean for professional programs and the assistant dean for student services.

In no case may the amount of financial aid awarded to a student from all sources in a given year exceed the estimated annual costs of attending the Nicholas School as determined by the school.

Eligibility for Financial Assistance

A significant portion of the financial assistance for students in the Nicholas School of the Environment is provided by federal, Title IV funds. To qualify for such funding, usually in the form of loans, students must meet federal eligibility requirements including the maintenance of satisfactory academic progress (see "Satisfactory Academic Progress" on page 55). Professional degree students must meet satisfactory academic progress standards to maintain eligibility for Title IV funds.

Although professional degree students, including DEL-MEM students, have five years from the first date of matriculation in the school to complete their degree requirements, they are eligible for federal financial assistance for the equivalent of four full-time semesters only. Students who fail to meet the satisfactory academic progress requirements or need federal financial assistance for more than the equivalent of four semesters may appeal to the Admissions and Awards Committee.
Fellowships for MEM/MF Students

Merit-based awards depend on the generosity of donors. Students receiving merit-based awards may be supported from one of the following endowments.

**Alumni Fellowship.** Established by graduates of the Nicholas School, the Alumni Fellowship Endowment provides fellowships to minority students and to rising second-year students to support master’s project research.

**Lawrence E. Blanchard Society of Scholars and Fellows.** Established by Charles and Bernard Blanchard, this fund provides scholarships to undergraduates and fellowships to graduate students studying at the Duke University Marine Laboratory.

**Norman L. Christensen Jr. Fellowship.** Established by alumni and friends in honor of the founding dean of the Nicholas School, this fellowship provides full tuition to candidates pursuing the master of environmental management degree.

**William Cleveland Fellowship.** Established by William Cleveland, this fellowship provides financial assistance to Nicholas School students.

**Timothy J. and Anne G. Creem Scholarship.** Established by Tim Creem, this fellowship is for candidates pursuing the master of forestry degree.

**Cummings Family Fellowship.** Established by Bruce and Myrna Cummings, this fellowship supports Nicholas School students.

**Barbara L. Dannenberg Fellowship.** Established by Richard Dannenberg, this fellowship is for Nicholas School students with a preference for the field of ecology.

**Kathryn M. Deane and Walter L. Deane Fellowship.** Established by Walter Deane and Kathryn Deane, this fellowship provides financial assistance to African American students during the summer session at the Marine Lab.

**Field Fellowship Fund.** Established by Marshall Field and Jamee Field, this fund provides fellowships for Nicholas School students.

**Virlis L. Fischer Student Recognition Endowment.** Established by Mrs. Bernice Fischer, this fund provides fellowships to second-year professional degree students at the Nicholas School and provides an award to the master of environmental management graduate with the highest academic achievement.

**Forestry and Environmental Studies Fellowship.** Established by the Cordelia S. May Trust, this fellowship provides financial support to Nicholas School students.

**Friends of the Earth.** Established by F. Daniel Gabel, Jr. T’60, this fund provides fellowships to Nicholas School students with a preference given to students who are associated with Friends of the Earth International or students with an interest in creative environmental advocacy.

**LeRoy George Scholarship.** Established by the LeRoy George Children’s Nature Museum Inc., this fund provides fellowships to Nicholas School students, with preference given first to students from Haywood and Buncombe Counties and Hendersonville in North Carolina. Second preference will be given to students from the Southern Appalachian region.

**Verne Lester Harper Fellowship.** Established by Verne Lester Harper, this fellowship provides financial support to Nicholas School students.

**Charlotte and Robert Hay Fellowship.** Established by Charlotte and Robert Hay, this fellowship provides support to Nicholas School students.

**Richard Heintzelman Family Fellowship.** Established by Richard Heintzelman, this fellowship is for Nicholas School students, with first preference given to those studying forestry or environmental economics.

**Tim and Karen Hixon Wildlife Conservation Fellowship.** Established by George C. and Karen Hixon, this fellowship is for Nicholas School students with interests in careers related to wildlife management and conservation.

**Richard E. Hug Fellowship.** Established by Richard Hug, this fellowship provides financial support to Nicholas School students.

**International Paper Corporation Fellowship.** Established by the International Paper Corporation, this fellowship is for Nicholas School students.

**Thomas W. Keesee Jr. Fellowship.** Established by Thomas Keesee Jr., this fellowship is for Nicholas School students.

**Gorguze-Peters Family Fellowship Fund.** Established by Lynn Gorguze and Scott Peters, this fund provides fellowships to graduate professional Nicholas School students.

**Carolyn Odom Little School of the Environment Scholarship.** Established by Terry H. Little, provides scholarships for Nicholas School students.

**Melanie Lynn Memorial Scholarship.** Established by Peter Lynn and David Lynn, this fellowship is for graduate students studying at the Marine Lab, with first preference to female students.

**The Masselink Family Fellowship.** Established by Mark D. and Priscilla P. Masselink, this fund provides fellowships to graduate professional Nicholas School students.

**Andrew W. Mellon Fellowship.** Established by the Andrew W. Mellon Foundation, this fellowship provides financial support for research experience at the Nicholas School.
Need-Based Grants

The Nicholas School reserves a limited amount of financial aid for students with significant financial need. Both domestic and international students in the on-campus MEM, MF and DEL-MEM degrees may apply for need-based aid. There is a separate required application process in order for a student to be considered for a need-based grant. The Nicholas School uses College Board (CSSProfile and IDOC) services for students to submit their applications. For students entering in the fall, the deadline for completing an application for need-based aid is February 17, 2020, for Fall 2020. Parental asset and income information is required as part of the application for a need-based grant. Parental asset and income information is required as part of the application for a need-based grant. Additional details regarding the application process may be found at the Nicholas School website, https://nicholas.duke.edu/admissions/financial-support-aid. Students must be enrolled full time in the MEM or MF degree and affirm that their financial situation has not improved by the end of the first year in order to receive the award in the second year. Students who complete the application for a need-based grant will be notified at the same time that they are notified of any other school-supported assistance. Students in dual degree programs may be eligible for the equivalent of three semesters of need-based aid provided they can affirm that their financial situation has not improved.

Academic Information for Professional Degree Students

Assistantships

Merit-based assistantships may be awarded to a select number of professional degree on-campus MEM and MF students during their first year of study to assist faculty and staff with teaching, research, professional, and other projects. It is expected that students will work for four hours a week on their assigned project. Assistantships require a regular work schedule to be arranged between the student and the faculty or staff member to whom he or she is assigned. Students receiving an assistantship will be informed of the positions available, application, interview and assignment process just prior to the start of the fall term.

Students who receive assistantships are paid by the Nicholas School on the monthly payroll, and taxes are taken out. For the 2019-2020 academic year, the award for eight hours per week of assistance is $3,000. Normally, assistantships are available only for the academic year and require full-time enrollment in the school. If a student completes the assistantship in full and makes adequate progress toward the degree during the first year, the student will receive the assistantship funds as scholarship applied directly to their bursar account toward their tuition for the second year.

The Nicholas School Professional Student Fellowship. Established by Sally S. Kleberg, this fellowship provides financial support to Nicholas School students.


Robert W. Safrit Jr. Fellowship. Established by Robert W. Safrit, this fellowship is for graduate students at the Marine Lab.

Gary H. Salenger Fellowship. Established by Gary Salenger, this fellowship is for Nicholas School students.

W. Schlesinger Scholarship. Established by friends of William H. Schlesinger, this fund provides scholarships to graduate professional Nicholas School students.

Truman T. and Nellie Semans Scholarship. Established by Truman and Nellie Semans, this fund provides fellowships for Nicholas School students.

Bartow Shaw Family Fellowship. Established by Bartow Shaw, this fellowship is for Nicholas School students, with preference given to students pursuing a master of forestry degree.

Syngenta Crop Protection Inc. Fellowship. Established by the company, this fellowship is for Nicholas School students, with preference given to students studying environmental toxicology or environmental risk assessment.

Yasuomi Tanaka Memorial Fellowship. Established by Frances Tanaka, this fellowship is given to Nicholas School students, with preference given to international students.

Thorensen Foundation Fellowship. Established by Paul O’Connell, this fund provides fellowships for Nicholas School students.

Wade Family Fund. Established by Charles B. Wade, Jr. T’38, this fund provides scholarships for Nicholas School students studying at the Marine Lab.

Dr. Larry R. Widell Memorial Fellowship. Established by Christopher M. Widell, this fund provides scholarships to graduate professional Nicholas School students, with a preference given to doctoral students.

Zirkle Fellowships. Established by Sara and Lewis Zirkle, this fellowship is offered to Nicholas School students.

The Orvis Fellowship. Established by the Perkins Charitable Foundation, the Orvis-Perkins Foundation, and the Leigh H. Perkins Charitable Lead Trust, this fellowship is offered to Nicholas School students.

The Orrin Pilkey Fellowship. Established by friends of Orrin Pilkey, this fellowship is for Nicholas School students applying research to human uses of the coastal zone.


The Robert W. Safrit Jr. Fellowship. Established by Robert W. Safrit, this fellowship is for graduate students at the Marine Lab.

The Gary H. Salenger Fellowship. Established by Gary Salenger, this fellowship is for Nicholas School students.

The W. Schlesinger Scholarship. Established by friends of William H. Schlesinger, this fund provides scholarships to graduate professional Nicholas School students.

The Truman T. and Nellie Semans Scholarship. Established by Truman and Nellie Semans, this fund provides fellowships for Nicholas School students.

The Bartow Shaw Family Fellowship. Established by Bartow Shaw, this fellowship is for Nicholas School students, with preference given to students pursuing a master of forestry degree.

The Syngenta Crop Protection Inc. Fellowship. Established by the company, this fellowship is for Nicholas School students, with preference given to students studying environmental toxicology or environmental risk assessment.

The Yasuomi Tanaka Memorial Fellowship. Established by Frances Tanaka, this fellowship is given to Nicholas School students, with preference given to international students.

The Thorensen Foundation Fellowship. Established by Paul O’Connell, this fund provides fellowships for Nicholas School students.

The Wade Family Fund. Established by Charles B. Wade, Jr. T’38, this fund provides scholarships for Nicholas School students studying at the Marine Lab.

The Dr. Larry R. Widell Memorial Fellowship. Established by Christopher M. Widell, this fund provides scholarships to graduate professional Nicholas School students, with a preference given to doctoral students.

The Zirkle Fellowships. Established by Sara and Lewis Zirkle, this fellowship is offered to Nicholas School students.
Work-Study

Work-study funds for professional degree students are administered through the Office of Student Services. At the beginning of the academic year, students are made aware of work-study opportunities and informed of the application procedures. Interested students must file the Free Application for Federal Student Aid (FAFSA) in order to determine eligibility. Because the FAFSA is available only to US citizens and permanent residents, work/study funds are not available for F-1 and J-1 students. Some on-campus jobs may not require work/study funding but many will require it. Currently, students enrolled in the DEL-MEM Program are not eligible for work-study funds.

Application for Awards for the Entering Student

Students wishing to be considered for merit-based scholarships must submit a complete application no later than January 17 preceding the fall for which admission is desired. Applications received after January 17 will be considered for merit-based assistance only if funds remain after considering all on-time applications. Applicants should initiate the necessary action early to ensure that the required documents are filed with the school’s Office of Student Services on or before January 17 to be assured of equal consideration for financial aid. Completed applications received after the January 17 deadline will be considered if vacancies occur at a later date.

Notification and Acceptance of Awards

Applicants who submit completed applications by January 17 and are subsequently offered admission will be notified soon after admission regarding merit-based aid. Once offered by the university or the school, funds are committed to one student and are therefore unavailable to others. As a consequence, it is the policy of the Nicholas School that all awards offered may be declined prior to April 17 without prejudice. However, offers accepted and left in effect after April 17 are binding for both the student and the school.

Loans

Federally insured student loans are often necessary and useful in helping a needy student afford the graduate program of his or her choice. Students considering federal loans should consider the nature of the loan and the positive and negative aspects of future loan payments and should also investigate all other forms of financial assistance.

Federal law requires all students to have completed a Free Application for Federal Student Aid (FAFSA) to determine financial need. The FAFSA form may be obtained online at https://fafsa.ed.gov or by contacting a college or university financial aid office or the Office of Student Services. No loan application will be processed without the FAFSA form having been submitted to the central processor. In addition, in some cases federal law requires verification of income and other information.

Federal Unsubsidized Loans

Federal Direct Unsubsidized loans of up to $20,500 are available for eligible graduate/professional students. For loans made to new borrowers, interest is calculated at a fixed annual rate of 6.079 percent for the 2019-2020 academic year. Interest on unsubsidized loans must be paid by the student during enrollment or capitalized to the principal at the borrower’s request. A loan origination fee of approximately 1.06 percent will be charged and will be deducted before the loan disburses.

Students who borrow through the federal direct unsubsidized program will be given entrance and exit interviews concerning the projected and actual costs of their loans. They will also be provided with information on loan consolidation should this repayment option be desired or needed.

Graduate Plus Loan Information

The Deficit Reduction Act of 2005 allows graduate and professional students to borrow under the Federal PLUS loan program beginning with the 2006-07 aid year. The PLUS (Parent Loan for Undergraduate Students) was previously available only to the parents of dependent undergraduate students. Beginning July 1, 2006, that availability was expanded to graduate/professional students. Students must be graduate/professional students enrolled at least half-time in a matriculated program; they must complete a current FAFSA; they must first apply for the maximum loan eligibility in Federal Unsubsidized loan before the PLUS can be awarded; parents of graduate students will not be eligible to borrow the loan.

PLUS Loan borrowers are required to pass a basic credit check. The borrower may borrow the difference between the total cost of the student’s education (including books, fees, and personal expenses) minus any financial aid the student will receive. The interest rate on the PLUS loan is 7.079 percent for the 2019-2020 academic year.

Repayment begins within sixty days after the final disbursement of each loan. The maximum repayment period is ten years, and the minimum monthly payment is $50. Students may be eligible to defer payments as long as they maintain at least half-time enrollment. A loan fee of approximately 4 percent will be charged and will be deducted proportionately prior to each loan disbursement. In addition, some loan guarantee agencies charge a 1 percent guarantee fee, which will also be deducted from disbursements.

Academic Regulations

Course Planning

Each of the professional programs has required courses or required areas of study, and responsibility for meeting these requirements before graduation rests with the student, with the assistance of the coursework advisor. During orientation, each student is assigned a faculty coursework advisor. Early in the first semester, the student and advisor should fill out a course planning form outlining four semesters of coursework that will meet program course and credit requirements. This form can be amended at any time before the last semester of a student’s program, provided the plan still meets all requirements for graduation. Prospective students interested in specific advisors should include the faculty member’s name in their application statement; it is not necessary to contact potential advisors before orientation.

It is usually possible to change coursework advisors, with the approval of both the current and prospective advisors, and it is common to have as a master’s project advisor someone other than the coursework advisor. It is also usually possible to change programs through the end
of the second semester (out of four required semesters of enrollment), provided that the student has met prerequisites for the new program and provided that it is still possible for the student to meet all requirements of the new program before graduation. A student changing programs will usually be assigned a new coursework advisor, and the student must complete a new course planning form showing how program requirements will be met. The student is responsible for ensuring that all degree requirements have been met. Faculty coursework advisors and staff in Student Services are available to advise and assist students but the final responsibility rests with the student.

Students in the DEL-MEM Program have the majority of their required coursework planned for them. Students work directly with the faculty program director and/or the Nicholas School registrar to ensure they are meeting these requirements before graduation; however, the responsibility rests with the students to successfully manage their coursework. DEL-MEM students will be assigned a master’s or capstone project advisor during their second semester.

Language Testing

Proficiency exams in written and spoken English will be given to non-native English speakers regardless of citizenship during the week prior to orientation week. Students found to lack the proficiency in English needed to do well at Duke will be required to enroll in additional English language instruction. Students who are required to take English language courses at Duke will be charged a $1,225 premium added to their bursar account for each English language course to help defray the added cost of the course. Students choosing to undertake outside tutoring in English should be prepared to assume all costs for being tutored and may need to reduce their course or research program while being tutored. If more than one English language course is required, MEM and MF students may count one English course toward their degree; otherwise, English language instruction does not count toward course credit required for the MEM or MF degree. Non-native English speakers applying to the DEL-MEM should consult with that program for specific requirements beyond the TOEFL, https://nicholas.duke.edu/admissions/how-apply.

Registration

Entering students who enroll in the Master of Environmental Management, Master of Forestry, or DEL-MEM degree programs will receive instructions from the Nicholas School of the Environment about registering for courses. Registration for new students should be completed during the orientation period. Students in residence register for succeeding semesters at times scheduled in the university calendar.

Registration is approved by the advisor and completed by the student using an online registration system. Registration is required in order to take courses for credit or audit. To establish eligibility for university and other loans, for the student health service, and for study and laboratory space, a student must be registered. All tuition and fee payments and any indebtedness must be settled before registration can be completed.

Course Credits

Candidates for the professional degrees are considered fully registered when they enroll full-time for the number of semesters required in their individual degree programs (for example, four semesters for the MEM or MF degree). Students normally register for 12.0 course credits per semester, although a variation from 9.0 to 15.0 course credits is common. Students must have the permission of their advisor to register for more than 15.0 course credits in a semester, and all students who wish to enroll for fewer than 9.0 course credits must make a formal request to the education committee to study part-time. The Nicholas School does not accept transfer credits; courses taken through the Interinstitutional Agreement (see below) are not considered transfer credits.

Courses below the 500 level may not be applied toward the required credits needed for a master's/graduate degree. With the approval of their department, graduate students may enroll in lower-level courses as a course overload, but these courses will not count toward any graduation requirement (including electives) and will not count toward the credits required to demonstrate full-time enrollment status. Graduate/professional students interested in enrolling in courses below the 500 level must complete the appropriate registration form and submit it to the Office of Student Services.

The DEL-MEM Program is a minimum thirty-course credit degree program. To complete the DEL-MEM Program within four consecutive semesters, students typically take between 6.0 and 9.0 course credits per semester. Permission is required to register for fewer than 6.0 credits or more than 9.0 course credits in a semester. Students must be enrolled with at least 6.0 course credits to be considered a full-time student and to receive federal financial aid, if eligible. Students registering for fewer than 6.0 course credits per semester are not eligible to receive federal financial aid.

Late Registration

All students should register at the times specified by the university. The charge for late registration is significant.

Drop/Add

The period for dropping and adding courses ends on the tenth calendar day of the fall and spring semesters. During the summer, dropping, or adding of courses is limited to the first three days of the term. Students are advised to make all class changes on the first day of class if at all possible.

Reciprocal Agreements with Neighboring Universities

Students enrolled full-time in the Nicholas School during the regular academic year may enroll for up to 6.0 course credits (two course maximum) per semester at The University of North Carolina at Chapel Hill, North Carolina State University, North Carolina Central University, or any other university participating in the Interinstitutional Agreement provided that they are also registered for at least 6.0 course credits at Duke during the same semester. Similarly, graduate students at these universities may take up to 6.0 course credits per semester at Duke. In the summer, students may take courses interinstitutionally provided that they are enrolled at Duke for at least the same number of hours they wish to take at the other school(s); graduate students are limited to two summer courses at other institutions. This agreement does not apply to contract programs such as the American Dance Festival. The student must pay any special fees required of students at the host institution and provide his or her own transportation. A bus service sponsored by the Robertson Scholars Program travels between Duke and UNC every
Academic Information for Professional Degree Students

thirty minutes during the academic year. The reciprocal agreements with neighboring universities do not apply to distance-learning programs. In general, online or distance-learning courses are not part of the interinstitutional agreement. If a student identifies a course at one of the participating institutions that is offered only in an online format, the student may petition the Nicholas School registrar and appropriate program chair for permission to take the course through the Interinstitutional Agreement. Decisions will be on a case-by-case basis with no expectation of setting a precedent.

Immunization Requirement

North Carolina law requires students entering a college or university in the state to be immunized against measles, rubella, tetanus, pertussis, diphtheria, and in some cases, polio. Each entering student is required to present proof of these immunizations in accordance with the instructions contained in the Student Health Services form provided with the student's matriculation material. This form should be completed and returned to Student Health Services prior to the student’s first day of classes. Duke University cannot permit a student to attend classes unless the required immunizations have been obtained. Students who fail to meet the immunization requirements will be withdrawn from the university. DEL-MEM students are exempt from this requirement unless the student's status changes to: on-campus courses, course load of more than four (4) credit hours, on-campus residence, and/or enrollment in daytime courses. If that happens, then a Certificate of Immunization or record of immunization must be presented on or before the date the person first registers for a semester.

Courses

Course Descriptions

Courses offered by the school are described in the final section of this bulletin. However, courses are subject to change. Prior to registration for a given term, the Office of Student Services prepares a list of courses to be offered as well as schedules of courses offered in other departments at Duke and at neighboring universities. These lists are made available online and can be printed should the need arise.

Independent Study

All professional degree students have the opportunity to pursue independent study with individual faculty members. After discussing the potential for an independent study with a faculty member, students register to take independent study credit under Environment 593 (Environment 997 for DEL-MEM students).

Master’s Project – On-Campus Students

All students must complete a capstone master’s project in which knowledge, skills and tools acquired during the two years of study are applied to address environmental problems. Students will receive 4.0 to 6.0 course credits for the master’s project. No student will be permitted to register for the fourth term of study until a project proposal has been approved and signed by the student's advisor and received by the school's Office of Student Services. During the final two terms, major emphasis should be placed on the project.

Most students in the MEM and MF programs complete collaborative, or group, master’s projects. In group master’s projects, teams of three to five students take on a real-world challenge facing a client. Students work directly with the client, under the supervision of an assigned faculty advisor, to address the challenge. These projects begin in the spring of the first year but are completed during the second year of study; some group master’s projects include summer work as well.

Fewer numbers of students complete individual and/or more research-based master’s projects. Students in this group should identify their project during the second term of study, work on it during the summer between academic years and complete it during the third and fourth terms.

Students may use summer internships as the basis for master’s projects and may consult closely with a supervisor outside the school to complete the work, though their faculty supervisor is the final reviewer and grader of the project. In most cases, project advisors for individual master’s projects are assigned by faculty committee, taking into account subject matter, experience, interest, as well as equitability of advising responsibilities.

Students should maintain close contact with their advisors throughout their work on the master’s project. Advisors review and approve the project in mid-March for public presentation in early April. All students are required to make a public presentation of their project at a Master’s Project Symposium that is open to the public.

All completed master’s projects are required to be uploaded to Duke Library’s DukeSpace website and are searchable across the Internet. If the master’s project contains sensitive information (e.g., from the client’s point of view, in terms of future publication elsewhere, or sensitivity for commercial ventures) students may create a redacted version of the written master’s project or request an embargo of up to two years. Requests must include specific justification for the embargo for the specific period of time. Requests are sent to the assistant dean for student services.

Master’s Project - DEL-MEM Students

All DEL-MEM students must complete a master’s project of 4.0 course credits. The project should be identified during the second term of study, initiated during the summer between academic years and completed during the third and fourth terms. During the final two terms, major emphasis should be placed on the project. In completing the project, the student applies theoretical and analytical training acquired during the two years of study to actual natural resource or environmental problems. DEL-MEM students are encouraged to use current professional career interest and projects as the basis for master’s or capstone projects and may consult closely with a supervisor outside the school, as well as with their faculty master’s project advisor, to complete their work. Students should maintain close contact with their advisors during the development and writing of the master’s project. Projects should reach final stages of completion by midterm of the final semester. A complete draft of the project must be delivered to the advisor prior to October 1 for those graduating in December, prior to March 1 for those graduating in May, and prior to July 1 for those graduating in September. The advisor is responsible for critical assessment and grading. Actual dates may fluctuate depending on possible changes to the organization of the MP process.
Auditing

Students registered for a full course load may audit courses free of charge. Otherwise, the audit fee is $1,860 per course. In classes in which enrollment is limited, students enrolled for credit will receive priority. Audited courses are recorded with a grade of AD for satisfactory completion or WA for unsatisfactory completion on the student’s permanent record. Regular attendance is expected. Changes from audit to credit are not permitted after the Drop/Add period. Audited courses may not be used to fulfill either program or graduation requirements. Audited courses may not be counted toward the number of credits required for graduation. Students must obtain written permission of the instructor to audit a course.

Executive Education Short Courses

Short courses are offered through the Nicholas School’s Executive Education (NSEE) Program. View registration and availability policies at https://nicholas.duke.edu/about/policies/nicholas-school-executive-education-short-course-policy-duke-university-students. Enrollment policies are subject to change. For more information, visit https://nicholas.duke.edu/academics/executive-education.

Retaking Courses

Courses required as a part of the program elected by the student or required by the advisor may be retaken if failed. Courses prerequisite to more advanced courses the student wishes to take must be retaken if failed. Elective courses may be retaken if the student wishes to do so. See the section on grades below for additional information.

Class Attendance

It is expected that students attend class every time the course meets. It is understood that on occasion the student may need to miss class due to illness. Whenever possible, as a courtesy to the instructor, the student should be in communication with the instructor in advance of the absence. If the absence is unexpected due to illness, the student should alert the instructor as soon as possible. If a medical condition or extended illness causes the student to miss more than one class meeting, a doctor’s note should be provided to Student Services. If a medical condition or extended illness causes absence from a test, mid-term, or exam, the instructor may arrange an alternate test date, at the instructor’s discretion. If such is the case the student must provide a doctor’s excuse to Student Services.

Grades

Grading System

The grading system used in the Nicholas School and The Graduate School is as follows: A (exceptional); B (good); C (satisfactory); F (failing); I (incomplete); Z (continuing). Plus (+) and minus (-) notations are permitted. Course instructors are unable to change grades once final grades have been submitted unless there has been an error in calculation or transcription.

The grades of P (pass) and F (fail) are used in the Nicholas School for seminars, master’s projects, program area seminars, and modular courses. At the instructor’s option, the grades of P or F or regular letter grades are used for intensive courses and independent projects. If a student wishes to take a regularly letter-graded course on a Pass/Fail basis, permission for the Pass/Fail option must be obtained in writing from the instructor prior to registration for the course. Regularly graded courses taken on a Pass/Fail basis may not count toward graduation or fulfill programmatic requirements.

The grade of Z is assigned for an independent project or a master’s project that extends over a period of more than one semester; a final grade is given upon completion of the project.

Incomplete Grades

A grade of I indicates that some portion of the student’s work is lacking, for an acceptable reason, at the time grades are reported. Students unable to complete course requirements by the deadline must have communicated with the instructor well in advance of the conclusion of the course so that the instructor may determine if an Incomplete is appropriate and necessary. Students who fail to communicate with the instructor and who fail to complete the course requirements will be assigned a failing grade (F). Requirements of all courses in which an instructor assigns a grade of Incomplete must be fulfilled within one calendar year following the date of the assignment of the incomplete grade.

In exceptional circumstances, upon recommendation of the professor who assigned the grade of Incomplete, the dean of the Nicholas School may extend the time for completion of the course requirements. If, in the judgment of the professor and the student’s advisor, completion of the requirements is not a reasonable alternative for the student, the student may petition the Education Committee to allow the grade of I to stand permanently on his or her record. No student will be allowed to graduate with an Incomplete unless permission has been granted for it to stand permanently on the record.

Failure

Failing a course may leave a student short of credits for graduation or lacking program curriculum requirements. If the failed course is not necessary to complete program curriculum requirements, the student may substitute another course to make up the lost credit, with the advisor’s approval. If the failed course is necessary to complete program curriculum requirements, the student must retake either that course or an acceptable substitute, with the advisor’s approval. Both the original failing grade and the grade received for the retaken or substitute course will appear on the student’s transcript.

Failure of a course also subjects the student to dismissal.

Probation and Dismissal

Any of the following situations will result in probationary status for the following semester:

• Failing one or more courses
• Two or more C (C-, C, C+) grades in a semester
• Failing to maintain a cumulative average of at least B-
A student on probation must meet jointly with his/her advisor and one additional regular-rank faculty member selected by the student and his/her advisor before the end of Drop/Add (preferably before the beginning of the semester) to discuss what is going wrong and how to remedy it. These faculty committees or the Education Committee have the discretion to suggest that a student take a leave of absence for a semester if they judge that to be the best way for the student to improve academic performance. A student on probation must meet again with the advisor and second faculty member a month after the first meeting to review academic progress.

Any student who does not meet academic standards at the end of the probationary semester will be subject to dismissal from the Nicholas School. The Education Committee will make decisions on dismissal.

In addition, students must have at least 48.0 course credits (30.0 course credits within the DEL-MEM Program) with a grade point average of B- or better to graduate. Students who fail to meet that standard during their final semester must take additional Duke credits to meet the standard before they can graduate. Any exceptions are at the discretion of the Education Committee.

For students placed on probation, the Nicholas School’s policy regarding awards from the school (e.g., merit-based financial aid, fellowships, scholarships, recognition awards with no monetary component) is as follows:

1. Students not in good standing (with regard to academics or honor code) are not eligible for any new awards from the Nicholas School (e.g., scholarships, fellowships, school-supported internships, and recognitions without monetary component) whether academic performance is a criterion or not.
2. Students holding scholarships or other awards when they are put on probation may be allowed to keep them for one semester if the student’s petition to do so is approved by the associate dean for professional programs and the assistant dean for student services. Any student not released from probation after one semester will not be eligible to retain the scholarship/fellowship.

Students who are dismissed for honor code or other serious violations must relinquish any awards.

Satisfactory Academic Progress

Federal regulations require that, in order to be eligible for assistance from any Federal Title IV student aid program, including but not limited to the Federal Direct Unsubsidized Loan and the GradPLUS loan, a student must be making satisfactory academic progress.

For the purpose of Title IV financial aid eligibility only, a student enrolled in the Master of Environmental Management and/or Master of Forestry degree in the Nicholas School of the Environment as a full-time degree-seeking student must meet the following standards of satisfactory academic progress:

1. The student must have a cumulative grade point average of at least a B- (2.7) or higher after completing their first semester and at the end of each subsequent semester (fall and spring semesters; does not include summer terms one and two).
2. A student in either the MEM or the MF must earn their degree before earning 72.0 course credits (150% of the standard minimum 48.0 credits). A student in the dual MEM/MF must earn at least 72.0 course credits in order to graduate and successfully complete the degree requirements before earning 108.0 course credits. A student in a dual degree program must complete successfully at least 36.0 course credits and earn their degree before earning 54.0 course credits on their Nicholas School transcript. Students must successfully complete all of their degree requirements before obtaining 150% of the credits needed to graduate from each program as outlined.
3. The student must earn satisfactory grades in at least 67% of their cumulative credits. Satisfactory grades in the Nicholas School are A, B, C (including + and -), CR and P.

Any student who fails to meet satisfactory academic progress will be placed on Title IV warning for one semester. During that semester, the student will continue to be eligible for Title IV aid. At the end of a term during which a student is on Title IV warning, if the student still fails to meet any of the requirements, the student will become ineligible for Title IV assistance.

Honor Code

The Nicholas School of the Environment advocates the highest standard of professional ethics and academic integrity. Students and faculty have developed an honor code for the school that is distributed to all students prior to matriculation and then discussed and signed during orientation. The Nicholas School uses the Community Standard (see below) as its basis.

The Duke Community Standard

Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity.

The Pledge

Students affirm their commitment to uphold the values of the Duke University community by signing a pledge that states:

• I will not lie, cheat, or steal in my academic endeavors;
• I will conduct myself honorably in all my endeavors; and
• I will act if the Standard is compromised.

A more complete explanation of the application of this standard in the Nicholas School may be found at https://nicholas.duke.edu/about/policies/nicholas-school-honor-code.

Harassment Policy

Harassment of any kind is not acceptable in the Nicholas School of the Environment or at Duke University. It is inconsistent with the university’s commitments to excellence and to respect for all individuals.

Harassment is described by Duke University as the creation of a hostile or intimidating environment in which unwelcome verbal or physical conduct, because of its severity, pervasiveness, and/or persistence, interferes significantly and unreasonably with an individual’s work or education or adversely affects an individual’s living conditions. Sexual harassment also includes unwelcome sexual advances, requests for
sexual favors, or other verbal or physical conduct of a sexual nature, when submission to such conduct is made either implicitly or explicitly a term or condition of employment, or when submission to or rejection of such conduct by an individual is used as the basis for employment or educational decisions affecting the individual.

Allegations of harassment will be handled under either the Student Sexual Misconduct Policy (misconduct by students) or the Harassment Policy (misconduct by employees or third parties). Members of the Nicholas School of the Environment community who have questions about these policies, how to deal with a suspected violation, and options for resolution should contact the Office for Institutional Equity or the Office of Student Conduct.

Academic Irregularities

All cases falling outside the regular policies and procedures of the school are referred to the Education Committee for decision. The committee reviews and makes decisions regarding course requirements for graduation, student probation and dismissal, student petitions for waivers of degree requirements and all actions that deviate from established academic regulations. Any waiver requests to reduce credits, course requirements, minimum semesters of tuition, or in-residence requirements must be made before half of the total credits are completed for the student's degree program.

A student who desires to petition the committee should do so by writing to its chair. A precise statement of the reason for the request is required. The student will be notified in writing of the decision of the committee by the chair.

Transcripts of Credit

A student who is registered for a course and who successfully completes the requirements as prescribed by the instructor receives credit on university records. A transcript fee, charged to all students during their first semester of enrollment, covers all future transcript requests. Only the Office of the University Registrar issues transcripts of credit. Currently enrolled students may request transcripts through DukeHub. Alumni wishing to request transcripts should go to https://registrar.duke.edu/student-records-resources/transcripts-and-verifications and complete the online form. No transcripts will be issued for students who fail to clear all financial obligations to the university upon graduation.

Length of Study

For full-time on-campus students and DEL-MEM students, the normal time for completing a professional master’s degree is four semesters, not including summer. All degree requirements for the MEM, MF, and DEL-MEM must be completed within five years of the first term of admission. Any term/s during which the student is not enrolled for any number of credits still count and are included in the five-year window for completion.

For a typical dual degree student, the normal time for completing both professional degrees is four to eight semesters depending on the other concurrent degree being pursued. The time to degree completion remains five years from the first term of admission. Any term/s during which the student is not enrolled for any number of credits still count and are included in the five-year window for completion.

Leave of Absence or Withdrawal

Occasionally, special circumstances require a student to leave the university for one or two semesters at a time. If the reason for the departure is considered an emergency, the student may request a leave of absence for a period not to exceed one year. If the reason is to study elsewhere in a combined degree program, a leave will be granted for the length of study. If the student plans to do field studies or an internship, he or she must maintain university enrollment by paying a registration fee each semester of the academic year until full-time study is resumed.

Under all circumstances, the student must request the leave for a specific length of time prior to departure from the university. Extensions must be requested if they are required for a maximum of two semesters, except as indicated above. Failure to request a leave or an extension of leave may result in a penalty charge and/or dismissal from the university. A student is eligible to request a leave of absence only after having completed at least one semester of study.

A student who wishes to withdraw from the university must make a written request to do so. For refunds upon withdrawal, see the section on financial information above.

Graduation

Even if degree plans are tentative, a candidate for a degree must apply for graduation at the designated time for each semester. The registration is valid only for the semester in which it is filed. If the student does not receive the degree as expected, he or she must register again at a later time.

All candidates are encouraged to attend the commencement exercises at which their degrees are to be awarded. A student who is unable to attend must notify the assistant dean for student services no later than four weeks prior to commencement to receive the degree in absentia.

Debts

Students are expected to meet all financial obligations to the university prior to completion of the degree. Failure to pay all university charges by the due dates specified by the university will bar the student from registration, class attendance, receipt of transcripts, certification of credits, leave of absence, or graduation until the account is settled in full. Further, an individual in default may be subject to dismissal from the university.
Career and Professional Development

The Nicholas School of the Environment recognizes the importance of blending rigorous academic study with professional development and career opportunities. The Nicholas School has its own Career and Professional Development Center (CPDC) to provide a wide variety of services, programs, and resources to enhance a student’s professional preparation and career opportunities.

The CPDC staff assists students with exploring career options, developing individualized strategies for finding internships and permanent employment and making contacts with alumni and employers. The CPDC provides Nicholas School students with many services, including individual advising and job search assistance, networking opportunities, internship panels with experienced students, workshops and critiques for interviews, resume and cover letter writing, and employment and salary statistics for negotiating offers. The CPDC staff also provides guidance to the Duke Environmental Leadership (DEL) MEM students interested in career advancement. Nicholas School alumni have lifetime services for career transition and career advancement coaching.

The Nicholas School recommends three main career networking platforms—a Nicholas School Job Share Facebook group managed by alumni, the Duke Alumni Association database, and the NSOE LinkedIn group. The LinkedIn group is managed by CPDC, and members are vetted to ensure they are a member of the Nicholas community (student, alumni, faculty, or staff) before being admitted to the group.

The CPDC schedules career exploration opportunities, employer information sessions, site visits and on-campus recruiting events throughout the academic year to allow students to meet employers and broaden their knowledge of the environmental profession.

Summer Enrichment Opportunities

Practical experience is integral to the Nicholas School’s educational process and even more important to employers seeking qualified candidates. Some type of summer enrichment experience is recommended, but not required, between academic years of study. The CPDC staff can assist students in identifying internships to meet professional development goals or research interests. Internships, fellowships or research experiences are opportunities for students to explore or enhance career experiences, learn or apply new skills, establish networks of practicing professionals and gain perspective on environmental issues in various regions or countries. Typically more than 90 percent of all Nicholas School students report completing summer enrichment experiences during their MEM or MF program.

Each year Nicholas School students participate in summer experiences throughout the United States and around the world. Students work with consulting firms, business, industry, nonprofit organizations, government agencies, and international organizations to supplement career preparation or research interests. Enrichment experiences may be secured at other times and for longer durations. In addition, they may serve as the foundation for a master’s project or open doors to new career interests and employment options.

Summer Enrichment Opportunity Funds

The CPDC staff may also assist students in identifying paid opportunities or securing small grants for underfunded summer projects. The Nicholas School has grants and endowments that MEM, MF, and DEL-MEM students can apply for funding to partially support both US-based and international internships.

Made possible by the generous support of Mr. and Mrs. Fred Stanback, the Nicholas School partners with targeted conservation organizations to administer the Duke University Stanback Fellowship Program. Its purpose is to provide all Duke students with a significant paid summer learning experience in policy, research, applied resource management and stakeholder engagement. Each year more than 150 internship projects with more than fifty non-governmental conservation organizations are offered to Nicholas School and Duke University students. Incoming MEM and MF students may become eligible to apply once Student Services confirms receipt of the tuition deposit.
Employment Trends and Statistics

The variety and geographic distribution of organizations that employ Nicholas School graduates demonstrate the value and relevance of the Master of Environmental Management and the Master of Forestry programs. Graduates' career success confirms the marketability of a professional/graduate degree from Duke.

The following employment statistics are based on data collected for the Nicholas School class of 2018, six months following graduation.

**OVERALL EMPLOYMENT BY SECTOR**

- **BUSINESS/INDUSTRY**: 32%
- **CONSULTING**: 29%
- **EDUCATION**: 6%
- **ENTREPRENEUR/START-UP**: 3%
- **FEDERAL GOVERNMENT**: 4%
- **NONPROFIT/NGO**: 11%
- **RESEARCH INSTITUTE/THINK TANK**: 7%
- **STATE/LOCAL GOVERNMENT**: 8%

**SALARY RANGE**

Salaries vary widely depending on the type of employer, individual qualifications, previous experience and job location.

**Median salary range for MEM and/or MF graduates**

$55,000-60,000

**Median salary range for MEM/MBA or MF/MBA concurrent degree students**

$120,000-130,000
<table>
<thead>
<tr>
<th>Type of Employer</th>
<th>Average Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business/Industry/Legal</td>
<td>$77,500</td>
</tr>
<tr>
<td>Consulting</td>
<td>$62,500</td>
</tr>
<tr>
<td>Education</td>
<td>$42,500</td>
</tr>
<tr>
<td>Federal Government</td>
<td>$57,500</td>
</tr>
<tr>
<td>Nonprofit/NGO</td>
<td>$52,500</td>
</tr>
<tr>
<td>Research Institute/Think Tank</td>
<td>$47,500</td>
</tr>
<tr>
<td>State/Local Government</td>
<td>$52,500</td>
</tr>
<tr>
<td>Entrepreneur</td>
<td>$47,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2018 Salary Distribution by Program Area</th>
<th>MEM/MF Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business and Environment</td>
<td>$65,000-$70,000</td>
</tr>
<tr>
<td>Coastal Environmental Management</td>
<td>$40,000-$45,000</td>
</tr>
<tr>
<td>Ecosystem Science and Conservation</td>
<td>$55,000-$60,000</td>
</tr>
<tr>
<td>Ecotoxicology and Environmental Health</td>
<td>$50,000-$55,000</td>
</tr>
<tr>
<td>Energy and the Environment</td>
<td>$80,000-$85,000</td>
</tr>
<tr>
<td>Environmental Economics and Policy</td>
<td>$55,000-$60,000</td>
</tr>
<tr>
<td>Global Environmental Change</td>
<td>$40,000-$45,000</td>
</tr>
<tr>
<td>Water Resources Management</td>
<td>$65,000-$70,000</td>
</tr>
<tr>
<td>MEM/MF</td>
<td>NA</td>
</tr>
</tbody>
</table>

Sample First Destination Employers (2013-2018)

<table>
<thead>
<tr>
<th>Employer</th>
<th>Location/Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abt Associates</td>
<td>Chaparral Lands Conservancy</td>
</tr>
<tr>
<td>AICPA</td>
<td>Chesapeake Bay Foundation</td>
</tr>
<tr>
<td>Alliance for the Chesapeake Bay</td>
<td>China Academy of Urban Planning and Design</td>
</tr>
<tr>
<td>Amazon</td>
<td>China Merchants Bank</td>
</tr>
<tr>
<td>American Forest Management</td>
<td>City of Sunnyvale</td>
</tr>
<tr>
<td>Apple, Inc.</td>
<td>ClearPath Foundation</td>
</tr>
<tr>
<td>Aquidneck Land Trust</td>
<td>Climate Corporation</td>
</tr>
<tr>
<td>Bain and Company</td>
<td>Coastal Protection and Restoration Authority of Louisiana</td>
</tr>
<tr>
<td>Baltimore County DEP and Sustainability</td>
<td>Coastal Resources, Inc.</td>
</tr>
<tr>
<td>Baltimore Gas &amp; Electric</td>
<td>Columbia Sportswear</td>
</tr>
<tr>
<td>Bank Information Center</td>
<td>COMPASS</td>
</tr>
<tr>
<td>BASF</td>
<td>Conservation Northwest and the Pacific Wolf Coalition</td>
</tr>
<tr>
<td>Bates White Economic Consulting</td>
<td>Cradle to Cradle Products Innovation</td>
</tr>
<tr>
<td>Beveridge &amp; Diamond, P.C.</td>
<td>Croatian Institute</td>
</tr>
<tr>
<td>Bio-Ops</td>
<td>CSA Ocean Sciences, Inc.</td>
</tr>
<tr>
<td>Blue Earth Consulting</td>
<td>Datu Research, LLC</td>
</tr>
<tr>
<td>Booz Allen Hamilton</td>
<td>Delaware Coastal Programs</td>
</tr>
<tr>
<td>Boston Pacific Company, Inc.</td>
<td>Deloitte Consulting</td>
</tr>
<tr>
<td>Botswana Predator Conservation Trust</td>
<td>Dewberry</td>
</tr>
<tr>
<td>Cadmus Group, Inc.</td>
<td>DNV GL</td>
</tr>
<tr>
<td>California Coastal Commission</td>
<td>DNV GL</td>
</tr>
<tr>
<td>California Recreation Fisheries</td>
<td>Dolphin Ecology Project</td>
</tr>
<tr>
<td>Campbell Global</td>
<td>Dow AgroSciences</td>
</tr>
<tr>
<td>Cape Cod Commercial Fishermen’s Alliance</td>
<td>Drive Oregon</td>
</tr>
<tr>
<td>Cardno Chemrisk</td>
<td>Duke Kunshan University</td>
</tr>
<tr>
<td>Carolina Mountain Land Conservancy</td>
<td>Duke University</td>
</tr>
<tr>
<td>Carollo Engineers</td>
<td>Duke Carbon Offsets Initiative</td>
</tr>
<tr>
<td>Carollo Engineers</td>
<td>E Source</td>
</tr>
<tr>
<td>ENVIRON</td>
<td>EA Engineering, Science and Technology</td>
</tr>
<tr>
<td>Earth Resources Technology</td>
<td>Environmental Services Technology</td>
</tr>
<tr>
<td>Environmental Science Technology</td>
<td>Environmental Defense Fund</td>
</tr>
<tr>
<td>Environmental Finance Center at UNC Chapel Hill</td>
<td>Environmental Incentives</td>
</tr>
<tr>
<td>Environmental Resources Management (ERM)</td>
<td>Environmental Resources Management (ERM)</td>
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<td>Environmental Services, Inc.</td>
<td>Envision Charlotte</td>
</tr>
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<td>Enviva LP</td>
<td>Express</td>
</tr>
<tr>
<td>F4 Tech</td>
<td>F4 Tech</td>
</tr>
<tr>
<td>Federal Energy Regulatory Commission</td>
<td>Dewberry</td>
</tr>
<tr>
<td>Florida Dept. of Environmental Protection</td>
<td>fishwise</td>
</tr>
<tr>
<td>Florida Fish and Wildlife Research Institute</td>
<td>Florida Dept. of Environmental Protection</td>
</tr>
<tr>
<td>GE Ventures</td>
<td>Florida Fish and Wildlife Research Institute</td>
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<td>Geromino Energy</td>
<td>GE Ventures</td>
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<td>GE Ventures</td>
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<tr>
<td>Greenwood Resources, Inc.</td>
<td>Greenwood Resources, Inc.</td>
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<tr>
<td>Haynes and Company</td>
<td>Haynes and Company</td>
</tr>
<tr>
<td>Academic Information for Professional Degree Students</td>
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<table>
<thead>
<tr>
<th>Sample First Destination Employers (2013-2018) (continued)</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Highstead Foundation</th>
<th>Nike</th>
<th>Tesla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi Consulting</td>
<td>NOAA</td>
<td>The Cadmus Group, Inc.</td>
</tr>
<tr>
<td>ICF International</td>
<td>Nomura Research Institute</td>
<td>The Environmental Integrity Project</td>
</tr>
<tr>
<td>International Center for Trade and Sustainable Development</td>
<td>Norfolk Southern Corporation</td>
<td>The Esplande Association</td>
</tr>
<tr>
<td>John Deere</td>
<td>North Carolina National Estuarine Research Reserve: NC Division of Coastal Management</td>
<td>The Nature Conservancy</td>
</tr>
<tr>
<td>Johnson &amp; Johnson</td>
<td>Northern Alaska Center</td>
<td>The North Carolina Energy Association</td>
</tr>
<tr>
<td>Jones Lasalle Lang</td>
<td>Northrop</td>
<td>The Pew Charitable Trusts</td>
</tr>
<tr>
<td>JP Morgan Chase</td>
<td>NRDC</td>
<td>TransCanada Energy Company</td>
</tr>
<tr>
<td>Knauss Sea Grant Fellowship</td>
<td>Oceana</td>
<td>Tridec Technologies/MD Dept Natural Resources Chesapeake &amp; Coastal Service</td>
</tr>
<tr>
<td>Korea Environmental Industry &amp; Technology Institute</td>
<td>ORISE/US EPA</td>
<td>Trinity Consultants</td>
</tr>
<tr>
<td>Koror State Legislature</td>
<td>Pacific Forest Trust</td>
<td>UNEP China Office</td>
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<tr>
<td>Kunoa Cattle Company</td>
<td>Pacific Northwest National Laboratory</td>
<td>UNICEF</td>
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<tr>
<td>Larry Walker Associates</td>
<td>Parsons Brinkerhoff</td>
<td>US Army Corps of Engineers</td>
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<tr>
<td>Levi Strauss &amp; Co.</td>
<td>Peace Corps</td>
<td>US Coast Guard</td>
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<tr>
<td>Lockheed Martin</td>
<td>Piedmont Environmental Council</td>
<td>US Congress Joint Economic Committee</td>
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<tr>
<td>Loggerhead Marine Life Center</td>
<td>PowerAdvocate</td>
<td>US Court of Appeals for the Eleventh Circuit</td>
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<tr>
<td>Logos Research Systems</td>
<td>Quantum Spatial Inc.</td>
<td>US DOE</td>
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<tr>
<td>Marine Megafauna Foundation</td>
<td>Raffetlis Financial Consultants</td>
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<td>Mars Petcare</td>
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<td>McDonald’s Corporation</td>
<td>REGEN Energy, Inc.</td>
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<td>McKnight Foundation</td>
<td>RESOLVE</td>
<td>Verdis Group</td>
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<tr>
<td>Metlife Timber Investment</td>
<td>Resource Energy Systems, LLC</td>
<td>Vestas</td>
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<tr>
<td>Michael Baker International</td>
<td>Resources for the Future</td>
<td>Virginia DCR</td>
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<td>National Association for Environmental Management</td>
<td>Rocky Mountain Institute</td>
<td>Voices for Biodiversity</td>
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<td>National Grid</td>
<td>RTI International</td>
<td>Votorantim Industrial</td>
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<td>National Young Farmers Coalition</td>
<td>Ruby Canyon Engineering, Inc</td>
<td>Washington Gas</td>
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<td>Navigant Consulting</td>
<td>Southwest Fisheries Science Center - Ecology Division</td>
<td>Water Institute of the Gulf</td>
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<td>NC Aquarium</td>
<td>Spokane County</td>
<td>Welltok</td>
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<td>NC Division of Water Resources</td>
<td>Sprig: Eat Well</td>
<td>Weyerhaeuser</td>
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<td>Nicholas Institute for Environmental Policy Solutions</td>
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International Master of Environmental Policy (Duke Kunshan University)

The Sanford School of Public Policy and the Nicholas School offer a two-year International Master of Environmental Policy (iMEP) Program based at the Duke Kunshan University campus. The iMEP Program offers a highly analytical and multi-disciplinary master’s degree based on the Duke Master of Public Policy (MPP) and Master of Environmental Management (MEM) programs. With an emphasis on both international and Chinese experience and contexts, the iMEP combines a world-class faculty, a cutting-edge research center, an innovative curriculum, and unparalleled career opportunities.

Duke Kunshan University’s iMEP Program prepares its graduates to meet the pressing environmental and economic challenges facing the international community through effective policy solutions by drawing from an array of disciplines. The core curriculum combines economics, science, law and governance, policy, and program evaluation. The program is four semesters and includes sixteen courses for a total of 48.0 graduate course credits. The program allows Duke Kunshan University students to spend their third semester at Duke with an option to arrive at Duke the summer before to participate in educational opportunities, including coursework and internships. In their second year, iMEP students complete a client-based or quantitative research master’s project in partnership with an academic advisor.

The iMEP Program simultaneously creates a one-semester study away opportunity for Sanford MPP and Nicholas School MEM students, who may travel to Duke Kunshan University in their third semester. Duke and Duke Kunshan faculty may participate in a similar exchange.

iMEP Program Admissions

Eligibility
iMEP seeks applications from a variety of academic, professional, ethnic, and cultural backgrounds. The iMEP Program is international program seeking applicants from across the globe. The selection committee considers the applicant’s academic performance as an undergraduate, range of courses taken, Graduate Record Examination (GRE) scores, TOEFL and IELTS scores, English and writing skills, personal statement, relevant work experience, and faculty and employer evaluations.

As prerequisites, applicants must hold the equivalent of a US bachelor’s degree from an accredited institution. Also, iMEP recommends students complete both basic statistics and microeconomics courses prior to enrollment.

Application
Applications are submitted online through the iMEP admissions website. The application priority deadline for the iMEP Program is January 15. After the priority deadline, applications for the iMEP will continue to be accepted and considered on a space available basis until May 31. The iMEP Program waives the application fee. Online application page: https://dukekunshan.edu.cn/en/environment/start-application

In addition to the prerequisite bachelor’s degree, the following are required:

- Complete online application form
- Résumé/CV
- Statement of Purpose (500-1,000 words): As part of the online application, the applicant must upload a Statement of Purpose. The statement should be one to two pages and single-spaced. It should briefly discuss:
  - Purposes and objectives in pursuing graduate study;
  - Special interests and plans;
  - Strengths and weaknesses in the applicant’s chosen field;
  - Any research projects or any independent research in which the applicant has actively participated and how they have influenced his/her career choice and desire to pursue graduate studies; and
  - Any particular reasons the applicant may have for applying to Duke Kunshan University (e.g., the applicant would like to work with a specific faculty member).
- Transcript(s): Transcript from each post-secondary institution attended is required (an uploaded unofficial transcript with degree posted and other transcripts for all colleges and universities attended).
- Test Scores:
  - Graduate Record Examination (GRE). Ask Educational Testing Service to send an official copy of the scores to Duke Kunshan University, using institution code 7552. No department code is needed. If ETS requires a department code, select any one of the department codes listed. Regardless of the department code entered, the scores will come to Duke Kunshan University as long as applicants use institution code 7552. Be sure to alert the iMEP Program if the name on an application is different from the name on an applicant’s score report.
  - Test of English as a Foreign Language (TOEFL) or International English Language Testing System (IELTS). The program’s language of instruction is English, and written and spoken English proficiency is required. Students who are not native English speakers must provide language evaluation test scores with their application materials.
    - TOEFL: The minimum score for the TOEFL Internet-based Test (TOEFL iBT) is 90. Ask Educational Testing Service to send an official copy of the scores to Duke Kunshan University, using institution code 624. Applicants do not need a department code. If ETS requires a department code, select any one of the department codes listed. Regardless of the department code entered, the scores will come to Duke Kunshan University as long as applicants use institution code 624.
  - IELTS: The minimum score for IELTS is 7.0. Please email iMEP@dukekunshan.edu.cn for mailing address. The IELTS is administered by Cambridge ESOL, British Council, and IDP: IELTS Australia. See https://www.ielts.org/ for more information.
- Three Letters of Recommendation: At least two letters of recommendation (two academic references and one professional preferred).
Merit-Based Scholarship

Duke Kunshan University is committed to enrolling a highly talented, diverse, and international student body. All students are automatically considered for merit scholarships based on their Graduate School application. No additional application is required to be considered for these awards.

Bayeco Environment Fellowship

Bay Environmental Technology (Beijing) Corp (Bayeco) established the first fellowship program to support the iMEP Program at Duke Kunshan University. The establishment of the Bayeco Environment Fellowship will attract more talents with global vision and focus towards environmental challenges to enroll and study at the iMEP Program. The fellowship will create more opportunities for students to experience the global and innovative education model at Duke Kunshan and help to educate the next generation of environmental leaders for China and the world.

Fubon Scholarship

The Fubon Scholarship was created by the Fubon Group, an early supporter of the iMEP Program at Duke Kunshan. The scholarship aspires to groom innovative, skilled agents of change who can offer workable, highly impactful solutions for addressing the world’s most pressing environmental dilemmas and creating a profound, lasting impact on environmental sustainability.

Need-Based Financial Aid

Citizens of People’s Republic of China are eligible to apply for a need-based financial aid if their family financial situation meets the criteria set by Duke Kunshan University. US citizens may apply for need-based financial aid through Duke University by completing the FAFSA. The MPP Program’s director of financial aid is responsible for loans for US citizens and permanent residents. Loan funds are provided through the Federal Direct Unsubsidized and Graduate PLUS programs.

Guo Tingting Scholarship

All graduate program applicants from developing countries demonstrating financial difficulties will be considered for the scholarship, with preferences given to students from sub-Saharan Africa.

Work-Study Opportunity at Duke Kunshan

Resident Assistant

Resident Assistants (RAs) and Graduate Resident Fellows (GRFs) are student leaders who live on the residence hall floor and serve as a primary resource for students, providing peer help on academic, social, and personal issues; ensuring the health and safety of residents; and building a positive community within the residence hall. The RA position is for one semester, while the GRF position is for one academic year. RAs and GRFs receive training on topics of student development theories, roommate conflict resolution, preventive mental health, programming, assessment, community building, leadership, and team work. Currently, all RAs and GRFs receive single-room housing remuneration for their work.

How to apply: https://dukekunshan.edu.cn/en/student-life/residence-life#assistant
Questions about RA: email residenccelife@dukekunshan.edu.cn

Student Workers

Students enrolled in a Duke Kunshan degree program can work on campus on a variety of activities, from research assistantship to administrative operations. The maximum working hours of the student workers is 40 hours/month. The payment varies depending on the grades of students and type of work. International students may get positions as student workers.

Visiting Duke Kunshan and the iMEP Program

Professors, scholars, and prospective students are welcomed to visit iMEP at Duke Kunshan University. During the visit, they can learn detailed information about academic programs, research projects, administrative method, and cooperation opportunities. To schedule a meeting with the iMEP Program, please contact program coordinator Xue Qiu (xue.qiu@dukekunshan.edu.cn).

Registration for the iMEP Program

Credit Hours

The curriculum for the iMEP degree will consist of sixteen courses (48.0 course credits) spread out over two years. Students will be required to take seven core courses (21.0 course credits) so as to ensure quality and consistency in the degree. They will also be required to enroll in a full year of the master’s project class (MP, 6.0 course credits). Unlike the traditional MA programs in China, the iMEP Program does not offer a thesis option but a capstone project. There will be flexibility with the seven elective courses (21.0 course credits) so as to allow students to pursue particular environmental policy and resource issues as well as enhance their methodological skills. Finally, students will have the opportunity to complete a summer internship, ideally connected to their MP.

The curriculum includes:
- Two-week Boot Camp the summer prior to first semester
- Seven core courses (21.0 course credits)
- Seven elective courses (21.0 course credits)
- Two MP capstone courses (6.0 course credits)
- Summer Internship

The program includes a statistics and economics prerequisite. Students are required to take two examinations prior to enrollment to ensure that they have the appropriate skills in statistics and economics. If the student does not pass the examination, they will take an online class prior to enrollment and take refresher courses during the two-week Boot Camp the summer before their first semester.
This program also administers an English reading and writing examination prior to enrollment. Because iMEP is an English-only program, students will need to be screened for language before they can enroll. For students that need additional support in writing, they will be required to enroll in one of the English-language courses offered through the writing program at Duke Kunshan University (in addition to their 48.0 credits). For students whose native language is not Chinese, the Language and Culture Center at Duke Kunshan University provides different levels of Chinese courses. Chinese coursework is entirely optional, does not confer credit, and must be taken in addition to the required coursework. In addition to a weekly introductory course for graduate students, independent language study with a support coach is available for students with some previous Chinese experience.

Withdrawal from a Course

If a course must be dropped after the official Drop/Add period ends for a given semester, the student must formally withdraw from the course by contacting Duke Kunshan University registrar Lingling Wang (lingling.wang@dku.edu.cn). All withdrawals will be noted on the student’s record with a grade of W (withdrew from course).

Study Away Semester at Duke

iMEP students will have the option to study away at Duke the fall semester of their second year. While at Duke the students will enroll in the first semester of their MP course and three electives chosen from the Sanford School of Public Policy or the Nicholas School of the Environment. Students will register for courses at Duke during the graduate student registration window during the previous spring semester. iMEP students may also register for courses outside of the Sanford and Nicholas schools by following the same registration policies laid out by the MPP Program. iMEP students will receive registration service and support through the iMEP Program Coordinator.

Students must arrive at Duke in time for new graduate student orientation week when students will participate in an iMEP orientation and other Sanford and Nicholas orientation activities. iMEP students receive visa application support from the iMEP Program Coordinator and Duke Visa Services. iMEP students who are not US citizens are required to enroll in the Student Medical Insurance Plan (SMIP) provided by Duke and meet all immunization requirements for international students.

iMEP students will have the option to participate in field trips during the semester organized by the iMEP Faculty Lead and the Program Coordinator. The iMEP Program Coordinator at Duke will provide student services to the iMEP students during their study away semester. Any questions about this semester of the iMEP Program should be directed to Tatiana Sherman (tatiana.sherman@duke.edu).

Grades

Grades in the iMEP Program are as follows: A, B, C, F, I, X, Z, and W.

I (incomplete) indicates that some portion of the student’s work is lacking, for an acceptable reason, at the time the grades are reported. Sanford School graduate students have up to one year to resolve an incomplete (I), or it will become a permanent part of the student’s record. The student and instructor should coordinate a timeline for submission of the missing work. Program or continuation fees may be assessed for students who must register for an additional semester to resolve an incomplete.

The grade of X indicates that a student has missed the final examination for a course and must make it up by the end of the fifth week of the following semester to receive a grade for the course.

The grade of Z indicates satisfactory progress at the end of the first semester of a two-semester course. For graduate students enrolled in the summer session, a temporary F for a course may be assigned after the student has submitted a written request. If the request is approved by the instructor of the course, then the student must satisfactorily complete the work prior to the last day of classes of the subsequent summer term.

A grade of W indicates that the student officially withdrew from the course.

A grade of F in a core course normally occasions withdrawal from a degree program not later than the end of the ensuing semester or term; a grade of F in any other course occasions at least academic probation.

To be certified as making satisfactory progress toward the degree, graduate students must maintain at least a 3.0 (B) cumulative grade point average. Students falling below this average jeopardize not only their financial support, but their continuation in the program.

Academic Standing

To remain in good academic standing, and to graduate from the iMEP Program, students must maintain at least a 3.0 (B) cumulative grade point average. Students must also demonstrate satisfactory progress in research and related activities beyond coursework. Students falling below the 3.0 average jeopardize their financial support and are subject to dismissal. A failure to maintain good academic standing, for whatever reason, will result in the student being placed on probation for one semester. If the student has not regained good academic standing by the end of that semester, the student may be dismissed from the program without receiving a degree.

Graduation Requirements for the iMEP Program

Core Courses

ENVIRON 805K. Environmental Economics (Year 1 Fall) – This course teaches students to apply modern microeconomics to environmental and natural resource policy problems. The course covers both conceptual and methodological topics and applies these tools to normative and positive aspects of current environmental questions. Material covered in the course includes: basic theory and methods of economic analysis applied to environmental problems; cost-benefit analysis and efficient policies; economics of the environment, particularly the economics of pollution control and regulation; and natural resource management. Cases will include air and water pollution, toxics, energy, fisheries, and forests.

PUBPOL 870K. Statistics and Program Evaluation (Year 1 Fall) – This course teaches students to use data to analyze the impact of policies, make recommendations, attempt to persuade others, and make environmental policy decisions. It will cover the tools and techniques of program evaluation, familiarizing students with the various research methods that can be employed to evaluate the effect of environmental policies and innovations. It will also teach students to read empirical research in a more critical manner. Finally, through applied problem sets,
will use economic analyses to examine these challenges and to devise policy solutions, especially given that developing countries often have implementation issues, and surveys the economic tools necessary to evaluate climate change policies.

In order for policy-makers to be effective, they need to know how to communicate data and policies to the broader public. Building on their work in the fall, the course will begin with economic and quantitative analysis of a particular environmental or natural resource problem. Students will then develop written and visual presentations of their analysis (including policy briefs and public speaking skills), with final projects completed in teams.

This course covers empirical methods (e.g., contingent valuation, hedonic pricing, and benefits transfer) used to value non-market environmental and health outcomes, including morbidity and mortality, air and water quality, ecosystem services, and non-use values.

Non-governmental organizations (NGOs) that address conservation issues in China face large, complex, and urgent problems. To be successful, these NGOs must be equipped with the skills to be efficient, effective, and transparent when planning, implementing, and monitoring their conservation initiatives. In this hands-on course, students will become familiar with decision-support tools that allow organizations to systematically address strategic planning, project design, project budgeting, implementation, monitoring, evaluation, communication, and donor transparency. The students will apply these tools to real-world conservation problems. No prerequisites are required.

The course covers the fundamental aspects of geographic information systems and satellite remote sensing for various environmental applications.

This course focuses on the challenges developing countries face in balancing environmental management and economic growth. Class will use economic analyses to examine these challenges and to devise policy solutions, especially given that developing countries often have donor transparency.

Below are electives that have been taught by iMEP faculty, adjuncts, or visiting Duke faculty. Not all electives will be offered each year. These are just samples of the classes that could be offered. The program may interest Duke faculty outside of the Nicholas School of the Environment and Sanford, including those who teach history, engineering, law, and sociology, for example. As the program develops, it will continue to provide additional course offerings.

**Air Quality: Management**

Management systems are discussed, including varied approaches used to address criteria air pollutants, air toxics, mobile sources and acid deposition. Course prepares students to understand systems approach to apply science and technical information to inform policy decisions affecting air quality; understand and be conversant in varied approaches to manage air quality to meet policy objectives; be familiar with major common air pollutants and air quality management approaches applied to each and why approaches vary.

**Applied Environmental Valuation Methods**

This course covers empirical methods (e.g., contingent valuation, hedonic pricing, and benefits transfer) used to value non-market environmental and health outcomes, including morbidity and mortality, air and water quality, ecosystem services, and non-use values.

**Building an NGO Toolkit**

Non-governmental organizations (NGOs) that address conservation issues in China face large, complex, and urgent problems. To be successful, these NGOs must be equipped with the skills to be efficient, effective, and transparent when planning, implementing, and monitoring their conservation initiatives. In this hands-on course, students will become familiar with decision-support tools that allow organizations to systematically address strategic planning, project design, project budgeting, implementation, monitoring, evaluation, communication, and donor transparency. The students will apply these tools to real-world conservation problems. No prerequisites are required.

**Environmental Impact Evaluation**

Program and impact evaluation is necessary to understand the effectiveness of current and future policies, as well as how they can be improved. This course will cover the process and methodology of designing and implementing state-of-the-art quantitative evaluations appropriate for environmental policies, including logic chains, metric choice, survey design, survey implementation, and relevant statistical analysis.

**Climate Change Law and Policy**

This course covers different policy instruments used to address climate change including legal regime, emissions taxes, allowance trading, regulatory tools at different spatial scale (local, regional, national, global).

**Climate Change Economics and Policy**

Explores the economic characteristics of the climate change problem, assesses national and international policy design and current implementation issues, and surveys the economic tools necessary to evaluate climate change policies.

**Fundamentals of Geospatial Analysis**

This course covers the fundamental aspects of geographic information systems and satellite remote sensing for various environmental applications.

**Environment and Development Economics**

This course focuses on the challenges developing countries face in balancing environmental management and economic growth. Class will use economic analyses to examine these challenges and to devise policy solutions, especially given that developing countries often have
weak institutional capacity and fewer financial resources to cope with environmental pollution.

Energy Economics and Policy
This course examines the economics of markets and policies for different energy supply sources (such as petroleum, coal, natural gas, electricity, renewables, nuclear), energy demand and efficiency, and their interactions with each other and with the rest of the economy and environment. Other topics include markets for energy and energy-using technologies, energy price regulation, and energy security.

Business Strategy and the Environment
This course explores ways in which businesses are applying strategic management tools to incorporate sustainability and corporate social responsibility into decision-making and operations. Focus will be on different types of corporate/business structures (e.g., private businesses, state-owned enterprises, and multi-national corporations) and the different environmental challenges they face.

Key Areas in International Environmental Policy
This course's seven modules cover international environmental economics, international environmental policy and politics, international environmental negotiations, policy debates and simulations. The principal goal of the course is to preview the application of social sciences (economics, public policy, and political science) to the environment, and to facilitate the translation of core curricular concepts into a variety of real-world applications. Students will engage in self-directed research and learning on international environmental policy.

Independent Study
For iMEP students or Duke students studying abroad at Duke Kunshan University. Directed readings or research at the graduate level to meet the needs of individual students. Units to be arranged.

Natural Resources and Protected Area Management
Toolkit for practical natural resources management and understanding the challenges involved in protected area management. Wildlife monitoring, environmental change tracking, socio-economic surveys, and stakeholders engagement. Combines lectures for essential survey methods and experiential education through a seven-day field course. Students will design their own group project to carry out in the local context.

Cross-listed Global Environmental Health Elective
Global Environmental Health
Economics and Policy: Social science perspective on global environmental health. Students will learn to identify primary environmental causes of high burden diseases such as malaria, diarrhea, and respiratory infections; describe how to measure socio-economic impacts of global environmental health diseases; discuss key policies to control global environmental health problems based on private prevention and therapeutic behaviors; and propose frameworks to empirically monitor and evaluate global environmental health policies. A sub-module will focus on climate change and water-borne diseases.

Master’s Project Capstone
MP Capstone Class (Year 2 Fall and Spring) - The Master’s Project (MP) is a 15-25 page single-spaced paper, policy memo, or journal article required of all master's students in the iMEP Program. Two types of projects are possible: a project for an actual client that involves a variety of methodological approaches (client-based), or a project based on quantitative methods that may or may not have an actual client (research-based). Hybrids of these projects are also possible. Students are encouraged to build their projects from their summer internships where possible and to deepen their policy-area expertise by taking appropriate elective courses.

Research-Based Projects
This type of MP more closely resembles a thesis. Research MPs follow the standard format for scientific research—abstract, introduction, methods, results, and discussion—and introduce a brand new idea or theory, and may involve original field data collection. Students interested in a doctoral degree or employment in research roles may benefit from this type of MP. Working with the MP advisor, the student needs to follow scientific methods in their topic area. The research topic must be relevant to environmental policy, and involves rigorous quantitative and/or qualitative methodology. If analysis involves using data with human subjects, then students may need the Duke Kunshan University IRB to review and approve their protocol. Research MPs should be of publishable quality, although they do not need to be published.

Client-Based Projects
This MP is designed to help a client decide what to do about an environmental policy problem. The purpose is to recommend a specific course of action. This project must also measure up to standards of good analysis, including a clear definition of the problem and careful evaluation of the relevant evidence, identification of important trade-offs, and identification of conclusions and recommendations. The student needs to identify a client or a policy problem as the first step. This project could follow from the summer internship, or an organization that the student would like to work with in the future. The student will conduct initial research into the specific policy problem. To be approved as a MP topic, the client must have a significant policy problem posed in the form of “What should the client do?” Students are encouraged to turn their MP into a case study for teaching purposes.

Process for Completing the Project
In the spring semester of their first year, iMEP students should start the process of identifying a client, and a policy problem to address. Before the end of the semester, students must choose an MP advisor. The MP advisor must be iMEP faculty with a primary appointment at Duke Kunshan University, or from Duke University with a secondary appointment at Duke Kunshan University. The advisor can be changed at a later date. The choice should be emailed to Xue Qiu and approved by the director of graduate studies. Also due by the end of the spring semester, the student must complete a one-page brainstorming proposal (up to three ideas). The topic may be changed or finalized later. The brainstorm proposal should be submitted to their MP advisor seven days after the last final exam. If the project involves human subjects, then the student should begin the IRB process and prepare proper documents to submit in the beginning of this spring semester.
In the summer before their second year, it is recommended to initiate the MP process by cultivating advisor and client relationships. Before and during the required summer internships, students should determine if their summer placements can yield MP client relationships and policy problems. Students should check with their employer whether there is a confidentiality clause and if data from the internship can be stored in the public domain.

In their second year, all iMEP students enroll in the required fall and spring MP course. For most students, the fall semester of their second year will take place at Duke University in Durham, where the iMEP Faculty Lead Jackson Ewing will teach the MP course. The fall term course is designed to help each student conceptualize their project, to provide guidelines related to applied research (IRB procedures and study design) and to complete a proposal. In the beginning of the semester, the student must complete a 3-to-5-page introductory document describing their final topic and/or client and problem. After gaining approval from the MP advisor, the student will submit this document to the instructor of the MP course for review. Students will maintain long-distance communication with their advisor if he or she is based at Duke Kunshan University.

It is recommended that the student complete all data collection before the beginning of their last semester. The first draft is due to their MP advisor in March of the final semester. The final copy is due in April of the final semester. The final copy must be submitted in electronic (PDF) format to Xue Qiu at xue.qiu@dukekunshan.edu.cn. 

Grading of the Master’s Project

The MP committee consists of the MP advisor and a rotating group of faculty in the iMEP Program. The committee shall discuss the MP and form a consensus on one of the following marks: unconditional pass, conditional pass, or fail.

Estimated Cost of Attendance 2019-2020

Duke Kunshan University offers a world-class education for highly qualified students from all backgrounds. The cost of attending Duke Kunshan reflects the university’s commitment to providing an outstanding educational experience and is comparable to that of other leading private universities.

Duke Kunshan is committed to enrolling a highly talented, diverse and international student body. Scholarship support is available to support these goals. All applicants will automatically be considered for available scholarships, up to and including full scholarships.

Special financial aid will be offered to all Chinese students from mainland China, Hong Kong, Macau and Taiwan to lower the tuition standard to RMB 180,000 per year. Additional scholarships of varying amounts will be available based on academic achievement and family financial circumstances. Admitted students will be given an opportunity to submit supplemental financial information.

Tuition and Fees for the 2019-2020 Academic Year

Cost of Attendance for International Students (non-Chinese citizens)

*Figures are in USD.*

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1 All figures are estimates only.
**Cost of Attendance for Domestic Students (Chinese Citizens)**

*Figures are in RMB.*

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<td>Graduate Student Service Fee</td>
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<tr>
<td>Total Cost of Attendance</td>
<td>¥119,922</td>
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</table>

**Cost of Attendance (COA) Notes**

- All fees and rates provided at this time are estimates.
- All tuition will be invoiced by and paid to Duke Kunshan University. Other fees and charges will be invoiced and paid in either China or the United States.
- Duke Kunshan student residence and dining facilities are closed during the winter break between the fall and spring semesters and for seven days during the Chinese New Year Holiday. Students should arrange the accommodation during the campus closing periods. The costs are not included in the above estimated costs of attendance. Students need to pay the costs by their own.
- International travel includes an estimate of the cost of one round-trip flight to the United States for Chinese students or from an international destination to Shanghai for international students, typical visa costs, and, for non-Chinese students, additional health check and registration costs associated with establishing legal residence in China. Students wishing to return to their home countries during breaks in their study before the end of the year should budget additional funds for these trips.
- US based and international students from outside the United States (i.e., India, Africa, Hong Kong, Macau, Taiwan) who do not apply through Duke’s GEO (Study Abroad) application system are required to enroll in the Global Health Insurance Plan.
- Insurance plan year is August 1–July 31; insurance will be charged at the actual approved rate regardless of prior estimates.
The Nicholas Institute for Environmental Policy Solutions has built its reputation on providing unbiased evaluations of policy risks and rewards tailored to decision makers’ needs. These evaluations have allowed the Nicholas Institute to improve environmental policymaking worldwide through objective, fact-based research to confront the climate crisis, clarify the economics of limiting carbon pollution, harness emerging environmental markets, put the value of nature’s benefits on the balance sheet, develop adaptive water management approaches, and identify other strategies to attain community resilience.

The Nicholas Institute is part of Duke University and its wider community of world-class scholars. This unique resource allows the Nicholas Institute’s team of economists, scientists, lawyers, and policy experts not only to deliver timely, credible analyses to a wide variety of decision makers, but also convene these decision makers to reach a shared understanding of this century’s most pressing environmental problems. The results of these efforts are reflected in accounts of our researchers’ contributions to improved decision making and novel approaches to environmental issues as well as by reflections of students and former employees who have used access to the Nicholas Institute’s experts to effect positive lasting change in the environmental policy space. To learn more about the impact of the institute, visit https://nicholasinstitute.duke.edu/about/our-impact.

The Nicholas Institute occupies three houses on Campus Drive on Duke’s West campus, but it also has staff in Duke’s Washington, DC, office and at the Duke Marine Lab in Beaufort, North Carolina.

**Working with Students**

Educating the next generation of environmental leaders is one of the many ways the Nicholas Institute is helping to bridge the gap between science and policy. Staff members aid in this mission by teaching courses across campus and partnering with students on research projects. Nicholas School doctoral and professional graduate students as well as students from other Duke units and universities can work with the Nicholas Institute as interns and engage in research through the Nicholas School’s assistantship program.

In 2013, the Nicholas Institute created the Duke Environmental Economics Doctoral Scholars (DEEDS) program, a competitively funded fellowship to foster dynamic intellectual exchange among the Nicholas Institute, Duke doctoral students in environmental economics, and Duke University faculty. The DEEDS program offers support to doctoral students working with and being mentored by a Duke faculty member in collaboration with the Nicholas Institute and the University Program in Environmental Policy.

To learn more about the institute’s offerings for students, visit https://nicholasinstitute.duke.edu/education.

**Publications and Events**

The Nicholas Institute offers a policy-neutral, data-rich environment for stakeholders to discuss complex topics. The insights from that interdisciplinary dialogue are reflected in a large body of substantive research across six programs. For more information, read the latest publications (https://nicholasinstitute.duke.edu/publications) and engage with the institute at an upcoming event (https://nicholasinstitute.duke.edu/events).
The PhD prepares students most commonly for careers in academia. In more recent years, students earning their doctorate from the environmental programs at Duke have gone on to have satisfying careers in consulting, business, government and other arenas that allow them to apply their knowledge. Doctoral students emphasize scholarly research as a major part of their degree programs though a growing number of students focus their research on those areas with direct practical applications. An active research program is a vital component of the Nicholas School of the Environment, and most of the research projects in the school utilize PhD candidates as research assistants. The Nicholas School does not normally consider applications for the MS, although some students may be awarded an MS as part of a doctoral program.

A majority of faculty in the Nicholas School are members of the faculty of The Graduate School and are actively involved in the training of doctoral (PhD) students in the fields of earth and ocean sciences, marine science and conservation, environmental, and toxicological sciences. Prospective students should contact individual faculty mentors prior to applying to the doctoral program to ensure mutual interests in research topics. Policies and procedures for admission and registration, academic regulations and requirements for the PhD are given in detail in the bulletin of The Graduate School and not repeated in detail here.

Doctoral students are admitted to work with Nicholas School faculty by direct application within The Graduate School via four pathways: 1) application in the subject areas environment, earth and ocean sciences, or marine science and conservation; 2) application to the Integrated Toxicology & Environmental Health Program (ITEHP), also known as the University Program in Environmental Health (UPEH); 3) application to the University Program in Ecology (UPE), with an advisor chosen from within the Nicholas School faculty; or 4) application to the University Program in Environmental Policy (UPEP), with an advisor chosen from within the Nicholas School faculty.

The Environment (ENV) Program is one of several programs at the Nicholas School that offer a PhD. Major and minor work for the environment graduate program is offered through the environmental sciences and policy division of the Nicholas School of the Environment. The research emphasis of the environmental sciences and policy division is in the areas of ecosystem science and management, environmental chemistry and toxicology, aquatic and atmospheric sciences, and environmental social sciences. Applicants are strongly encouraged to contact the individual faculty member under whose supervision they are interested in pursuing graduate study. Direct inquiries to dgsa@nicholas.duke.edu. Information about the program and the faculty can be found at https://nicholas.duke.edu/academics/dottoral-programs/environment-env.

The Earth and Ocean Sciences (EOS) PhD Program offers research opportunities in three broad areas of geoscience: biogeosciences, oceans and climate, and earth resources. Biogeosciences in EOS focuses on the interactions between life, water and landscapes including coastal ecomorphodynamics and remote sensing, watershed ecohydrology, and landscape evolution including that of coupled human-landscape systems. Oceans and climate research in EOS includes ocean circulation, atmospheric dynamics, paleoclimatic/paleoenvironment reconstruction, marine biogeochernistry, and ocean/Atmosphere interactions, particularly as they relate to global climate change. And research in earth resources addresses the geologic formation and human use of mineral, energy, water, and land resources, including mineral formation, life-cycle analysis, energy consumption/emissions, water quality as it relates to human health, and the role of technology in the Anthropocene.

A student in the PhD program may elect to get an MS degree while working toward the PhD. If this option is elected, the requirements are the same as for the MS program in terms of coursework, time limits, and thesis requirements. Direct inquiries to dgsa@nicholas.duke.edu. More information about the program and the faculty can be found at https://nicholas.duke.edu/academics/dottoral-programs/earth-ocean-sciences-eos.

Marine Science and Conservation (MSC) Doctoral Study at the Duke University Marine Laboratory

Duke Marine Laboratory (DUML) campus is located in the coastal town of Beaufort, NC, situated 180 miles from the main Durham campus. DUML is home to the Marine Science and Conservation (MSC) PhD Program established in 2008 with an interdisciplinary, research-focused, five-year program with an emphasis on both natural and social sciences. Faculty research in the MSC Division is focused on oceanography, marine biology, marine biomedicine, marine biotechnology, and coastal and marine policy and management. Faculty and students study the biology of marine species, address global-scale marine issues, and use advanced technologies, analysis, and modeling that allow science and policy to be evaluated across space, time and disciplines.

MSC doctoral students typically spend the first two semesters taking graduate classes on the Durham campus before moving to Beaufort to complete their research; however, residence in Durham is not a requirement. Although residency of the advisor is not necessary to study at the Marine Lab, some sources of funding are contingent upon having an advisor from the Marine Lab’s resident faculty. Students receive up to five years of full support, including stipend, tuition and fees, if they maintain satisfactory progress toward their degree. Students seeking admission to the MSC program are encouraged to contact faculty of interest directly prior to submitting their application to The Graduate School.

For information on the MSC PhD, please visit https://nicholas.duke.edu/academics/dottoral-programs/marine-science-conservation-msc or contact Rachel Lo Piccolo, Program Coordinator of Graduate Studies, at rachel.lopiccolo@duke.edu or 252-504-7585. Additional DUML information can be found at https://nicholas.duke.edu/marinelab.
Cooperative University Programs

Integrated Toxicology & Environmental Health Program (ITEHP)

The Integrated Toxicology & Environmental Health Program (ITEHP), also known as the University Program in Environmental Health (UPEH), prepares students for research careers in environmental health and toxicology. Interdepartmental and multidisciplinary, a PhD is awarded from the school the student chooses to affiliate with (such as the Nicholas School of the Environment) with the ITEHP certificate granted by the program upon graduation. Upon completion of doctoral studies, these students are experienced in the design, execution, and interpretation of current research in environmental health and toxicology, exposure science, and epidemiology, among other things. Completion of this training at the doctoral level provides career opportunities in academia, industry, and government, including positions involved in research, risk assessment, and policy.

Research directed by Nicholas School faculty covers a broad array of studies in the areas of environmental health, toxicology and exposure science. Current studies are concerned with chemical exposures to humans, particularly children, and to ecosystems, molecular mechanisms of toxicity, aquatic toxicology, and interconnections between human and ecosystem health. Environmental pollutants of concern in these studies include nanomaterials, flame retardants, aromatic hydrocarbons, pesticides, metals and metalloids, and endocrine disrupters. There are several avenues possible for prospective students interested in applying for admission to the ITEHP. Students may seek admission directly into this PhD program and its NIEHS-funded Training Grant by filing an application with The Graduate School. This first option is only available to US citizens or legal permanent residents. A second avenue for admission permits both domestic and international students to apply for entry via one of Duke’s participating departments, such as the Nicholas School. Finally, a certificate option is available to any graduate student who has been admitted to Duke, is affiliated with a participating Duke department and who wishes to pursue the additional coursework leading to certification. Interested prospective students will find complete program details and contact information at https://nicholas.duke.edu/academics/doctoral-programs/university-program-integrated-toxicology-and-environmental-health-itehp.

University Program in Ecology (UPE)

Duke hosts strong research programs in ecology, with highly productive faculty from a number of departments working at all levels of biological organization—from the organism to the ecosystem. Areas of special strength include global change ecology, evolutionary ecology, and forest and marine ecology. Since 2016, USA News ranked Duke as sixth best global university in environment and ecology.

The University Program in Ecology was formed in 2000 to provide a common home for students who are pursuing doctoral studies in ecology in various departments across the University, including many students in the Nicholas School.

Students are admitted for doctoral work in the University Program in Ecology through The Graduate School. Departments participating in the ecology program guarantee that any student admitted is automatically admitted for PhD study in the home department of the student’s major professor.

The University Program in Ecology admits students with the promise of two years of financial support from the program, followed by support from the department of the student’s selected major advisor. Students are supported for up to five years of doctoral study if they maintain satisfactory progress toward their degree.

Students seeking admission to the University Program in Ecology should file an application with The Graduate School, specifying consideration by the UPE or one of the participating departments. Direct inquiries to dgsa@nicholas.duke.edu or to Graduate Studies, University Program in Ecology, Box 90328, Duke University, Durham, NC 27708. Find more information at https://nicholas.duke.edu/academics/doctoral-programs/university-program-ecology-upe.

University Program in Environmental Policy (UPEP)

The University Program in Environmental Policy was established in 2009 and is jointly administered by the Nicholas School and the Sanford School of Public Policy. It is the first and only PhD program in the United States jointly administered by a school of the environment and a school of public policy. It is a multidisciplinary, research-focused five-year doctoral degree, intended to prepare candidates for positions in applied academic departments and professional schools (e.g., environment and natural resources, public policy, public administration, international affairs), domestic and international public agencies, and environmental organizations, research institutes, and policy-consulting firms. Although the program is multidisciplinary, it is designed to ensure that students have strength in a particular social science discipline. Students designate their concentration when applying and currently may select either environmental economics or environmental politics.

The University Program in Environmental Policy provides a focal point for faculty and graduate students in the Nicholas School and Duke University’s Sanford School of Public Policy who are interested in environmental policy. It draws on the intellectual resources of not only the two schools but also related disciplinary departments (economics and political science) and other professional schools (Duke Law School, The Fuqua School of Business, Pratt School of Engineering) at Duke. Faculty in the program conduct research on economic and political aspects of a wide range of topics, including air and water quality, biodiversity conservation, climate change, community resource management, corporate sustainability, ecosystem services, energy, environmental health, fisheries, forests, and freshwater and marine resources, in both US and international contexts. Applicants are encouraged to contact faculty members with related interests to learn more about their current research projects and interest in accepting new doctoral students.

Students seeking admission to the University Program in Environmental Policy should file an application with The Graduate School, specifying consideration by the UPEP. Direct inquiries to dgs@nicholas.duke.edu. Graduate Studies, University Program in Environmental Policy, Box 90328, Duke University, Durham, NC 27708. Further information on the University Program in Environmental Policy can be found at https://nicholas.duke.edu/academics/doctoral-programs/university-program-environmental-policy-upep.
Qualification of Students

Students seeking admission to The Graduate School must have earned an AB or BS degree (or the equivalent in the case of foreign students) from an accredited institution. Usually the student should have majored in the area of intended graduate study or one closely related to it. Because research is such an integral part of doctoral education in the Nicholas School, the student’s undergraduate record must evidence the capability, motivation, and commitment to conduct independent study and research at an advanced level.

Admission

Applicants for the PhD must use The Graduate School’s electronic application, available at https://gradschool.duke.edu/admissions. An individual faculty member in the Nicholas School (or the Sanford School, in the case of the University Program in Environmental Policy) must accept responsibility to advise an applicant before admission can be offered (this is not necessarily the case for ITEHP though students should contact faculty ahead of time); thus, students applying to the doctoral programs are strongly encouraged to correspond with prospective faculty advisors and visit the campus. Brief summaries of individual faculty research interests are given with the faculty listing in this bulletin.

Graduate School Registration

Students in PhD programs initiate course registration through the directors of graduate studies of the Nicholas School (in earth and ocean sciences, environment, University Program in Ecology, University Program in Environmental Policy, and University Program in Environmental Health) and/or their advisor/s. Registration for courses is completed through the student online registration system (DukeHub). Registration requirements and procedures are described in the bulletin of The Graduate School, the department/program websites and in consultation with faculty advisor/s.

Fellowships and Assistantships for Doctoral Students

Students in all of the doctoral programs are normally supported for up to five years of study if they maintain satisfactory progress toward their degree. Some students receive fellowships to support their studies, while others are employed as teaching assistants, receiving a stipend and fellowship that cover tuition and fees. Other students are employed as research assistants, with funding derived from research grants managed by their major professor. In recent years, a significant fraction of the doctoral students have also been successful in national competition for graduate fellowships from the National Science Foundation, National Aeronautics and Space Administration National Oceanic and Atmospheric Administration, Environmental Protection Agency, and other agencies.

Normally, students are supported on teaching assistantships for only two or three years of their graduate study, the balance by research assistantships and/or fellowships. Students supported on teaching or research assistantships may also receive support for up to three summer months from research funding. ITEHP students are funded fully through the NIEHS Training Grant for the first two years of study; then, the above is true for the remaining time.

Fellowships Offered through the Nicholas School

W. D. Billings Fellowship. The University Program in Ecology awards the W. D. Billings Fellowship to an entering doctoral student who plans to specialize in some area of plant ecology. The award covers all tuition and fees and provides a full stipend for the first year of graduate study. The fellowship was established by Shirley M. Billings in honor of her husband, the late W. Dwight Billings, a physiological plant ecologist at Duke for more than thirty years who was renowned for his work in arctic and alpine environments.

Rachel Carson Fellowship. Established by William C. Powell, Thomas E. Powell Jr. and friends, the Carson Fund provides fellowships to PhD candidates who use the Rachel Carson Sanctuary site in Beaufort, North Carolina, as a major component of their research. First consideration will be given to PhD students in residence at the Duke University Marine Laboratory.

Robert W. Safrit Jr. Fellowship. Established by Robert W. Safrit, this fellowship is for students at the Duke University Marine Laboratory.

Harvey W. Smith Graduate Fellowship. Established by Evelyn Chadwick Smith, the Harvey W. Smith Graduate Fellowship Endowment provides fellowships to doctoral candidates in marine science.

Dr. Larry Widell Memorial Fellowship. Established by Christopher M. Widell, this endowment provides fellowships to Nicholas School students, with preference given to doctoral candidates.

Fellowships Offered through The Graduate School

The Graduate School offers a number of campus-wide competitive fellowships and scholarships. The James B. Duke Fellowships and University Scholars Program are available to incoming doctoral students in all departments. Advanced students may apply for the Katherine Stern Fellowship, which provides dissertation-year support. They are also eligible for conference travel awards and for a variety of other special internships or fellowships. The Graduate School also provides a number of awards for international research travel for doctoral students.

Minority doctoral students may receive support from the Dean’s Graduate Award Fellowships and Presidential Fellowships or through the National Consortium for Graduate Degrees for Minorities in Engineering and Science Inc.

The Frederick K. Weyerhaeuser Forest History Fellowship is given annually by the Forest History Society to a Duke University graduate student who wishes to study broadly in the area of forest and conservation history.

For detailed information about campus-wide financial aid opportunities for doctoral students, including application procedures, please consult the bulletin of The Graduate School.
National, Regional, and Foundation Awards

In addition to those awards available through the Nicholas School or the university, students are urged to compete for national and foundation awards for graduate study. Of particular interest to doctoral students in the Nicholas School are National Science Foundation Graduate Fellowships and Minority Fellowships, NASA Doctoral Fellowships in Global Change and Earth System Science, and EPA STAR Fellowships. The websites of these agencies offer details on applying for these fellowships.

Teaching Assistantships

Each year a selected number of PhD candidates may be offered a financial aid package consisting of full tuition plus a monthly stipend. The monthly stipend requires up to 19.9 hours of work per week during the nine-month academic year. Students receiving these stipends are assigned by the director of graduate studies to serve as teaching assistants for various faculty or courses.

Research Assistantships

Funded from grant and contract research under the direction of various members of the faculty, research assistantships provide support during the course of study of the PhD candidate. Typically, the research assistant completes one or more phases of a research project under the direction of the principal investigator, a member of the faculty. Normally, the research completed forms a substantial component of the requirements of the PhD dissertation. However, in some instances students may pursue dissertation research in an unrelated area of study.

The academic year stipend is salary for research involving up to twenty hours per week. A regular schedule of research under the direction of the principal investigator must be maintained; therefore, some research assistantships require full-time service during the summer.
Research Centers
Research centers in the Nicholas School of the Environment are by design and intent flexible, multidisciplinary units. A major aim is to bring together specialized groups of scholars and professionals from many disciplines to focus their attention on current natural resource and environmental problems. The centers are headed by a director and staffed by an interdisciplinary faculty from Duke, neighboring universities and a variety of public and private research organizations. Depending on the level of funding, the centers may also employ research assistants and other support staff. The centers do not offer courses or degrees; rather, they offer students, scientists, and other professionals an opportunity to participate in research through collaboration with affiliated faculty.

**Grainger Center for River Science**

**Co-Directors:** Martin Doyle, Professor of River Science and Policy, Division of Environmental Sciences and Policy, Nicholas School of the Environment; James Heffernan, Assistant Professor of Ecology, Division of Environmental Sciences and Policy, Nicholas School of the Environment; and Emily Bernhardt, Gerry G. and Patricia Crawford Hubbard Professor of Biogeochemistry, Division of Environmental Sciences and Policy, Nicholas School of the Environment, and Director of Graduate Studies, Ecology PhD program (UPE)

The River Center was formed in 2011 as an intellectual community of faculty, postdocs, students and technical staff who share a common passion for the study of rivers and their watersheds. The current group consists of three Duke research labs (Doyle, Heffernan, and Bernhardt) that have an interest in advancing river science. Current research in the multidisciplinary labs spans watershed hydrology, geomorphology, ecology, biogeochemistry, and environmental economics and social sciences. Researchers in these labs also seek to inject the best possible science into ongoing discussions about stewardship of river ecosystems and their watersheds through policy and management. Research in the River Center includes both close collaborations among the core River Center labs and work with other faculty in the Nicholas School, in other departments at Duke, and with collaborators around the nation and the world.

The physical home of the River Center is located in the Duke Water Science Laboratory and Research Center, a state-of-the-art facility containing shared lab space and a shared analytical facility. Find more information at [http://www dukerivercenter.org/](http://www.dukerivercenter.org/).

**Duke University Wetland Center**

**Director:** Curtis J. Richardson, John O. Blackburn Distinguished University Professor of Resource Ecology, Division of Environmental Sciences and Policy, Nicholas School of the Environment

The goal of the Duke University Wetland Center is to provide sound scientific knowledge that will lead to sustainable wetland ecosystem functions and services locally, nationally, and globally. The center works toward this goal by conducting, sponsoring, and coordinating research and teaching on critical wetland issues, especially wetland and stream restoration, climate change effects on wetland nutrient cycling, carbon sequestration, invasive species, and the role of wetlands in improving water quality and retention on the landscape.

Perhaps no single environmental issue has so polarized public opinion as the protection of wetlands. Part land, part water, wetlands are ecosystems in which water level and low oxygen support a unique ecological habitat conducive to the development of specific plant and animal species. Wetlands improve water quality, provide flood control, supply habitat for fish, and are a vital link between surface water and groundwater. They also store over 30 percent of the world’s carbon. Unfortunately, much of the public, not knowing about these functions and services, believe wetlands are of low value and should be drained or developed. As a result, the United States has lost over 50 percent of its wetlands.

By bringing together scientists, educators, and professionals, the Duke University Wetland Center is able to focus attention on wetland issues of regional, national, and international scale. Core researchers for the center are the director, faculty, visiting scholars, and graduate students. As part of a professional school within a private university, the Duke University Wetland Center works independently on wetland issues without the political pressures often brought to bear upon public institutions. Find more information at [https://nicholas.duke.edu/wetland](https://nicholas.duke.edu/wetland).

**Superfund Research Center**

**Director:** Richard Di Giulio, Sally Kleberg Professor of Environmental Toxicology, Division of Environmental Sciences and Policy, Nicholas School of the Environment

It is increasingly recognized that early life stages of humans and other organisms are particularly sensitive to environmental stressors such as pollutants. The Superfund Research Center unites researchers from the Nicholas School of the Environment, the Pratt School of Engineering, and the Duke University Medical Center in examining the effects of selected chemicals that are widespread in the environment, including Superfund sites. Of particular concern are effects on wildlife and human development, later life consequences of early life exposures, and new strategies for remediating heavily polluted areas such as Superfund sites. The center is supported by the National Institute of Environmental Health Sciences (NIEHS).

The goal of the center is to elucidate exposures, mechanisms of toxicity, health consequences in humans and ecosystems, and remediation strategies for specific toxic chemicals selected based upon their potential importance as developmental toxicants. Of particular interest are selected pesticides, metals, hydrocarbons, and flame retardants that affect development of the nervous system, cardiovascular system, and endocrine systems. In addition to conducting basic research in these areas, the center’s key activities include undergraduate, graduate, and post-doctoral training in the environmental health sciences and engineering, the translation of basic research findings into useful information for health professionals, government agencies, and the public, and active engagement with communities concerned with exposures to hazardous chemicals. Find more information at [https://sites.nicholas.duke.edu/superfund/](https://sites.nicholas.duke.edu/superfund/).
**Core Faculty**

**Abbreviations Key**

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<th>Abbreviation</th>
<th>Division</th>
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<tr>
<td>ESP</td>
<td>Division of Environmental Sciences and Policy</td>
</tr>
<tr>
<td>EOS</td>
<td>Division of Earth and Ocean Sciences</td>
</tr>
<tr>
<td>MSC</td>
<td>Division of Marine Science and Conservation</td>
</tr>
<tr>
<td>*</td>
<td>Holds a secondary appointment in the Nicholas School of the Environment, with primary appointment elsewhere at Duke University</td>
</tr>
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</table>

*Susan Alberts*, Professor of Biology; BA, Reed College; MA, UCLA; PhD, University of Chicago  
Email: [susan.alberts@duke.edu](mailto:susan.alberts@duke.edu)  
Dr. Alberts studies animal behavior, focusing on behavioral responses to changes in physical and social conditions and how these responses affect the animal’s life. (MSC)

**Elizabeth Albright**, Assistant Professor of the Practice of Environmental Policy and Methods; BA, the College of Wooster, MS/MPA, Indiana University; PhD, Duke University  
Email: [elizabeth.albright@duke.edu](mailto:elizabeth.albright@duke.edu)  
Dr. Albright’s area of focus is environmental policy; adaptation and resilience to extreme climatic events; decision analysis; stakeholder participatory processes; river basin management. (ESP)

**Paul A. Baker**, Professor of Geochemistry; BA, Geology, University of Rochester; MS, Geology, Pennsylvania State University; PhD, Earth Sciences/Marine Geology, Scripps Institution of Oceanography, University of California, San Diego  
Email: [pbaker@duke.edu](mailto:pbaker@duke.edu)  
Dr. Baker’s major focus is on understanding climatic and oceanographic history of the tropics as preserved in the sedimentary records of lakes, paleolakes, rivers, and the ocean. His work involves field, as well as laboratory, study. Analytical methods that he employs include stable isotopic and elemental geochemistry as well as all types of traditional geological and geophysical methods. (EOS)

**Ana Barros**, Professor of Civil and Environmental Engineering; PhD, University of Washington  
Email: [barros@duke.edu](mailto:barros@duke.edu)  
Dr. Barros studies the physics of water cycle processes in mountainous regions with a focus on cloud formation and precipitation; remote sensing of the environment; long-range predictability and risk analysis of natural hazards; and computational environmental fluid mechanics. (EOS)

**Xavier Basurto**, Associate Professor of Sustainability Science; BS, Marine Resource Management, ITESM Campus Guaymas, Mexico; MS, School of Natural Resources, University of Arizona; MPA, School of Public Administration and Policy, University of Arizona; PhD, Management with a minor in Cultural Anthropology, University of Arizona  
Email: [xavier.basurto@duke.edu](mailto:xavier.basurto@duke.edu)  
Dr. Basurto’s experience lies in the governance and theory of common-pool resources, community-based management, and institutional analysis of social-ecological systems, especially in the context of coastal marine environments and protected areas in rural Latin America. (MSC)

**Lori Snyder Bennear**, Juli Plant Grainger Associate Professor of Energy Economics and Policy; AB Economics and Environmental Studies, Occidental College; MA, Economics, Yale University; PhD, Public Policy, Harvard University  
Email: [lori.bennear@duke.edu](mailto:lori.bennear@duke.edu)  
Dr. Bennear’s areas of specialization are environmental and natural resource economics, applied microeconomics, and empirical methods. Her research focuses on estimating the effect of different regulatory innovations on measures of facility-level environmental performance, such as pollution levels, chemical use, and technology choice. Her recent work has focused on measuring the effectiveness of management-based regulations, which require each regulated entity to develop its own internal rules and initiatives to achieve reductions in pollution, as well as the effectiveness of regulations that mandate public reporting of toxic emissions. (ESP)

**Emily Bernhardt**, Professor; BS, The University of North Carolina at Chapel Hill; PhD, Ecology and Evolutionary Biology, Cornell  
Email: [emily.bernhardt@duke.edu](mailto:emily.bernhardt@duke.edu)  
The core of Dr. Bernhardt’s interests are in watershed biogeochemistry, and in understanding how the ways in which people live on and use the landscape alters the structure, function and chemistry of receiving streams and wetlands. (ESP, MSC)

**Alan E. Boudreau**, Professor of Geology; BA, Geology, University of California, Berkeley; MS, Geology, University of Oregon; PhD, Geology, University of Washington  
Email: [boudreau@duke.edu](mailto:boudreau@duke.edu)  
Dr. Boudreau’s research has focused on understanding the crystallization of large layered intrusions, with particular attention to the Archean Stillwater complex in Montana. Besides the intriguing problems proposed for the crystallization of magmas, these intrusions are host to important mineral reserves. Much of Dr. Boudreau’s recent work has investigated the degassing history of these intrusions and the role of volatiles in the formation of platiniferous ore zones in South Africa. Another fundamental problem involves the mechanisms by which igneous layering may develop. Dr. Boudreau has worked...
on models that challenge the conventional “two magma” mixing models often called upon to explain such features. The search for new observations to constrain and test these and other hypotheses is a major focus of his studies. (EOS)

*Kelly Brownell, Robert L. Flowers Professor of Public Policy and Director of the World Food Policy Center, Duke University; PhD, Rutgers University (ESP)
Email: kelly.brownell@duke.edu

Nicolette Cagle, Lecturer; PhD, Duke University
Email: nicolette.cagle@duke.edu
Dr. Cagle is an environmental educator with a passion for writing. She teaches courses emphasizing natural history and environmental education and communication. (ESP)

Lisa M. Campbell, Rachel Carson Professor of Marine Affairs and Policy and Director of Graduate Studies (Marine Science and Conservation); BA & Sc, Arts and Sciences, McMaster University, Canada; MA, Geography and Environmental Studies, University of Toronto; PhD, Geography, Cambridge University
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Dr. Campbell’s research focuses on policies designed to reconcile wildlife (and other resource) conservation with socioeconomic development, primarily in rural areas of developing countries. She studies the process of policymaking, the transition from policy to practice, and the impacts of (and responses to) implementation at the local level. At the policymaking stage, she examines how the interaction of science and other values, and how negotiations among stakeholders (local people, bilateral agencies, NGOs and experts) inform the process. A major research focus has been on marine turtle conservation policy and its implementation in Latin America and the Caribbean. Dr. Campbell is more generally interested in research methodology, including qualitative methods, interdisciplinary research and ethics. (MSC)

Nicolas Cassar, Professor of Biogeochemistry and Senior Associate Dean for Research and PhD Programs; BS, McGill University; PhD, Oceanography, University of Hawaii
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Cassar’s experience lies in biogeochemistry and isotope biogeochemistry, marine productivity and carbon cycling, and algal ecophysiology. (EOS, MSC)

Charlotte Clark, Assistant Professor of the Practice in Sustainability Education and Director of Undergraduate Programs; AB, MEM and PhD, Duke University
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Dr. Clark’s primary interest is environmental education, specifically in the area of decision-making by the general public on issues of environmentally-related behavior. (ESP)

James S. Clark, Nicholas Professor of Environmental Science, Professor of Biology, and Professor of Statistical Science; BS, Entomology, North Carolina State University; MS, Forestry and Wildlife, University of Massachusetts; PhD, Ecology, University of Minnesota
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Dr. Clark’s research focuses on how global change affects forests and grasslands. Current projects include studies of plant migrations, the effects of recurrent drought on vegetation cover and fire in the Northern Plains and the effects of aridity and fire on North American temperate and boreal forests during recent millennia. He is also developing approaches to forecast ecosystem change. Analyses of forest succession at Duke University’s Free Air CO2 Experiment (FACE) are being used to assess how changing atmospheric chemistry is affecting the trajectory of change in modern forests. Dr. Clark has authored more than one hundred scientific articles and edited the book Sediment Records of Biomass Burning and Global Change (Springer, 1997). (ESP, EOS)

Richard T. Di Giulio, Sally Kleberg Professor of Environmental Toxicology; BA, Comparative Literature, University of Texas at Austin; MS, Wildlife Management, Louisiana State University; PhD, Wildlife Biology, Virginia Polytechnic Institute and State University
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Dr. Di Giulio’s research is concerned with mechanisms of contaminant metabolism, adaptation and toxicity, and the development of mechanistically based indices that can be employed in biomonitoring. Of particular concern are mechanisms of oxidative metabolism of aromatic hydrocarbons, mechanisms of free radical production and antioxidant defense, and mechanisms of chemical carcinogenesis, developmental perturbations and adaptations to contaminated environments by fishes. The goals of this research are to bridge the gap between research and the development of tools for environmental assessment, and to elucidate linkages between human and ecosystem health. Dr. Di Giulio serves as director of Duke University’s Integrated Toxicology Program and the Superfund Basic Research Center. (ESP, MSC)

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Dr. Doyle’s experience lies in river science including hydrology, geomorphology, and engineering. (ESP)

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Dr. Dunn’s research focuses on applying ecological theory to develop applied solutions to natural resource management and conservation problems across a range of scales. (MSC)

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Fay’s experience lies in spatial analysis of species ranges under changing environmental conditions, habitat connectivity analysis, and geospatial tool development for use in mapping, inventoring, and managing ecosystem services. (ESP)
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Dr. Ferguson's research centers around the application of high-performance mass spectrometry techniques to problems in environmental toxicology and chemistry. Active areas of investigation include development of methods for broadband qualitative and quantitative analysis of polar organic contaminants in the environment, as well as the use of proteome analysis techniques for investigating mechanisms and biomarkers of chemical stress in aquatic organisms. (ESP)

*Christine Folch, Assistant Professor of Cultural Anthropology; PhD, City University of New York
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Dr. Folch works on water and energy politics amidst the constraints of the Anthropocene. (ESP)

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Dr. Gallagher’s research focuses on public policies related to the interaction of business and the environment. Sustainable strategic management and the professionalization of sustainability is a particular focus of her work. In addition, she has examined business-government partnerships for environmental protection, such as brownfields redevelopment and the devolution of environmental public policy implementation to the private sector. (ESP)

*Alan E. Gelfand, James B. Duke Professor of Statistical Science and Decision Sciences and Professor of Environmental Sciences and Policy; BS, Mathematics, City College of New York; MS and PhD, Statistics, Stanford University
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Dr. Gelfand’s major research focus is on stochastic modeling of complex systems. In particular, he works on applications in ecology, environmental science, and atmospheric science. A key feature of nearly all of this work is that the system under investigation can be viewed as a space-time process leading to the use of spatio-temporal modeling tools. Hierarchical specifications provide the framework for this effort, enabling convenient synthesis of knowledge about the behavior of the system with available data sources. (ESP)

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Dr. Gill's research centers on marine coupled human-natural systems, focusing predominantly on marine management and tropical coral reef systems. (MSC)

Alex Glass, Senior Lecturer, Invertebrate Paleontology and Science Education, and Director of Undergraduate Studies (EOS); PhD, University of Illinois
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Dr. Glass' experience lies in paleontology, evolution, fossil echinoderms, geology, nature of science, and science education. Glass has a strong interest in the relationship between science and religion, particularly the public’s debate over creation and evolution. (EOS)

*Greg Gray, Professor of Medicine and Global Health; MD, University of Alabama; MPH, Johns Hopkins (ESP)

*Claudia Gunsch, Associate Professor of Civil and Environmental Engineering; PhD, University of Texas, Austin
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Dr. Gunsch's research focuses on characterizing and engineering environmental microbiomes to help degrade contaminants or act as biosensors to detect pathogens. She also investigates the genetic adaptation mechanisms of bacteria following contaminant exposures to elucidate their role in modifying the environment. (ESP)

Patrick N. Halpin, Professor of Marine Geospatial Ecology; BA, International Studies, MPA, International Management, George Mason University; PhD, Environmental Sciences, University of Virginia
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Dr. Halpin’s research interests are in landscape ecology, GIS and remote sensing, and conservation management. His research activities include spatial analysis of environment and vegetation patterns, Geographic Information Systems analysis, ecological applications of remote sensing and terrestrial and marine protected area management. Dr. Halpin has conducted research on the international impacts of global climate change in montane environments. He is currently a principal investigator in research projects involving the spatial analysis of environmental change in urban environments, spatial analysis of forest structure and conservation applications of GIS. Dr. Halpin has a special interest in the application of GIS and spatial analyses to environmental problem solving in terrestrial and marine research and management problems. (MSC, ESP)

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Harrell’s experience lies in GIS and remote sensing. (ESP)

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Dr. Heffernan’s experience lies in nutrient cycling in wetlands and aquatic ecosystems; disturbance and resilience; ecology of urban environments; and ecosystem restoration. Current study sites include spring-fed rivers of North Florida, and the wetlands of the Florida Everglades. (ESP)

James L. Hench, Associate Professor of Oceanography; BS, Civil Engineering, North Carolina State University, MS, Civil Engineering, Stanford University; PhD, Physical Oceanography, The University of North Carolina at Chapel Hill
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Dr. Hench is a physical oceanographer with research interests in shallow-water circulation characterized by unsteadiness, strong
advective accelerations, and frictional boundary layers that occupy much or all of the water column. He also is interested in the effects of stratification on shallow flows. Currently he is working on several projects, including wave-driven circulation and exchange in coral reef, lagoon, and pass systems; understanding the effects of rough bottoms such as corals on circulation and scalar mixing; and the impact of stratification on circulation and tidal exchange in a freshwater tidal river.

He also has a strong interest in interdisciplinary problems that have a significant physical component, such as larval fish transport, small-scale shear effects on phytoplankton, selective tidal-stream transport, sponge excurrents, and the effects of wave forcing on coralivory. (MSC)

David E. Hinton, Nicholas Professor of Environmental Quality; BS, Zoology, Mississippi College; MS, PhD, Anatomy, University of Mississippi
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Dr. Hinton's research is focused on the development and growth of fishes in normal health and in the case of toxicant-induced disease. His areas of interest include the development and application of biomarkers of exposure, the examination of adverse effects and sensitivity to studies of early life stages of fishes, and the long-term consequences of early life stage toxicant exposure to adult structure and function. (ESP, MSC)

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Dr. Kim's research areas include aquatic chemistry and geochemistry, trace element environmental chemistry, nanogeoscience, mercury biogeochemistry, metal-sulfide colloids, voltammetric methods and electrochemistry. (ESP)

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Dr. Hunt's research lies in the area of microbial ecology, specifically the drivers of bacterial diversity and dynamics in the marine environment. Bacterial adaptation to emerging pollutants. (MSC)

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Dr. Jeuland's areas of research include environment and energy, environmental law, regulation and policy, and global health. (ESP)

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Dr. Johnston is a marine conservation ecologist who focuses on the foraging ecology and habitat needs of marine animals in relation to pressing conservation issues. (MSC)

Timothy Johnson, Associate Professor of the Practice, PhD, Carnegie Mellon University
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Dr. Johnson's work examines the social and environmental consequences of technology change across the energy system. In addition to technology-specific assessments, he looks at long-range scenarios of energy system evolution; the economic, social, and technical forces driving this change; and their social and environmental impacts. (EOS)

Zackary Johnson, Associate Professor of Biological Oceanography and Marine Biotechnology; BS, Civil and Environmental Engineering, Massachusetts Institute of Technology; PhD, Botany, Duke University
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Dr. Johnson's research currently focuses on 1) developing marine algae as a source of biofuels and 2) studying the diversity, structure and biogeochemistry of marine microbial ecosystems using Prochlorococcus as a model marine microbe. (MSC)

Prasad Kasibhatla, Professor of Environmental Chemistry and Director of Undergraduate Studies (ENV); BS, Chemical Engineering, University of Bombay; MS, PhD, Chemical Engineering, University of Kentucky
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Dr. Kasibhatla's research is focused on the development of a fundamental and quantitative understanding of the factors that determine the chemical composition of the atmosphere. He is particularly interested in delineating natural and anthropogenic impacts on the chemical composition of the atmosphere, and in exploring the potential for these impacts to affect natural ecosystems. His research involves the use of numerical models in conjunction with remote and in situ measurements of atmospheric composition. (ESP)

Gabriel Katul, Theodore S. Coile Professor of Hydrology and Micrometerology; BE, Civil Engineering, American University of Beirut; MS, Civil Engineering, Oregon State University, PhD, Civil Engineering, University of California, Davis
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Dr. Katul's work is focused on developing an understanding of the cycling of water, carbon, and energy within the soil-plant-atmosphere continuum. His approach is based on the application of fluid mechanics to quantify the net exchange of carbon dioxide, water,
heat and momentum between ecosystems and the atmosphere. His work spans from below the root zone in the soil to the lower layers of the atmospheric boundary layer. While studies of this domain include the traditional disciplines of surface hydrology, terrestrial ecology and boundary layer meteorology, the basic principles of fluid mechanics provide the integration across this natural continuum and thus the most logical basis for developing a comprehensive, robust theory in land-atmosphere interaction research. (ESP)

*Richard Kay, Professor of Biological Anthropology and Anatomy and of Geology; BS, Anthropology and Zoology, University of Michigan; MPhil, PhD, Geology and Geophysics, Yale University  
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Dr. Kay’s current research interests center on the evolutionary history of the primates. He is especially interested in further documenting the fossil history of neotropical monkeys, whose history is poorly known. Another focus of his research has been the use of quantitative methods to understand the dietary adaptations of the teeth of living primates. Dr. Kay is chairman of Duke’s Department of Biological Anthropology and Anatomy. (EOS)

Emily M. Klein, University Distinguished Service Professor of Earth and Ocean Sciences and Chair, Division of Earth and Ocean Sciences; BA, English, Barnard College; MS, PhD, Geology, Columbia University  
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Dr. Klein’s research focuses on the geochemistry of oceanic basalts, using diverse tools of major, trace and isotopic analyses. The goals of her research are to understand the processes that lead to the creation of the ocean crust, including the physical and chemical characteristics of the sub-ridge mantle. Through these studies, Dr. Klein examines how the Earth evolves chemically through geologic time. Her research involves sea-going expeditions to sample and map the ocean floor. (EOS)

Randall A. Kramer, Juli Plant Grainger Professor of Global Environmental Health and Associate Director for Strategy, Duke Global Health Institute; BA, Economics, The University of North Carolina at Chapel Hill; ME, Economics, North Carolina State University; PhD, Agricultural Economics, University of California, Davis  
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Dr. Kramer’s research has focused on ecosystem valuation, water resource economics and the economics of biodiversity and natural resource management in developing countries. Current projects in Indonesia focus on biodiversity economics, such as the effects of human population growth and migration on the sustainable use of coastal resources and the examination of how public and community-based fisheries management affects economic activity. Another set of studies is focused on the economics of protected areas in Indonesia, with an emphasis on nature-based tourism, agricultural, and forest extraction in buffer zones and watershed protection benefits. In North Carolina, Dr. Kramer studies public attitudes toward water quality protection and the economic and ecological criteria for selecting sites for wetlands restoration. (ESP, MSC)

*Ed Levin, Professor of Psychiatry and Behavioral Sciences; PhD, University of Wisconsin  
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Dr. Levin is chief of the Neurobehavioral Research Lab in the Psychiatry Department of Duke Medical Center. His primary research effort is to understand basic neural interactions underlying cognitive function and addiction and to apply this knowledge to better understand cognitive dysfunction and addiction disorders and to develop novel therapeutic treatments. (ESP)

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Dr. Li is an assistant professor of environmental sciences in the Environmental Research Center at Duke Kunshan University. (ESP)

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Dr. Li’s research interests focus primarily on the climate and terrestrial ecosystem interaction, hydrometeorology, climate and modeling. Her current research is to understand how the hydrological cycle changes in the current and future climate and their impacts on the ecosystems, and future climate over tropical lands. Her work has covered both diagnostic and modeling studies. (EOS)

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Dr. Mayer works in the areas of narrative politics; globalization and governance; international trade policy; climate politics; and international negotiations. (ESP)

Joel N. Meyer, Truman and Nellie Semans/Alex Brown & Sons Associate Professor of Molecular Environmental Toxicology, and Director of Graduate Studies (Integrated Toxicology & Environmental Health); BA, Environmental Studies and Peace and Conflict Studies, Juniata College; PhD, Environmental Toxicology, Duke University  
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Dr. Meyer studies the effects of genotoxic agents on human and wildlife health. He is interested in understanding the mechanisms by which environmental agents cause DNA damage, the molecular processes that organisms employ to protect prevent and repair DNA damage, and genetic differences that may lead to increased or decreased sensitivity to DNA damage. Mitochondrial DNA damage and repair are a particular focus. He studies DNA repair and other responses to DNA damage via PCR-based analysis of DNA damage and repair, gene expression and systems biology approaches, and organismal-level responses. (ESP)
Megan Mullin, Associate Professor of Environmental Politics and Director of Graduate Studies (Environmental Policy); BA and MA, Political Science, Bowdoin College; PhD, Political Science, University of California, Berkeley
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Dr. Mullin’s work is in the field of American politics, focusing on governmental processes and applied policy outcomes. (ESP)

*Susan Murphy, Associate Professor, Department of Obstetrics and Gynecology; PhD, Wake Forest University (ESP)
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A. Brad Murray, Professor of Geomorphology and Coastal Processes and Director of Graduate Studies (Earth and Ocean Sciences); BA, Journalism, BIS, General Science, MS, Physics, PhD, Geology, University of Minnesota
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Dr. Murray is interested in earth surface processes and patterns, focusing on rivers and desert, arctic and alpine geomorphology. His recent efforts have focused on coastal and nearshore processes. The nearshore environment is a spatially extended system that exhibits complex, dynamic spatial patterns, including the arrangement of bars and channels, waves and often an array of alongshore and crossshore currents. He approaches such systems with the perspective and techniques developed in the study of nonlinear dynamics and complex systems, looking for possibly simple, large-scale interactions that could explain complex behaviors. He uses relatively simple, cellular-automata models to test such hypotheses, applying the methods to beach and surf-zone problems as well as offshore currents and shoreline features. (EOS)

Brian Murray, Research Professor and Director, Duke University Energy Initiative; BS, Economics and Finance, University of Delaware; MS, Resource Economics and Policy, Duke University; PhD, Resource Economics and Policy, Duke University
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Dr. Murray’s research is in the area of environmental economics, climate change, ecosystem services, land use, forests and agriculture. (ESP)

Grant Murray, Associate Professor of Marine Policy; BS/BA, Tufts University; MEM, Duke University; PhD, University of Michigan (MSC)

Douglas Nowacek, Repass-Rogers University Professor of Conservation Technology and Associate Professor of Electrical and Computer Engineering; BA, Ohio Wesleyan University; PhD, Biological Oceanography, Woods Hole Oceanographic Institute of Technology
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Dr. Nowacek’s research is focused on the link between acoustic and motor behavior in marine mammals, primarily cetaceans and manatees, specifically, how they use sound in ecological processes. (MSC)

*Michelle Nowlin, Clinical Professor and Supervising Attorney, Environmental Law and Policy Clinic; BA, University of Florida; JD/MA, Duke University (ESP)
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Ram Oren, Nicholas Professor of Earth System Science; BS, Forest Resource Management, Humboldt State University; MS, Forest Ecology, PhD, Physiological Ecology, Oregon State University
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Dr. Oren’s research quantifies the components of water flux in forest ecosystems and the influence of certain biotic and abiotic factors on water flux. Climate variability, including elevated atmospheric carbon dioxide, affects the patterns and amounts of water used by forest ecosystems, and their spatial distributions. Using a local mass-balance approach and detailed measurements of water flux and driving variables in the soil, plants and atmosphere, Dr. Oren evaluates the likely responses of different forest ecosystems to environmental change. He also works to quantify the carbon and water balance in forests under current atmospheric CO₂ concentration and projected future concentration, and to evaluate the effect of soil fertility on carbon sequestration and water yield in pine forests. (ESP)

Sari Palmroth, Associate Research Professor; MSc, Silviculture, PhD, Forest Ecology, University of Helsinki, Finland
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Dr. Palmroth’s research interests are in the general area of forest carbon dynamics with emphasis on physical-physiological modeling of canopy radiative transfer and photosynthesis. Her recent work also deals with empirical modeling of ecosystem respiration, where she is examining gas exchange in leaves, stems, and soils. (ESP)

William Pan, Associate Professor of Environmental Health; BA, Boston College; MPH, Emory University; MS, PhD, University of North Carolina at Chapel Hill
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Dr. Pan’s primary research interests are to foster a deeper understanding of demographic processes, human health and environmental change using a combination of quantitative tools from biostatistics, geography, and economics. (ESP)

Dalia Patino-Echeverri, Gendell Family Associate Professor of Energy Systems and Public Policy; BS, University of Andes, Colombia; MS, University of Andes, Colombia; PhD, Carnegie Mellon University
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Dr. Patino-Echeverri’s research focuses on public policy design for energy systems, with a particular emphasis on managing the risks arising from the uncertainties influencing the outcomes of government actions. Much of her current work focuses on the policies that affect capital investment decisions within the electricity industry, and the corresponding costs to society of electricity and air-emissions levels. (ESP)

*Subhrendu Pattanayak, Professor of Public Policy and Environmental Economics; BA, Economics, University of Delhi; MS, Economics, Purdue University; PhD, Duke University
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Dr. Pattanayak measures resource and environmental values and models economic behavior under environmental constraints for
Lincoln F. Pratson, Gendell Family Professor of Energy and the Environment; BS, Geology, Trinity University; MS, Biology, San Francisco State University; PhD, Biology, University of Florida (ESP)

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Dr. Pratson studies how sedimentary processes shape continental margins. Specific research interests include the dynamics of both current- and gravity-driven sediment transport, submarine canyon formation, and seafloor evolution, the causes and consequences of submarine slope failure and the interplay between marine sedimentation and tectonics. He conducts this research using a variety of methods ranging from seafloor mapping using multibeam bathymetry, side-scan sonar imagery and shallow cores, to sequence stratigraphy based on seismic reflection profiles and borehole data constrained in some instances by gravity measurements. Dr. Pratson also uses numerical and experimental models of sedimentary processes for testing ideas about their dynamics and predicting their contribution to and imprint on the morphology and stratigraphy of continental margins. (EOS)

Andrew J. Read, Stephen Toth Professor of Marine Biology; Director, Duke University Marine Laboratory; Division Chair, Marine Science and Conservation; BSc, MSc, PhD, Zoology, University of Guelph

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Dr. Read's research interests are in the ecology and conservation biology of marine mammals. His work focuses on how dolphins and porpoises obtain prey in a three-dimensional environment and on the life history consequences of energy allocation. Much of his current research documents the direct and indirect effects of human activities on populations of marine mammals and attempts to find solutions to such conflicts, especially between marine mammals and commercial fisheries. This research involves field work, experimentation and modeling. He is particularly interested in the development and application of new conservation tools to resolve such conflicts. (MSC)

Chantal Reid, Assistant Professor of the Practice; BS, McGill University; MS, San Diego State University; PhD, Duke University

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Dr. Reid studies how plants grow in changing environments, with emphasis on effect of rising CO₂ and other air pollutants. She combines her research and teaching interests, engaging students in research through ecology courses and independent study. (ESP)

Curtis J. Richardson, John O. Blackburn Distinguished University Professor of Resource Ecology and Chair, Environmental Sciences and Policy Division; BS, Biology, State University of New York at Cortland; PhD, Ecology, University of Tennessee

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Dr. Richardson's research interests in applied ecology are centered on long-term ecosystem response to large-scale perturbations such as acid rain, toxic materials, trace metals, flooding, and nutrient additions. His main interests are in phosphorus nutrient dynamics in wetlands, the effects of environmental stress on plant metabolism and growth response, and wetland restoration. As director of the Duke University Wetland Center since its inception in 1989, Dr. Richardson has directed research efforts to understand the ecological basis for a phosphorus threshold in the Everglades and sustaining ecosystem structure and function. (ESP, MSC)

Daniel D. Richter Jr., Professor of Soils and Forest Ecology; BA, Philosophy, Lehigh University; PhD, Forest Soils, Duke University

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Dr. Richter's research centers on applying principles of soil and ecosystem sciences to the management of forests, soils, and watersheds. Recent research has focused on Ultisols and Inceptisols in the southeastern United States, boreal forest Gleysols in interior Alaska, and a wide range of soils in the humid tropics of Indonesia and Costa Rica. Dr. Richter's research centers on biogeochemical change in soil over three time scales: decades, in which contemporary ecosystems and their management affect ongoing dynamics of soil; centuries, in which past land-use practices affect soil properties and processes; and millennia, in which ecosystem processes form soils. Dr. Richter studies three main issues: carbon sequestration, soil-nutrient regeneration, and soil-ecosystem acidification. (ESP)
Dan Rittschof, Norman L. Christensen Professor of Environmental Sciences; BS, PhD, Zoology, University of Michigan
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Dr. Rittschof’s research focuses on ecology with emphasis on the chemical, behavioral, and spatial aspects of the discipline. Presently, he has two areas of focus: the ecology of local macroinvertebrates and the prevention of fouling of marine vessels. Dr. Rittschof is funded in both areas with grants to work on the spatial ecology of blue crabs in the basin drained by the Beaufort Inlet and to develop new antifouling technology. The most extensive of these is a three-year antifouling program in Singapore that started in early January 2002. This program has the goal of using medical drugs as environmentally benign antifoulants. (MSC)

*Stephen E. Roady, Professor of the Practice, Duke Law School; JD, Duke University
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Roady’s current research examines ways to protect air and water quality, and to manage natural resources sustainably. Prior to his appointment, he devoted more than three decades to litigation and administrative advocacy defending and enforcing the public health and environmental protections contained in federal statutes enacted originally in the United States between 1970 and 1990. His work focused particularly on air and water quality, mountains and streams, and ocean and coastal resources. (MSC)

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Dr. Schultz’s area of expertise is in marine biodiversity and conservation. He is the director of the Marine Conservation Molecular Facility. (MSC)

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Dr. Shapiro-Garza’s experience lies in human and environmental geography; political ecology; qualitative research design and methods; social impact assessment; community-based ecosystem management; market-based environmental policy; Latin America. (ESP)

Drew Shindell, Nicholas Professor of Earth Sciences; BA, Physics, UC Berkeley; PhD, Physics, State University of New York at Stony Brook
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Dr. Shindell’s research focuses on the interactions between atmospheric composition and climate change, climate and air quality linkages, and public policy. (EOS)

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Dr. Silliman’s research is focused on community ecology of salt marshes and rocky shores, conservation of coastal wetlands and reef fish populations, physical-forcing and disease-mediated control of food web dynamics, plant-animal interactions, and evolution of fungal farming behavior. (MSC)

Martin D. Smith, George Woodwell Professor of Environmental Economics; BA, Public Policy, Stanford University; PhD, Agricultural and Resource Economics, University of California, Davis
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Dr. Smith’s research focuses on spatial issues in natural resource use and management. He specializes in applied econometrics and bioeconomic modeling. His current research projects include evaluating marine reserves as a commercial fishery management tool, studying the spatial and intertemporal behavior of renewable resource harvesters, modeling the impacts of commercial fishing on endangered species through predator-prey interactions, analyzing private agricultural land use decisions in federally managed wetlands and identifying transition dynamics in the organic farming industry. (ESP, MSC)

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Dr. Stapleton’s investigates the fate, transport, and metabolism of halogenated organic contaminants in the environment. Her specific interests focus on species-specific differences in the metabolism of brominated flame retardants in aquatic organisms. Analytical methods employed in Dr. Stapleton’s laboratory include gas chromatography, liquid chromatography, and mass spectrometry. (ESP)

Toddi Steelman, Stanback Dean; BA, West Virginia University; MPA, Princeton University; PhD, Duke University
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Dr. Steelman’s research includes forest management and planning, water security, open space protection, and climate change, but she is best known for her work on community adaptation to wildfires and how communities and agencies can interact for more effective wildlife management. (ESP)
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Dr. Swenson is interested in modeling spatial patterns of species and ecosystems, species diversity, and their relationship with functional ecological factors. She has worked in the South American tropics using GIS and remote sensing technology to create information for conservation applications. (ESP)

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Dr. Timmins focuses on environmental and development economics, with recent projects supported by Resources for the Future, the World Bank, the National Science Foundation, and the Inter-American Development Bank. His current research examines the role of equilibrium models of sorting behavior in describing preferences for non-marketed environmental commodities, identifying agglomeration and congestion effects in urban economies, and describing the spatial variation in multidimensional measures of poverty in Brazil. (ESP)

Dean L. Urban, Professor of Landscape Ecology; BA, Botany and Zoology, MA, Wildlife Ecology, Southern Illinois University at Carbondale; PhD, Ecology, University of Tennessee
Email: deanu@duke.edu
Dr. Urban's interest in landscape ecology focuses on the agents and implications of pattern in forested landscapes. Increasingly, his research is centered on what has been termed theoretical applied ecology, developing new analytic approaches to applications of immediate practical concern, such as conservation planning. A hallmark of Dr. Urban's lab is the integration of field studies, spatial analysis, and simulation modeling in environmental problem solving. (ESP)

Cindy Lee Van Dover, Harvey Smith Professor of Biological Oceanography; BSc, Environmental Science, Rutgers University; MA, Ecology, University of California, Los Angeles; PhD, Biological Oceanography, Massachusetts Institute of Technology and Woods Hole Oceanographic Institute Joint Program
Email: cindy.vandover@duke.edu
Dr. Van Dover is a deep-sea biologist and explorer with a primary focus on the ecology of chemosynthetic communities at hydrothermal vents and methane hydrate seeps. Her interests include biogeography, biodiversity, community structure, and the processes that control these attributes within deep-sea ecosystems, and studies of biological adaptations to extreme environments. (MSC)

Avner Vengosh, Professor of Geochemistry; BS, Geology, Hebrew University of Jerusalem; MS, Geology, Hebrew University of Jerusalem; PhD, Environmental Geochemistry, Australian National University, Canberra, Australia
Email: vengosh@duke.edu
Dr. Vengosh’s major focus is on the quality of water resources, understanding flow paths, ground- and surface-water interactions, mechanisms of water salinization and contamination, and their societal impact. Current research includes natural contaminants and radioactivity in water resources and their effects on human health, salinization and sustainability of water resources in the Middle East, and anthropogenic modifications of the chemical and isotopic compositions of water resources. His work involves field and laboratory studies. Analytical methods that he employs include aquatic geochemistry, major and trace elements, and stable (boron, sulfur, nitrogen, oxygen, hydrogen) and radiogenic (lead, strontium, uranium, radium, radon) isotopic geochemistry. (EOS)

*Daniel Vermeer, Associate Professor of the Practice; PhD, Duke University; Director of Duke University’s Center for Energy, Development and the Global Environment (ESP)
Email: daniel.vermeer@duke.edu

Rebecca Vidra, Senior Lecturer and Director of the Duke Environmental Leadership Program; PhD, North Carolina State University
Email: rebecca.vidra@duke.edu
Vidra’s experience lies in environmental ethics, particularly in the ethical challenges of ecological restoration. Active practice in environmental communications. (ESP)

Jeffrey Robert Vincent, Clarence F. Korstian Professor of Forest Economics and Management; AB, Social Anthropology, Harvard University; MS, Forestry, Michigan State University; PhD, Forestry and Environmental Studies, Yale University
Email: jeff.vincent@duke.edu
Dr. Vincent is an authority on natural resource and environmental policy issues in developing countries, especially those in the Asia-Pacific region. He has particular expertise on issues related to tropical forests, air and water pollution, and green accounting (the incorporation of environmental quality into GNP and other measures of macroeconomic performance). He has some expertise on the economic impacts of AIDS and other infectious diseases in developing countries. (ESP)

Jesko von Windheim, Lynn Gorguze-Scott Peters Professor of the Practice of Environmental Entrepreneurship and Innovation; BSc McMaster University; MS, PhD, University of Guelph; MBA, University of North Carolina at Chapel Hill
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Dr. von Windheim has played an integral role in a number of start-up companies based on early-stage technologies. A current project is Zenalux (www.zenalux.com) which is commercializing technology developed at Duke that can detect biomarkers and diagnose disease such as cancer by shining light onto biological tissue. (ESP)

Erika Weinthal, Professor of Environmental Policy; BA, Government and Environmental Studies, Oberlin College; MA, MPhil, PhD, Political Science, Columbia University
Email: weinthal@duke.edu
Dr. Weinthal’s research focuses on global environmental politics, the political economy of the resource curse, regional cooperation, and state-society relations. She has carried out field work in Central Asia, the Caucasus, the Russian Federation, and the Middle East. She is the author of State Making and Environmental Cooperation: Linking Domestic and International Politics in Central Asia (Cambridge, Mass.: MIT Press, 2002). (ESP)
Jennifer Wernegreen, Lee Hill Snowdon Professor of Environmental and Evolutionary Genomics and Director of Graduate Studies (Environment); BA, Earlham College; PhD, Yale University
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Dr. Wernegreen studies the environmental and evolutionary genomics of bacteria. She also studies evolutionary ecology of symbiotic interactions, especially those involving beneficial microbes. (ESP)

*Jonathan B. Wiener, Professor of Law and of Environmental Policy; AB, Economics, Harvard College; JD, Harvard Law School
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Mr. Wiener studies the interplay of science, economics, and law in addressing environmental and human health risks. His policy work and writing have addressed topics including climate change, forest conservation, risk and risk-risk tradeoffs, biotechnology, mass torts and incentives in regulation and litigation. Before coming to Duke in 1994, Mr. Wiener worked on US and international environmental policy at the White House Council of Economic Advisers and Office of Science and Technology Policy, and at the United States Department of Justice, in both the first Bush and Clinton administrations. (ESP)

*Mark Wiesner, James L. Meriam Professor of Civil and Environmental Engineering; PhD, Johns Hopkins University
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Dr. Wiesner’s research addresses challenges at the interface between water, energy, and materials. (ESP, EOS)

*Robert L. Wolpert, Professor of Statistical Science and Decision Sciences and of the Environment; AB, Mathematics, Cornell University; PhD, Mathematics, Princeton University
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Dr. Wolpert works in collaboration with ecologists and other environmental scientists in developing and using statistical, mathematical, and computational models to help improve our understanding and management of complex environmental systems. His specific areas of interest include spatial statistics, stochastic processes, nonparametric Bayesian analysis and meta-analysis (the synthesis of evidence from multiple diverse sources). He works with epidemiologists in England in developing hierarchical Bayesian models for synthesizing evidence about the health effects of environmental pollutants. A new research area involves remote sensing of biomass and assessment of biodiversity. (ESP)

*Justin Wright, Associate Professor; BA, Williams College; PhD, Cornell University
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Dr. Wright’s interests are in the areas of community, landscape and ecosystem ecology, focusing on understanding the causes and consequences of patterns of biological diversity across the planet. (ESP, MSC)

Jim Zhang, Professor of Global Environmental Health; BS and MS, Peking University; PhD, Environmental Sciences, Rutgers University
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Dr. Zhang’s interests lie in the area of global environmental health, focusing on assessing human exposures to various environmental contaminants and resulting health effects. Specifically, he is interested in developing novel methods for measuring trace-level chemical agents in environmental media (air, water, soil, food) and in biological specimens (e.g., blood, breath, urine and hair). (ESP)

*Junjie Zhang, Associate Professor and Director, Environmental Research Center and Master of Environmental Policy Program, Duke Kunshan University; PhD, Duke University (ESP)
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Extended Faculty

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Faculty Emeriti
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Celia Bonaventura, Professor Emerita of Cell Biology
Joseph Bonaventura, Professor Emeritus of Cell Biology
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Norman L. Christensen Jr., Professor Emeritus of Ecology
Bruce H. Corliss, PhD, Professor Emeritus of Earth and Ocean Sciences
John D. Costlow, PhD, Professor Emeritus
George F. Dutrow, PhD, Professor Emeritus
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Peter Haff, PhD, Professor Emeritus of Earth Sciences
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S. Duncan Heron, PhD, Professor Emeritus of Geology
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*Meg McKean, Research Professor Emerita
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Joseph S. Ramus, PhD, Professor Emeritus of Biological Oceanography
Kenneth Reckhow, PhD, Professor Emeritus of Water Resources
James F. Reynolds, Professor Emeritus of Environmental Sciences and Policy and of Biology
William Schlesinger, PhD, James B. Duke Professor Emeritus of Biogeochemistry
John Terborgh, PhD, James B. Duke Professor Emeritus
Courses Taught in Durham

Environment (ENVIRON)

89S. First-Year Seminar. Topics vary each semester offered. Instructor: Staff. 1 unit.

102. Introduction to Environmental Sciences and Policy. An introduction to the study of environmental sciences and policy through exploration of basic environmental principles in the life, physical, and social sciences. Emphasis on understanding how the atmosphere, hydrosphere, lithosphere, cryosphere, and biosphere function, and how these spheres interact with human consumption, production, and technological patterns and processes. Field trips to a local site as well as the Duke University Marine Laboratory. Instructor: Vidra or Wernegreen. 1 unit.

147. Israel/Palestine: Comparative Perspectives. Introduction to the Israel/Palestine conflict, studied through an interdisciplin ary lens, including scholarship from the fields of anthropology, environmental studies, history, geography and cultural studies. Themes include: competing nationalisms, environmental politics and resource management, peace building, refugees and displacement, humanitarian crises and challenges, representational politics. Range of primary sources will be used including human rights reports and testimonials, natural resource policies, feature and documentary film, memoirs, political treatises, and maps. Instructor: Stein and Weinhart. 1 unit. C-L: see Cultural Anthropology 148; also C-L: Asian & Middle Eastern Studies 244, Jewish Studies 148, Public Policy 178, Political Science 159, Human Rights Program-Franklin Humanities Institute 148


155. Principles of Economics and the Environment. Teaches basic economic literacy and introduces environmental and natural resource issues through the lens of economics. Analyzes incentives and decisions of individuals, firms, and governments and how they interact with the natural environment. Examples include a consumer deciding to purchase organic produce, a firm deciding to install pollution control technology, a government choosing to regulate a carcinogenic chemical, and group of nations deciding to regulate greenhouse gas emissions. Stresses command of economic reasoning and analytical tools as ways to understand why people and governments do what they do and how policies might better address the needs of society. Instructor: Smith. 1 unit.

190FS. Topics in Environment. Topics vary semester to semester. Only open to students in the Focus Program. Consent of Instructor required. Instructor: Staff. 1 unit.

190S. Special Topics in Environmental Sciences and Policy. Content to be determined each semester. Instructor: Staff. 1 unit.

201. Integrating Environmental Sciences and Policy. Interaction between the natural and the social systems as they relate to the environment. Focus on ecological and earth system cycles, processes, and fundamental relationships. The environmental impact of human-induced change at the local, regional, and global levels. The role of technology and the policy process in determining how environmental problems evolve and are addressed. Use of ethical analysis to evaluate environmental tradeoffs. Use of case studies to integrate multiple disciplinary perspectives on environmental problems and to address issues of environmental justice. Prerequisite: Environment 102 or consent of instructor. Instructor: Pan, Clark, or Wernegreen. 1 unit.

205. Marine Megafauna. Ecology, systematics, and behavior of large marine animals including giant squid, bony fishes, sharks, sea turtles, seabirds, and marine mammals. Relations between ocean dynamics, large marine animals, and their role in ocean food webs. Impact of human activities and technological advancement on populations. Economic, social, and policy considerations in the protection of threatened species. Prerequisite: AP Biology, Introductory Biology, or consent of the instructor. Instructor: Staff. 1 unit. C-L: see Biology 205

209. Food, Farming, and Feminism. Viewing “agriculture,” “nature,” and “consumption” as pressing feminist themes and exploration of various dimensions of the cultural and political ecology/economy of producing, processing, circulating, preparing, and consuming sustenance. Particular focus on the ethical impact of US policy on rural farm communities and developing nations. Instructor: Staff. 1 unit. C-L: see Gender, Sexuality, and Feminist Studies 275; also C-L: Global Health 225, History 221

210D. Conserving the Variety of Life on Earth. An overview of biological diversity, its patterns, and the current extinction crisis. Historical and theoretical foundations of conservation, from human values and law to criteria and frameworks for setting conservation priorities; island biogeography theory, landscape ecology, and socioeconomic considerations in reserve design; management of endangered species in the wild and in captivity; managing protected areas for long term viability of populations; the role of the landscape matrix around protected areas; and techniques for conserving biological diversity in semi-wild productive ecosystems such as forests. Instructor: Pimm. 1 unit.

212. United States Environmental Policy. An overview of the major environmental legislation in the United States. Topics include: air and water pollution, hazardous waste, agriculture, wildlife, and institutions. Political, economic, ethical, and
214S. Ethical Challenges in Environmental Conservation. Examination of current ethical challenges in environmental conservation. Topics include the philosophical basis and challenges of mankind’s responsibility to the natural world; prioritization of often conflicting conservation efforts; balancing the needs of humans and the environment; the disputed role of scientists as advocates; and the philosophical and political obstacles to conservation efforts. Analysis of the evolving environmental movement, in relation to current issues. Instructor: Vidra. 1 unit. C-L: Human Rights Program-Franklin Humanities Institute 214S

216S. Environment and Conflict: The Role of the Environment in Conflict and Peacebuilding. Environmental and natural resources as a source of conflict and/or peacebuilding between and within nations and states. Analysis of the role of the environment in the conflict cycle and international security. Topics include refugees, climate change, water, and infectious disease. Particular focus on post-conflict and rebuilding in war-torn societies. Examination of the role of international organizations, non-governmental organizations, and emerging standards for environmental management. Examples drawn from conflicts such as Rwanda, Israel/Palestine, Nepal, Sierra Leone and others. Instructor: Weinthal. 1 unit. C-L: Public Policy 279S, Political Science 367S, International Comparative Studies 229S, Human Rights Program-Franklin Humanities Institute 229S

217. Restoration Ecology: Theory and Applications. Addresses fundamental principles of ecological restoration. Includes an overview of the discipline, scientific, ethical and philosophical underpinnings, and the legislative framework that guides much of the restoration work in the United States. Principles of ecosystem ecology introduced to provide an understanding of ecosystem processes across landscapes and within specific restoration sites. Students will conduct a comparative study of a restoration site with a reference site and work in small groups to create a monitoring report for this site. Prerequisite: introductory biology or environmental science, or consent of instructor. Instructor: Vidra. 1 unit.

222S. Environmental Conservation and Documentary Photography. Technical and aesthetic training in creating documentaries to communicate critical environmental issues so as to affect societal change. History of the essential role of documentary photography in land conservation, social justice, and protection of biodiversity from the early 1800’s to today leads into individual documentary projects. Studio, seminar, study of photography in university archives and field trips. Consent of Instructor required. Instructor: Satterwhite. 1 unit. C-L: Documentary Studies 248S

226S. Field Methods in Earth and Environmental Sciences. Introduction to basic field methods used in the earth and environmental sciences. Field investigations focus on topics such as groundwater and surface water movements, soil chemistry and identification, topographic and geologic mapping, the atmosphere/soil interface, and plant identification and distributions. Design of a field investigation, collection of data to address a specific goal, and interpretation and reporting of the results. Emphasis on learning to report field results in the format of scientific publications. Visits to five local field sites. Open only to juniors and seniors. Instructor: Klein or Dwyer. 1 unit. C-L: see Earth and Ocean Sciences 226S

228. Food and Fuel for a Growing Population: Nuts and Bolts of Plant Growth and Production. Covers primary physiological processes from subcellular to whole plant that affect plant growth in a changing environment. Processes include photosynthesis, respiration, water relations, nutrient and carbohydrate allocation, signaling, and stress responses to various biotic and abiotic factors for a range of plant species adapted to different environments. Applications include plant improvement for food and biofuel production, management of plant growth in response to global change. Local field trip planned. Recommended prerequisite: Biology 201L, 202L, or 203L. Instructor: Reid. 1 unit. C-L: Biology 228

228S. Food and Fuel for a Growing Population: Nuts and Bolts of Plant Growth and Production. Covers primary physiological processes from subcellular to whole plant that affect plant growth in a changing environment. Processes include photosynthesis, respiration, water relations, nutrient and carbohydrate allocation, signaling, and stress responses to various biotic and abiotic factors for a range of plant species adapted to different environments. Applications include plant improvement for food and biofuel production, management of plant growth in response to global change. Offered through the DukeImmerse program. Will include travel to farms in NC locally, to the mountains, and to the coast. Recommended prerequisite: Biology 201L, 202L, or 203L. Instructor consent required. Instructor: Reid. 1 unit. C-L: Biology 228S

231. Energy and the Environment. Overview of the challenges confronting humanity as a consequence of our reliance on energy. Challenges include dwindling supplies, rising demand and environmental degradation. Realistic responses require an understanding of the complexity of the energy system, including energy resources, uses, and impacts, in the context of social, political and economic imperatives. Lectures will be augmented by presentations from guest speakers from industry, government and non-profit organizations. Instructor: Pratson. 1 unit. C-L: Earth and Ocean Sciences 231, Energy 231

239. Introduction to Atmospheric Chemistry: From Air Pollution to Climate Change. Integrated scientific background for the impact of humans on the natural environment. Topics covered include greenhouse gases and climate, local and regional ozone pollution, long-range pollution transport, acid rain, atmospheric particle matter pollution, and stratospheric ozone depletion. Prerequisite: Chemistry 101DL. Instructor: Kasibhatla. 1 unit. C-L: Earth and Ocean Sciences 239

240S. Biodiversity Issues and Field Methods. Biodiversity is affected by many factors, both local and global, including climate and climate change, fire regimes, habitat fragmentation, and urbanization. These issues and others will be covered through readings, discussions, and field research. Explores and assesses local biodiversity through field exercises and field trips with emphasis on local flora and fauna identification. Applies field techniques to monitor, compare, and evaluate local communities for biodiversity in both urban and rural settings and their interface. Complements Environment 226, 210, and 217. Instructor: Staff. 1 unit.

265. Environmental Law and Policy. Legal principles governing environmental problems in the United States, including endangered species, hazardous waste, air pollution. Introduction to the overarching topics in law and in regulatory design that shape the contributions and roles law plays in solutions to environmental problems. Instructor: Staff. 1 unit.

269T-1. Voices in the Environment: Spanish. In this course, students will explore how language and culture impact environmental policy
and practice. Through authentic text, video, and case studies in Spanish, students will analyze environmental issues in Latin America to develop their understanding of core issues in the field. 1/2 credit. Sat/Unsat. Tutorials meet for 75 minutes/week. Taught in Spanish. Instructor: Staff. 0.5 units. C-L: see Spanish 272T-1

274. People, Plants and Pollution: Introduction to Urban Environments. Cities turn natural lands into impervious surfaces, like roofs and parking lots, while trees, forests, and grass decrease. Course covers urban environmental issues, including energy and carbon, air, heat, and water pollution, the health and welfare of people, and changes in other species and regional/global climatic patterns. Examines costs/benefits of urban nature on solving urban environmental problems, including enhancing the social welfare of people’s lives. Instructor: Wilson. 1 unit. C-L: see Biology 262

290. Special Topics in Environmental Sciences and Policy. Content to be determined each semester. Instructor: Staff. 1 unit.

290A. Duke-Administered Study Abroad: Advanced Special Topics in Environmental Sciences and Policy. Topics differ by section. Instructor: Staff. 1 unit.

290S. Special Topics in Environmental Sciences and Policy. Same as Environment 290 but taught as a seminar. Instructor: Staff. 1 unit.

310. Forest Measurements. This course aims to familiarize students with the field and analytic measurement skills expected of professionals in forest ecosystem management. In this course, we consider techniques for measuring forest characteristics at three different scales: individual plant, forest stand, and landscape. These techniques require the use of traditional forestry instruments (e.g., clinometers, Biltmore sticks) and contemporary handheld GPS units. This course heavily emphasizes field activities and quantitative skills. Recommended prerequisite: Environment 311 (Dendrology, past or concurrent) and/or instructor consent. Instructor consent required. Instructor: Cagle. 1 unit.

311. Dendrology. This course aims to familiarize students with the secret lives of trees. We begin by learning to identify over 130 woody plants of the Piedmont. To do this, we will also grapple with dichotomous keys and plant systematics to help us identify plants anywhere in the world. We also address topics like the chemical communication of trees, the relationships among wildlife and trees, and the value of trees. Most of this course will be outside. Instructor consent required. Instructor: Cagle. 1 unit.

314. Managing the Oceans to Solve Global Problems. This course highlights the importance of the oceans in addressing central development and environmental problems facing the world, including poverty, hunger, access to energy, climate change, and biodiversity loss. The fundamental role the oceans could play in helping to solve these problems depends on public policies created to manage them. The course will expose students to the important laws and policies that make the resources and services provided by the ocean resilient and sustainable, and explore challenges of protecting corals, regulating fishing and pollution, and helping climate refugees. Instructor: Roady. 1 unit. C-L: Public Policy 314

315S. Environmental Issues & the Documentary Arts. Survey how filmmakers, authors, photographers, and other artists have brought environmental issues to the public’s attention in the last century, and in some cases instigated profound societal and political change. Examine the nebulous distinctions between persuasion and propaganda, agenda and allegory, point of view and content. Evolve as a viewer of the environment and a maker of documentary art. Initiate your own projects to address and/or depict environmental issues in one form of a broad range of media. Instructor: Staff. 1 unit. C-L: Documentary Studies 315S, Arts of the Moving Image 315S, Visual and Media Studies 309S

336A. Seabird Survival and Dispersal Analysis. Introduction to bird migration, navigation, seabirds as indicator species, natural history of sooty tern birds in the context of conservation. Introduction to field survey methods for seabirds, capture-recapture technique, population estimate and population evaluation, and habitat description for long-term monitoring, and its importance. Sampling activities include bird capture, banding, and morphometric measurements. Field course primarily at the Dry Tortugas National Park, FL where students can interact closely with park managers. Required field trip during Spring Break. Prerequisite: Environment 210D. Instructor: Pimm. 0.5 units.

338S. Introduction to Environmental Life Cycle Assessment: Applications to Food Systems. This DukeImmerse course introduces fundamental concepts and methods to conduct Environmental Life Cycle Assessments (LCA) to identify magnitude, type, and location of environmental impacts by food production from input for crops to the disposal of the final products. Discuss the Economic-Input Output LCA (EIO-LCA). Emphasis in understanding and estimation of the environmental impacts associated to the production, transportation, storage, and waste of food for human consumption, paying special attention to the water and energy use associated to these processes. Instructor consent required. Instructor: Patino-Echeverri. 1 unit.

343S. Energy Futures and Environmental Justice. Advanced undergraduate seminar on comparative energy crises and natural resource management. Uses case studies of fossil fuel, nuclear, and renewable energy resources drawn from anthropology, natural sciences, and even business economic readings. Appropriate for students interested in interested in global politics, economic development, human rights, or environmental issues. Instructor: Folch. 1 unit. C-L: see Cultural Anthropology 345S; also C-L: Human Rights Program–Franklin Humanities Institute 334S


348. Global Environmental Politics. This course examines the international community’s responses to various global environmental problems. Because many environmental problems cross national borders, solutions require some form of global governance such as state-led mechanisms in the form of international environmental regimes. The course will thus explore how and why states both succeed and fail to negotiate international governance mechanisms. The course will also examine why some international environmental regimes are more effective than others and why states choose to comply with environmental regimes. Instructor: Weinthal. 1 unit. C-L: Political Science 348, Public Policy 349

350S. Marine Science and Conservation Leadership. Course will explore the complex interactions among science, policy and economics in the use of marine resources and the role individuals play in promoting marine conservation and environmental sustainability. Utilizing case studies ranging from fisheries to offshore energy, students will evaluate trade-offs systematically and learn to assess how different policy
359. Fundamentals of GIS and Geospatial Analysis. Fundamental aspects of geographic information systems and satellite remote sensing for environmental applications. Concepts of geographic data development, cartography, image processing, and spatial analysis. Consent of instructor is required. Instructor: Harrell. 1 unit. C-L: Earth and Ocean Sciences 359

360. Environmental Chemistry and Toxicology. An overview of the fate and effects of chemicals in the environment. Topics include chemical characterization of pollutants, chemistry of natural waters, soil sediment chemistry, atmospheric chemistry, transfers between and transformations within environmental compartments, toxicokinetics, cellular metabolism, biological levels of organization, and approaches for assessing chemical hazards. Incorporates case studies focused on human health and ecosystem protection. Prerequisite: Biology 201L, 202L, or 203L, and Mathematics 21 or 111L. Recommended prerequisite: Chemistry 210DL. Instructor: Stapleton. 1 unit.

362S. Changing Oceans. Our oceans are under severe stress. This seminar will explore human disturbances of marine environments, including ocean warming, sea level rise, melting of ice caps and sea ice, ocean acidification, coastal eutrophication, changes in primary production and food web dynamics, invasive species, overfishing, increased subsurface hypoxia, changes in circulation, stratification, and physical, chemical (e.g., oil spills) and noise pollution. Instructor: Cassar. 1 unit. C-L: see Earth and Ocean Sciences 364S

363. Environmental Economics and Policy. The role of the environment in the theory and practice of economics. Topics include ways in which markets fail to efficiently allocate resources in the presence of pollution, along with the array of policies regulators used to correct those failures; the empirical techniques used by economists to put values on environmental commodities; and an examination of questions related to everyday environmental issues, particularly those confronting the developing world. Prerequisites: Economics 201D and one Statistics course; Economics 208D recommended. One course. C-L: Environment 363, Marine Science and Conservation, Energy and the Environment. Instructor: Timmins. 1 unit. C-L: see Economics 339

365-20. Engineering Sustainable Design and the Global Community: Structural Focus. Design and testing of solutions to complex interdisciplinary design products in a service-learning context with a focus on structural products. Technical design principles; sustainable and engineering best practices; prototype formation, testing and evaluation; and establishment of research and analysis methodologies in a community-based research experience. Working in partnership with a community agency (local, national, or international) and participation in an experimental learning process by engineering a design solution for an identified community need. Evaluation focused on design deliverables, fabricated prototypes and a critical reflection of the experimental learning process. Instructor: Schaad. 1 unit. C-L: see Civil and Environmental Engineering 315-20; also C-L: Public Policy 211-20, Human Rights Program-Franklin Humanities Institute 315-20

365-60. Engineering Sustainable Design and the Global Community: Environmental Focus. Design and testing of solutions to complex interdisciplinary design products in a service-learning context with a focus on structural products. Technical design principles; sustainable and engineering best practices; prototype formation, testing and evaluation; and establishment of research and analysis methodologies in a community-based research experience. Working in partnership with a community agency (local, national, or international) and participation in an experimental learning process by engineering a design solution for an identified community need. Evaluation focused on design deliverables, fabricated prototypes and a critical reflection of the experimental learning process. Prerequisite: Engineering 201L or Electrical and Computer Engineering 110L or consent of instructor. Instructor: Schaad. 1 unit. C-L: see Civil and Environmental Engineering 315-60; also C-L: Public Policy 211-60, Human Rights Program-Franklin Humanities Institute 315-60

366. Green Germany: World Leader in Environmental Policy. Exploration of Germany’s leading global role in developing and implementing “green” technologies and environmental policies. Analyzes Germany’s current and past policies on energy, agriculture, and pollution control. Examines policies in context by studying German ideas about nature, history of German environmentalism, and by looking at Green Germany in European and global perspective. Discusses extent ethics can or ought to influence debates about global climate change and its ramifications. Readings include scholarly studies, exemplary policies, and groundbreaking ecological texts. Instructor: Dolan. 1 unit. C-L: see German 364; also C-L: History 250, Energy 364

390. Special Topics in Environmental Sciences and Policy. Content to be determined each semester. Instructor: Staff. 1 unit.

390-1. Special Topics in Environmental Sciences and Policy. Content to be determined each semester. Consent of instructor required. Half credit course. Instructor: Staff. 0.5 units.

390A. Duke-Administered Study Abroad: Advanced Special Topics in Environmental Sciences and Policy. Topics differ by section. Instructor: Staff. 1 unit.

390S-1. Special Topics in Environmental Sciences and Policy. Content to be determined each semester. Half credit course. Instructor: Staff. 0.5 units.

391. Independent Study. Individual readings course or other non-research-based independent course under the supervision of a faculty member, resulting in an academic product. Open to qualified students with consent of instructor and director of undergraduate studies. Instructor: Staff. 1 unit.

391-1. Independent Study. See Environment 391. Open to qualified students with consent of instructor. Half credit. Instructor: Staff. 0.5 units.

393. Research Independent Study. Individual research in a field of special interest, under the supervision of a faculty member, the central goal of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to qualified students with consent of instructor and director of undergraduate studies. Instructor: Staff. 1 unit.

393-1. Research Independent Study. See Environment 393. Open to qualified students with consent of instructor and director of undergraduate studies. Instructor: Staff. 0.5 units.

452L. Energy and Environment Design. An integrative design course addressing both creative and practical aspects of the design of systems related to energy and the environment. Development of the creative design process, including problem formulation and needs analysis, feasibility, legal, economic and human factors, environmental impacts, energy efficiency, aesthetics, safety, and design
461. Ocean Engineering. A challenging Ocean Engineering project will be undertaken in this class. Past examples include participation in a national XPRIZE contest to build an Ocean Sensor. Students define project scope and form task-oriented sub-teams to make significant progress toward overall class project goal. Students are expected to spend several hours per week outside of class working on the team projects. Students will need to be in teams that can all meet for at least couple of hours at the same time each week. Prerequisite: one of ECE 230L, ECE 250D, ECE 270DL, ECE 280L, Mechanical Engineering 221L, Engineering 244L, or Environment 102. Instructor; Brooke, Nowacek. 1 unit. C-L: see Electrical and Computer Engineering 461; also C-L: Mechanical Engineering and Materials Science 426

464. Mathematics of Dynamical Systems Describing Complex Environmental Phenomena: A Modern Crystal Ball? Environmental problems require construction of and solutions to systems of equations for relations between rates and states of variables. Covers construction and use of differential equations and corollary analytical tools. Differential equations used to explain concepts as stability, resilience, and equilibria (e.g., climate, ecosystems, conservation efforts). Computer-aided software (MATHEMATICA and Matlab) used to solve analytically and numerically such equations. Case studies illustrate the mathematical tools derived in dynamical systems (e.g., bifurcations and catastrophe theory, boom-bust, crashes). Prerequisite: Mathematics 111L or equivalent and Physics 141L or equivalent. Instructor: Katul. 1 unit.

495. Senior Capstone Course. Interdisciplinary and in-depth study of contemporary environmental issues. Content to be determined each semester. Prerequisite: Environment 201. Consent of instructor required. Instructor: Reid. 1 unit.

496. Advanced Research in Environmental Sciences and Policy. Advanced research in Environmental Sciences and Policy leading to Graduation with Distinction. Weekly one-hour seminars to guide student's independent research towards thesis. Topics include background context through efficient library searches of literature, hypothesis testing, research design, data analysis, and proposal writing. Students write a proposal including a comprehensive literature review, methods description, and preliminary results demonstrating methods' feasibility. Student peer-review used to explore various topics. Students are expected to work with a faculty mentor conducting original research in a research independent study. Instructor: Reid. 0.5 units.

497. Communicating Research in Environmental Sciences and Policy. Weekly one-hour workshop intended for students writing a senior thesis in Earth and Ocean Sciences, Environmental Sciences, or Environmental Sciences and Policy. Topics include writings styles of environmental sciences in natural and social sciences, presentation of data analysis and findings, written and visual communication of research findings. Using peer-review of participants writing, each student will communicate their knowledge and perspective to other, develop a depth of knowledge in their particular area while gaining knowledge in various environmental topics. Assessments will be based on peer evaluation of iterations of sections of thesis drafts and poster drafts. Instructor consent required. Instructor: Reid. 0.5 units.

498S. Building a Sustainable Tomorrow. Capstone for Certificate in Sustainability Engagement open to senior undergraduates who have completed all other Certificate requirements. Interdisciplinary insights to shed light on major contemporary debates in sustainability and world's most pressing problems. Synthesis and integration of ideas, concepts, and themes from their academic coursework and experiential activities with each dimension of sustainability, enhancing their systems analysis of chosen theme. Classes include discussion, readings, and guest speakers on topics in sustainability. May include fieldwork and other learning experiences relevant to sustainability. Held in Spring semesters. Open only to Sustainability Engagement certificate students. Prerequisite: Sustainability Engagement 245/Environment 245. Instructor: Staff. 1 unit. C-L: Sustainability Engagement 498S, Public Policy 473S

501. Environmental Toxicology. An introduction to the field of environmental toxicology. Study of environmental contaminants from a broad perspective encompassing biochemical, ecological, and toxicological principles and methodologies. Discussion of sources, environmental transport and transformation phenomena, accumulation in biota and ecosystems. Impacts at various levels of organization, particularly biochemical and physiological effects. Prerequisites: organic chemistry and an upper-level biology course, or consent of instructor. Instructor: Di Giulio/Meyer. 3 units.

502. Climate Change and the Law. This seminar will examine global climate change and the range of actual and potential responses by legal institutions, in the US and internationally. In so doing it will also explore fundamental questions about legal response to looming crises using climate change as the focal point of a broader discussion. Can legal institutions deal with such mega-problems? Will doing so lead to basic changes in legal institutions? Instructor: Wiener. 2 units. C-L: see Law 520

503. Forest Ecosystems. Emphasis on the processes by which forests circulate, transform, and accumulate energy and materials through interactions of biologic organisms and the forest environment. Ecosystem productivity and cycling of carbon, water, and nutrients provide the basis for lecture and laboratory. Instructor: Oren. 3 units.

505. Functional Ecology of Plants. This course is designed for graduate and undergraduate students with interest in plant functional ecology. We explore how (woody) plants function and respond to changing climate. We focus on plant functional traits (e.g., leaf properties, wood density, maximum height) and the main tradeoffs controlling plant form and function in various environments. Instructor: Palmroth, Domec. 3 units. C-L: Biology 505

510K. Environmental Change and Evolution of Ecosystems. The processes that control ecosystem production, the carbon cycle, and delivery of ecosystem services as well as the resilience of ecosystems exposed to environmental stress have been molded by millions of years of evolution under Global Change. Our developing understanding of earth system processes and current Global Change depends strongly on looking to the past and considering evolution of the climate system, plant and ecosystem processes, biological feedbacks, soils development, and all of these with respect to ecosystem (biosphere) carbon, water, and nutrient cycles. Taught at Duke Kunshan University. Instructor: Tenhunen. 3 units.

511K. China and US Comparative Environmental Law and Governance. This course will study China’s environmental challenges and governance and compare them with those in the US. We will consider how environmental law may shape business, government, and culture, and the ways in which China and the US may learn from one another. Taught at Duke Kunshan University. Instructor: Guttmann. 3 units.
513. Groundwater and the Environment. An introduction to the principles of groundwater flow, development, and protection, with an emphasis on aquifer and groundwater evaluation and management. Topics include: baseflow analyses; stream-groundwater interactions; aquifer and vadose zone characterization; groundwater hydraulics and recharge; field hydrogeological data; groundwater modeling; water quality; and groundwater management. Open only to students who have taken at least one college-level natural science course (e.g., earth science, chemistry, physics, biology). Instructor: Staff. 3 units. C-L: see Earth and Ocean Sciences 513

517. Tropical Ecology. Ecosystem, community, and population ecology of tropical plants and animals with application to conservation and sustainable development. Prerequisite: a course in general ecology. Instructor: Poulsen. 3 units. C-L: Biology 561

520. Resource & Environmental Economics I. Part 1 of a survey course in environmental and natural resource economics. Part 1 focuses on basic theory and methods of economic analysis of environmental problems including benefit-cost analysis, non-market valuation, and instrument choice. Prerequisite: Introductory course in microeconomics and one semester of calculus. Instructor: Bennear or Smith. 1.5 units. C-L: Economics 530, Public Policy 576, Energy 520

520D. Resource and Environmental Economics and Policy. Discussion section for Environment 520. Instructor consent required. Instructor: Bennear or Smith. 3 units. C-L: Economics 530D, Public Policy 575D

521. Resource & Environmental Economics II. Part 2 of a survey course in environmental and natural resource economics. Part 2 focuses on basic theory and methods of economic analysis of natural resource problems including extraction of non-renewable resources over time, fisheries economics and forest economics. Prerequisite: Environment 520. Instructor: Bennear, Smith, or Vincent. Variable credit. C-L: Economics 531, Public Policy 584

524. Water Quality Health. Explore basic concepts of water quality and human health with focus on the global water cycle, global water demand and availability, chemical properties of water, contaminants in water, health implications, and environmental isotopic hydrology. Highlights relationships between human activities, water scarcity, water quality degradation, and ecological and health consequences. Addresses some policy implications related to conflicts over water resources and impact of energy production on water resources. Prerequisites: prior knowledge of introductory calculus and chemistry or consent of instructor. Instructor: Vengosh. 3 units. C-L: see Earth and Ocean Sciences 524; also C-L: Global Health 534, Energy 524

530. Remote Sensing in Coastal Environments. Introduction to the field of remote sensing and image processing with focus on applications to coastal monitoring and currently open research questions. Students will acquire an operational knowledge of various remote-sensing tools and data types, with emphasis on their application in coastal areas. Content will include theory, in-class laboratory exercises, and projects with environmental applications. Prerequisite: introductory or AP physics preferred or permission of instructor. Instructor: Silvestri. 3 units. C-L: see Earth and Ocean Sciences 530; also C-L: Civil and Environmental Engineering 574

531L. Economic Valuation of the Environment. Quantitative course with focus on economic valuation of changes in environmental quality. Covers theoretical foundations of major nonmarket valuation methods and, through a series of problem sets, provides opportunities to develop skills applying those methods. Also covers a range of regression methods commonly employed in valuation studies. Prerequisite: Environment 520 or equivalent and Environment 710 or equivalent. Instructor: Vincent. 3 units.

532. Evaluation of Public Expenditures. Basic development of cost benefit analysis from alternative points of view, for example, equity debt, and economy as a whole. Techniques include: construction of cash flows, alternative investment rules, inflation adjustments, optimal timing and duration of projects, private and social pricing. Adjustments for economic distortions, foreign exchange adjustments, risk and income distribution examined in the context of present value rules. Examples and cases from both developed and developing countries. Instructor: Staff. 3 units. C-L: see Public Policy 596; also C-L: Economics 521


536. Food, Agriculture and the Environment: Law and Policy. This class examines agriculture and food production through some of the laws and policies that promote environmental protection and consumer welfare. Agriculture is the largest single land use in the US, occupying approximately 50% of the land mass. The industrial-agricultural model that has come to dominate food production has brought about env degradation in many communities. In many areas of the country, including NC, local food markets represent one of the most exciting opportunities for env stewardship, econ growth, and community building. However, these opportunities will not be realized without attention to the legal and policy structures that confront sustainable food production. Instructor: Nowlin. 2 units.

537. Environmental Health. Introduction to environmental effects on human health, as well as ecological health. Focus on chronic effects of exposure to pollution on key health endpoints including cancer, neurological health, reproduction and development, cardiovascular and pulmonary health, the interaction between anthropogenic environmental changes and infectious diseases, and the relationship between human health and ecosystem health. Includes lectures from a variety of experts in this field from throughout the Triangle region. Course is designed to facilitate maximum student participation through discussion. For graduate and advanced undergraduate students. Instructor: Di Giulio. 3 units.

538. Global Environmental Health: Economics and Policy. Social science perspective on global environmental health. Students will learn to identify primary environmental causes of high burden diseases such as malaria, diarrhea, and respiratory infections; describe how to measure socio-economic impacts of global environmental health diseases; discuss key policies to control global environmental health problems based on private prevention and therapeutic behaviors; and propose frameworks to empirically monitor and evaluate global environmental health policies. A sub-module will focus on climate change and water-borne diseases. Prerequisites: Introductory course in statistics. Instructor: Pattanayak. 3 units. C-L: see Public Policy 582; also C-L: Global Health 538

539. Human Health and Ecological Risk Assessment. Topics central to both health and ecological risk assessment are explored. Basic concepts of hazard identification, dose-response relationships, exposure assessment, and risk characterization and communication are discussed in the context of both human health and environmental assessment. The basis and rationale for using specific, as well as
extrapolated, scientific information and expert judgment, and the strengths and weaknesses of alternative approaches, are evaluated. Applications emphasizing real cases are used to illustrate the interdisciplinary process and products of risk assessment, as well as the regulatory use of the information. Group projects emphasized. Instructors: Mhaich/McMasters. 3 units.

540. Chemical Fate of Organic Compounds. Equilibrium, kinetic, and analytical approaches applied to quantitative description of processes affecting the distribution and fate of anthropogenic and natural organic compounds in surface and ground waters, including chemical transfers between air, water, soils/sediments, and biota; and thermochemical and photochemical transformations. The relationships between organic compound structure and environmental behavior will be emphasized. Sampling, detection, identification, and quantification of organic compounds in the environment. Prerequisites: university-level general chemistry and organic chemistry within last four years. Instructor: Stapleton. 3 units. C-L: Civil and Environmental Engineering 563

542L. Environmental Aquatic Chemistry. Principles of chemical equilibria and kinetics applied to quantitative chemical description of natural and engineered aquatic systems. Topics include acid/base equilibrium, the carbonate system, metal complexion, oxidation/reduction reactions, precipitation/dissolution of minerals, and surface absorption. Instructor: Ferguson or Hsu-Kim. 3 units. C-L: Civil and Environmental Engineering 561L

543S. Water Cooperation and Conflict. Focuses on potential for transboundary water resources-related conflict and cooperation. Discusses water scarcity concepts, natural resource conflict theory, hydro politics, hydro hegemony, water security, water markets and institutions, game theory, and international water law. Other topics include the economics of water and health. Case studies complement the broader course outlook. Instructor: Jeuland. 3 units. C-L: see Public Policy 580S; also C-L: Global Health 533S, International Comparative Studies 580S

544S. Collective Action, Property Rights, and the Environment. The rational choice tradition (public goods, collective action, game theory, property rights, new institutionalism) as applied to environmental problems, resource exploitation, environmental justice, and the design of an environmentally sound society. Instructor: Staff. 3 units. C-L: see Political Science 549S

548. Solid Waste Engineering. Engineering design of material and energy recovery systems including traditional and advanced technologies. Sanitary landfills and incineration of solid wastes. Application of systems analysis to collection of municipal refuse. Major design project in solid waste management. Prerequisite: Civil and Environmental Engineering 462L, or consent of instructor. Instructor: Staff. 3 units. C-L: see Civil and Environmental Engineering 672

549. California Water Crises: A Case Study Approach. Reviews history of California’s water dependent economy, leading to a capture, storage system with conveyances extending thousands of miles to deliver water for agriculture, industry and homes. Examines recent political change coupled with chronic issues of a water-rich north, an expanding urban population and a water-poor but politically strong south. Emphasis includes climate change, seismic vulnerability, redirection of river flows, and large scale water reuse. Course will cover specific water crises in other states and nations, providing in depth coverage of aspects of the international crisis in quantity and quality of freshwater. Instructor: Hinton. 3 units.


552. Climate and Society. Advanced, interdisciplinary course on causes, consequences, and future trajectory of climate change. Course will cover physical observations of past climate change, role of human activities in driving climate change to date, and impacts of climate change on human and natural systems. Course will analyze how socioeconomic choices affects future climate as well as factors influencing those choices, including risk analyses, geoengineering proposals, intergenerational equity, climate metrics and the media. Instructor: Shindell. 3 units. C-L: see Earth and Ocean Sciences 550

556. Environmental Conflict Resolution. Practical techniques and scholarly underpinnings of environmental conflict resolution, including interest-based negotiation, mediation, public disputes, science-intensive disputes, and negotiation analysis. In-class time will be spent conducting negotiation role plays of increasing complexity and then debriefing them. Outside of class, students will prepare for the role plays and read background material to aid in debriefing. Instructor: Addor. 3 units.

557. Social Science Surveys for Environmental Management. Social science research methods for collecting data for environmental management and policy analysis. Sampling, survey design, focus groups, pretesting, survey implementation, coding, and data analysis. Team projects emphasize development and practice of survey skills. Prerequisite: introductory applied statistics or equivalent. Instructor: Kramer. 3 units.

559. Fundamentals of Geographic Information Systems and Geospatial Analysis. Fundamental aspects of geographic information systems and satellite remote sensing for environmental applications. Covers concepts of geographic data development, cartography, image processing, and spatial analysis. Gateway into more advanced training in geospatial analysis curriculum. Consent of instructor required. Instructor: Halpin/ Harrell. 4 units.

561K. Chinese Environmental Policy. This course provides a venue for students to investigate the most recent environmental and energy policies in China. We will study the causes and consequences of environmental and energy problems. We will examine Chinese environmental and energy governance: institutions, laws and regulations for environmental protection, energy production and consumption. We will also explore the practices of Chinese government to address the emerging environmental and energy problems, with a special focus on climate change. Taught at Duke Kunshan University. Instructor: Zhang. 3 units.

563. Cost-Benefit Analysis for Health and Environmental Policy. Course considers the importance of economic analysis, or cost-benefit analysis (CBA), for public policy assessments. Specific focus is on health and environmental policy, and the steps in identification / cataloging, quantification, and monetization of impacts of potential policies and projects. Covers: Economic rationale for CBA; Basic principles for assessing the economic effects of projects; Techniques for valuing health and environmental impacts; Intergenerational/philosophical concerns related to CBA; Social discounting; Risk and uncertainty; Comparisons of CBA with other approaches (i.e. cost effectiveness analysis, multi-objective analysis). Instructor: Jeuland. 3 units. C-L: see Global Health 531; also C-L: Public Policy 607
564. Biogeochemistry. Processes controlling the circulation of carbon and biochemical elements in natural ecosystems and at the global level, with emphasis on soil and surficial processes. Topics include human impact on and social consequences of greenhouse gases, ozone, and heavy metals in the environment. Prerequisite: Chemistry 101DL or equivalent; Recommended: Chemistry 210DL. Instructor: Bernhardt. 3 units. C-L: see Biology 564

564D. Biogeochemistry. Discussion version of Biology 564. Processes controlling the circulation of carbon and biochemical elements in natural ecosystems and at the global level, with emphasis on soil and surficial processes. Topics include human impact on and social consequences of greenhouse gases, ozone, and heavy metals in the environment. Recommended prerequisite: Chemistry 101DL and 210DL. Instructor: Bernhardt. 3 units. C-L: see Biology 564D

565. Stormwater Science: Pollution, Pavement, and Precipitation. Examines pollution emissions/deposition, impervious surfaces, evapotranspiration, groundwater, stormwater runoff, nutrients, thermal pollution, and freshwater effects. Uses primary literature, as well as a couple of books. Also examines "stormwater control measures" that mitigate problems. Student-driven course: Reading, presenting, and discussing primary literature, asking/answering questions in class, and seeking answers. Course designed for graduate and advanced undergraduate students. Prerequisites: one course in Ecology or Environmental Science or instructor consent. Instructor: Wilson. 3 units. C-L: see Biology 563S

566. Environmental Analytical Chemistry. This course covers the fundamentals and applications of analytical chemistry as applied to detection, identification, and quantification of anthropogenic contaminants in environmental samples including air, water, soil, sediment, and biota. The topics include both sample preparation methods (i.e., wet chemistry) and instrumental analysis (e.g., mass spectrometry, chromatography, and optical spectroscopy). Particular emphasis is placed on current advancements in measurement science as applied to environmental chemistry. The material includes both theoretical and practical aspects of environmental analysis. Prerequisite: CHEM 131 or CHEM 151L or consent of instructor. Instructor: Ferguson. 3 units. C-L: see Civil and Environmental Engineering 565

569. Should I Eat Fish? Economics, Ecology and Health. Examines role that individual consumer can play in promoting marine conservation. Course considers array of issues that confront seafood consumers and tradeoffs that only an informed consumer can assess. In context of evaluating seafood students will learn how to evaluate tradeoffs systematically, assess how different policy options affect incentives for users and polluters. This process allows students to place consumer initiatives in context of other approaches to marine conservation. Interdisciplinary approach but economic themes will inform course. Course intended for Master of Environmental Management students, but open to advanced undergraduates with permission. This course is intended for MEM students and is based on a Marine Conservation Leadership Certificate capstone course offered previously to undergraduates. Advanced undergraduates permitted pending space availability. Instructor: Smith. 3 units.

570. Isotopes in Earth and Environmental Sciences. The use of stable and radioactive isotopes in earth and environmental sciences, with applications to processes including climate change, hydrology, oceanography, geology and biology. Recommended prerequisite: Introductory college chemistry and calculus. Instructor: Baker. 3 units. C-L: see Earth and Ocean Sciences 571; also C-L: Civil and Environmental Engineering 551

572. Economic Evaluation of Sustainable Development. Examines how one could rationally defend a choice of ‘sustainable development’ policy. Applies cost-benefit thinking in environment-natural-resources and development contexts. Presents microeconomic concepts emphasizing logic and principles more than mechanics. Intertemporal equity is a focus and equity-efficiency tradeoffs are a theme. Microeconomic prerequisite not required. Instructor: Pfaff. 3 units. C-L: see Public Policy 574

573. Coastal and Marine Pollution. Sources, fate, and effects of organic, inorganic, and particulate pollutants in the marine environment. Topics include oil spills, coastal eutrophication, marine debris, harmful algae, sewage contamination, dredging, and emerging contaminants. Methods for measuring pollution in the marine environment and consequences for human and ecological health will be discussed. Case studies of impacted marine environments will be highlighted. Short local field trips possible. Recommended prerequisite: introductory chemistry and biology, or consent of instructor. Instructor: Ferguson. 3 units.

577. Environmental Politics. Environmental policy formation and implementation in comparative perspective. Topics include interest groups, environmental movements and parties, public opinion, political systems and institutions. Case students selected from the United States and other advanced industrialized countries and the developing world. Spring. Instructor: Albright or Mullin. 3 units. C-L: Public Policy 577, International Comparative Studies 577

579S. Collective Action, Environment, and Development. Examines the conditions under which collective or participatory decisions may raise welfare in defined ways. Presents the growing empirical evidence for an environment and development setting including common property issues (tragedy of the commons and competing models). Identifies what evidence exists for sharing norms on a background of self-interested strategies. Definitions of and reactions to equity and/or its absence are a focus. Providing scientific information for policy is another. Experimental and behavioral economics are frequently applied. Instructor: Pfaff. 3 units. C-L: see Public Policy 579S

581. Global Environmental Health Problems: Principles and Case Studies. Many environmental problems occur both locally & globally. Having insights and experience from different parts of the world is important for students to gain problem-oriented training. This course will cover fundamental principles on physical & chemical processes related to major environmental problems. These principles will then be integrated to discussions of case studies addressing a specific set of problems. The case studies will involve the participation of invited guest instructors who are experts on specific topics/cases. Depending on preference of guest instructors, they can introduce a case study via online lecturing/chatting or providing a pre-made video. Online course. Instructor consent required. Instructor: Zhang. 3 units. C-L: Global Health 581

581K. Global Environmental Health Problems: Principles and Case Studies. Many environmental problems occur both locally & globally. Having insights and experience from different parts of the world is important for students to gain problem-oriented training. This course will cover fundamental principles on physical & chemical processes related to major environmental problems. These principles will then be integrated to discussions of case studies addressing a specific set of problems. The case studies will involve the participation of invited guest instructors who are experts on specific topics/cases. Depending on preference of guest instructors, they can introduce a case study via
online lecturing/chatting or providing a pre-made video. Online course. Open to Duke Kunshan students only. Instructor consent required. Instructor: Zhang. 3 units. C-L: Global Health 581K

583SK. **Energy and National Security.** Energy and National Security examines links between available, reliable, affordable, and sustainable energy supplies and economic and national security of an advanced economy in the early 21st Century. Countries of particular interest are China and the United States. Both are net energy importers, depend on smoothly functioning global energy markets and open sea-lanes, and face ethical and environmental issues as they choose among their energy sources and suppliers. Both also are highly dependent on energy to power their economies, fuel their militaries, and preventing enemies or competitors from inflicting damage on their economies or populations. Taught at Duke Kunshan University. Instructor consent required. Instructor: Staff. 3 units. C-L: see Public Policy 583SK; also C-L: Political Science 663SK

585. **Fisheries Biogeography and Ecology.** Current status of the distribution and abundance of fisheries globally and current topics in fisheries ecology, explored through lecture and discussion of primary literature. Participation in leading discussions and mini literature review. Basic knowledge of ecology and oceanography. Instructor consent required. Instructor: Dunn. 3 units.

590. **Special Topics.** Content to be determined each semester. May be repeated. Instructor: Staff. Variable credit.

590K. **Special Topics in Environmental Sciences and Policy.** Content varies each semester. Offered only at Duke Kunshan University. Instructor: Staff. 3 units.

593. **Independent Studies and Projects.** Directed readings or research at the graduate level to meet the needs of individual students. Consent of instructor required. Units to be arranged. Instructor: Staff. Variable credit.

593K. **Independent Studies and Projects.** For iMEP students or Duke students studying abroad at Duke Kunshan University. Directed readings or research at the graduate level to meet the needs of individual students. Units to be arranged. Instructor consent required. Instructor: Zhang, Ji, Fürst, Li, Ward. Variable credit.

600K. **Key Areas in International Environmental Policy.** An overview of the key areas in international environmental policy. This course's seven modules cover international environmental economics, international environmental policy and politics, international environmental negotiations, policy debates and simulations. The principal goal of the course is to preview the application of social sciences (economics, public policy, and political science) to the environment, and to facilitate the translation of core curricular concepts into a variety of real-world applications. Students will engage in self-directed research and learning on international environmental policy. Taught at Duke Kunshan University. Instructor: Fürst. 3 units.

601K. **Building an NGO Toolkit: From Design to Monitoring.** Non-governmental organizations (NGOs) that address conservation issues in China face large, complex, and urgent problems. To be successful, these NGOs must be equipped with the skills to be efficient, effective, and transparent when planning, implementing, and monitoring their conservation initiatives. In this hands-on course, students will become familiar with decision-support tools that allow organizations to systematically address strategic planning, project design, project budgeting, implementation, monitoring, evaluation, communication, and donor transparency. Students will apply these tools to real-world conservation problems. Taught at Duke Kunshan University. Instructor: Furst. 3 units.

602K. **Natural Resources and Protected Area Management.** Toolkit for practical natural resources management and understanding the challenges involved in protected area management. Wildlife monitoring, environmental change tracking, socio-economic surveys and stakeholders engagement. Combines lectures for essential survey methods and experiential education through a seven-day field course. Students will design their own group project to carry out in the local context. Taught in Kunshan, China, at Duke Kunshan University. Instructor: Li. 3 units.

603. **Air Quality: Management.** Management systems are discussed, including varied approaches used to address criteria air pollutants, air toxics, mobile sources and acid deposition. Course prepares students to understand systems approach to apply science and technical information to inform policy decisions affecting air quality; understand and be conversant in varied approaches to manage air quality to meet policy objectives; be familiar with major common air pollutants and air quality management approaches applied to each and why approaches vary. Instructor: Vandenberg. 1.5 units.

604. **Air Quality: Human Exposure and Health Effects.** Looks at how individuals and populations are exposed to air pollution and what adverse health effects the exposure will cause. Covers exposure analysis methods, toxicological and epidemiological studies that examine health effects of air pollution exposure. Students will be prepared to understand concept and major methodologies of analysis for air pollution; how toxicology is used to determine adverse effects of air pollution exposure and underlying biological mechanisms; collect evidence on air pollution health effects in supporting health risk assessment. Prerequisites: general biology, statistics. Instructor: Zhang. 1.5 units. C-L: Global Health 634

610. **Ecotoxicology.** Overview of ecological and toxicological effects of chemicals on structure and function of ecosystems, primarily at population, community and ecosystem levels of biological organization. Topics include environmental fate and transport of contaminants, biomonitoring, biomarkers/bioindicators, evolution of resistance to pollution, and extrapolating from molecular interactions to ecosystems. Incorporates critical discussion of in-depth case studies to highlight application of ecotoxicological concepts to real-world scenarios. For graduate and advanced undergraduate students. Instructor: Raftery. 3 units.

6145. **Coastal Resilience in the Face of Climate Change.** Recent hurricanes have highlighted the need for coastal communities to address a wide range of issues associated with climate change including increasing resilience when faced with storms and rising sea levels; information-gathering (maps, drones, and scientific research about coastal/ocean processes); law and policy refinements (statutes, regulations, and guidance); and the use of litigation to develop useful common law doctrines relevant to the tidelands and the public trust. Through the use of current cases and policy issues under debate, students will analyze relevant facts, laws, policies, socio-economic considerations, and local ordinances and prepare proposed solutions. Instructor: Roady and Nowlin. 2 units. C-L: see Law 714

621. **Water Resources, Finance and Planning.** Introductory course to water in the built environment, with basic treatment of hydrology, treatment, regulation, and planning of water resources. Course will serve as a survey course for non-water specialists, and a bridge course
Courses of Instruction

623L. Ecological Diversity and Climate Change. Evaluates the science of biodiversity and climate change, including changes happening now, in the past, and what we can expect in the future. Topics include forest diebacks, intensifying drought, increased wildfire, insect and pathogen outbreaks, and poleward migrations of land and marine populations. Analytical tools used to quantify change include elements of basic distribution theory, data manipulation in R, and examples of simulation methods. Each lab implements one or more models, including regression, GLMs, and species distribution modeling. Prerequisites: calculus, statistics. Instructor: Clark. 3 units.

624. Agriculture and Sustainability: Feeding the Growing Human Population Today for the Future. Introduces agroecology through basic scientific knowledge of plant physiology and growth for crop production, crop diversity and breeding, and comparison of agricultural practices (industrial, subsistence, organic, sustainable). Covers resources needed for whole-plant growth, biomass output for human use including bioenergy, and impacts on ecosystems. Examines environmental sustainability through assessment of drawbacks and benefits of agricultural practices for human food and biofuel production. Applications include management plan for sustainable agroecosystems and forecast of crop agricultural practices in need of a future altered environment. Prerequisites: introductory Biology or Ecology. Instructor: Reid. 3 units.

626. River Processes. Course focuses on river processes and how rivers change and how to analyze rivers. Course is a mixture of hydrology, geomorphology, and ecology. Focus is on quantitative analysis of processes using simple modeling approaches. Problems will be drawn from policy and river management applications such as river restoration, channel design, dam management, and floodplain regulation. Instructor: Doyle. 3 units.

627. Molecular Ecology. Explore use of molecular tools to investigate ecological processes within natural populations and communities from terrestrial to marine. Emphasis on fundamental principles and predictions from ecological and evolutionary theory, as well as historical approaches and precedents. In addition to exploring very basic ecological questions, course discusses interpretation of molecular datasets to evaluate applied ecological problems with societal implications (e.g., conservation, antibiotic resistance, genetically modified crops, adaptation to climate change). Open to graduate students, and upper-level undergraduates with backgrounds in ecology and/or molecular biology. Instructor: Werngren. 3 units. C-L: Science & Society 627, Biology 627.

630. Transportation and Energy. Examination of transportation-related energy use and its impact on the environment. Learn how technology, infrastructure, and policy, as well as personal and cultural preferences, interact to meet demands for personal mobility and freight movement. Cutting across these themes will be consideration of strategies to reduce transportation energy use and its environmental impacts, with an introduction to information resources and tools for evaluating both. Provides opportunities to hone problem solving and analytical skills, and challenges students to think critically and creatively about the trade-offs among complex transportation options. Instructor: Johnson. 3 units. C-L: see Energy 630.

631. Energy Technology and Impact on the Environment. Efficiencies and environmental impacts of both new and established energy sources and conversion methods. Consideration of alternative energy technologies, including electricity generation by fossil fuels, nuclear, solar, wind and water; space heating and cooling by traditional methods and by solar; and transportation energy in automobiles, mass transit and freight. Environmental consequences of energy choices on local, national and global scales, including toxic emissions, greenhouse gases and resource depletion. Prerequisite: Environment 231 or Environment 711. Instructor consent required. Instructor: Johnson. 3 units. C-L: Energy 631.

632. Environmental Education and Interpretation. Course will provide students with foundational knowledge and practical communication skills drawn from five schools of environmental education (EE): natural resource interpretation, science education, European approaches to EE, placed-based learning, and nature connectedness. Through readings, program observations, practicums, and instructor- and peer-based evaluations, students learn to evaluate their audience, develop measurable goals for communication, and refine their presentation skills. Students will also be able to adapt presentations and programs based on the five school of EE addressed in class. Students successfully completing course will become NAI Certified Interpretive Guides. Instructor: Cagle. 3 units.

633. Critical Readings in Environmental Epidemiology. Basic introduction to epidemiological methods, skills to understand and critique, and emerging issues in environmental epidemiology reported in relevant journals. Students will gain knowledge of study designs and analytical methods used in applied epidemiology, practice designing translational and environmental epidemiological studies, and understand the role of epidemiology in Risk Assessment. Course will include lectures, readings, class discussion, oral presentation and written assignments. Instructor: Pan. 3 units. C-L: Global Health 635.

634. Introduction to Ecosystem Services and Methods for Quantification. An introduction to ecosystem services, which is increasingly recognized as a useful concept for decision-making, and provide an overview of the suite of methods that are used to quantify them. The course will also provide an overview of a suite of skills/courses needed for ecosystem services assessment and show how they contribute to quantifying ecosystem services. These skills include Structured Decision Making, Ecological Modeling, Bayesian Belief Networks, Multi-Criteria Decision Analysis, Monetary Valuation (non-market valuation methods), & Structural Equation Modeling. Prerequisites: ecology, microeconomics, Environment 520/521 or equivalent. Instructor: Olander. 1 unit.

635. Energy Economics and Policy. Economics of markets and policies for various energy supply sources, energy demand and efficiency, their interactions with each other, and with the economy and environment. Will explore rationales for why markets for energy and related technologies have been subject to extensive government intervention. Course will analyze effects of policy responses, including energy price regulation, the interface of energy, environmental, and technology policy, and policy motivated by energy security concerns. Prerequisites: Introductory Microeconomics (Economics 101 or equivalent) and college calculus. Instructor: Staff. 1.5 units. C-L: see Energy 635.

637K. Population and Environmental Dynamics Influencing Health. Examination of population, health and environment (PHE) dynamics with focus on interactions in developing or transition economies. Theoretical and empirical approaches governing PHE dynamics from multidisciplinary perspectives, including geography, public health/epidemiology, demography, and economics. Students will obtain experience in design and analysis of PHE studies, and epidemiology of vector-born, chronic and enteric infections. Taught at Duke Kunshan...
637S. Population and Environmental Dynamics Influencing Health. Course examines population, health and environment (PHE) dynamics with focus on interactions in developing or transition economies. Theoretical and empirical approaches governing PHE dynamics from multidisciplinary perspectives, including geography, public health /epidemiology, demography, and economics. Students will obtain experience in design and analysis of PHE studies, and epidemiology of vector-born, chronic and enteric infections. Instructor: Pan. 3 units. C-L: see Global Health 637S

638. Environmental Life Cycle Analysis & Decision. Provides theoretical foundations of environmental life cycle assessment tools and methods used for products and global supply chains. Introduces various life cycle inventory and life cycle assessment tools used by the community of scientists and industry. Instructor consent required. Instructor: Golden. 3 units. C-L: see Energy 638

640. Climate Change Economics and Policy. This course explores the economic characteristics of the climate change problem, assesses national and international policy design and implementation issues, and surveys the economic tools necessary to evaluate climate change policies. Discussion-oriented requiring high degree of student participation. Course objectives are increased comprehension of economic aspects of climate change and ability to apply tools of economic analysis to climate policy and the responses of firms and households to it. Course designed for graduate and advanced undergraduate students. Instructor: Pizer. 3 units. C-L: Public Policy 585K

640K. Climate Change Economics and Policy. Explores the economic characteristics of the climate change problem, assesses national and international policy design and current implementation issues, and surveys the economic tools necessary to evaluate climate change policies. Prerequisite: Public Policy 810 and 812, or equivalent, or consent of the instructor. Instructor: Pizer. 3 units. C-L: Public Policy 585K

642. Air Pollution: From Sources to Health Effects. Both urban outdoor air pollution and household indoor air pollution contribute significantly to global burden of disease. Course covers fundamentals about how major air pollutants are generated and transported in the atmosphere and how these pollutants affect human health. Relevant exposure assessment, toxicology and epidemiology case studies are discussed. Prerequisites: general chemistry; introductory-level statistics. Instructor: Zhang. 3 units. C-L: Global Health 630

646. Urban Ecology. Addresses how to understand urban areas as ecological and socio-ecological systems and the distinction between the study of ecology in and of cities. Examines both through theoretical lens of socio-ecological systems, in which humans and their actions are a component of, rather than disturbance imposed on, ecological systems. Applies theoretical and methodological tools to global, regional, and local urban issues. Prerequisites: One ecology course and one environmental social sciences course. Instructor: Heffernan. 3 units.

650S. Advanced Topics in the Conservation of Biodiversity. Current topics in conservation and biodiversity. Intended for graduate students; advanced undergraduate students admitted with permission of instructor. Prerequisite: introductory conservation biology or permission of instructor. Instructor: Pimm. 2 units.

658. Applied Qualitative Research Methods. Broadly covers qualitative and mixed methods research design, analysis, and interpretation. Students gather a limited amount of their own data and produce a pilot research project throughout the semester. Students learn to use NVivo10, a qualitative research software program. Instructor: C. Clark. 3 units.

665. Bayesian Inference for Environmental Models. Formulation of environmental models and applications to data using R. Distribution theory, algorithms, and implementation. Topics include physiology, population growth, species interactions, disturbance, and ecosystem dynamics. Discussions focus on classical and current primary literature. Instructor: J. Clark. 3 units. C-L: see Biology 665

666. Aquatic Geochemistry. Geochemistry of the water-solid interface of soils, minerals, and particles in earth systems. Topics will cover the chemical composition of soils, geochemical speciation, mineral weathering and stability, sorption and ion exchange, soil redox processes, and chemical kinetics at environmental surfaces. Prerequisites: CEE 461L or CEE 561L/ENVIRON 542L or permission of instructor. Instructor: Hsu-Kim. 3 units. C-L: see Civil and Environmental Engineering 666

667. Chemical Transformation of Environmental Contaminants. Mechanisms and principles underlying organic contaminant transformations in the ambient environment. Topics include hydrolysis, oxidation/reduction, direct and indirect photolysis, and reactions with disinfectant chemicals. Reactions will be considered in context of both natural (e.g., surface water and cloudwater) and engineered (e.g., drinking water, wastewater, and groundwater remediation) systems. Approaches will include both qualitative (reaction mechanism and product identification) as well as quantitative (reaction kinetics and stoichiometry) aspects of environmental reaction chemistry. Prerequisites: CEE 563/ENVIRON 540 or one semester of organic chemistry. Instructor: Ferguson. 3 units. C-L: see Civil and Environmental Engineering 667

678. Population Ecology for a Changing Planet. Overview of the expanding field of population ecology, including the use of new bioinformatic tools to study topics such as the impacts of climate change on population dynamics, population growth and regulation, adaptive evolution, and emerging diseases. Lecture and discussion of case studies will evaluate current knowledge and productive research directions, highlighting analysis of observational and experimental data sets. Prerequisites: introductory statistics and calculus. Instructor: J. Clark. 3 units. C-L: Biology 678

680. Economics of Forest Resources. Core economic theory of forest management and application of theory to selected forestry policy issues. Course focuses on management of forests for timber production as well as for non-timber values. Concepts explored include policy challenges such as biodiversity conservation, deforestation, community forest management, and payments for ecosystem services. Two groups of economic tools will be used: non-market valuation methods and program evaluation techniques. Prerequisites: college-level calculus, microeconomics and statistics, as well as Excel proficiency. Instructor: Vincent. 1.5 units.

684. Politics of the Urbanized Environment. Examines the politics of environmental management in urbanized areas. Students will gain understanding of political, economic and social constraints on local government decision-making; pathways by which local policy decisions shape environmental outcomes; tools to improve environmental outcomes and conditions for using the tools. Students will gain competencies in identifying opportunities for improved environmental outcomes, evaluating feasibility of environmental management strategies, and developing and communicating them appropriately. Course material will emphasize US cities with some attention to non-US urbanized environments. Course assumes familiarity with US government. Instructor: Mullin. 3 units.
700. Integrated Case Studies. A group of two to four students may plan and conduct integrated research projects on a special topic, not normally covered by courses or seminars. A request to establish such a project should be addressed to the case studies director with an outline of the objectives and methods of study and a plan for presentation of the results to the school. Each participant’s adviser will designate the units to be earned (up to six units) and evaluate and grade the work. Instructor: Staff. Variable credit.

701. Forest Measurements. Course is designed to provide field and analytical measurement skills expected of professionals working in forest ecosystem management. Additional emphasis on habitat assessment, forest vegetation, and wildlife identification. Extensive field work required. Instructor: Cagle. 2 units.

702. Ecology Seminar. Discussion of current research and literature. Instructor: Staff. 1 unit. C-L: see Biology 711S; also C-L: Evolutionary Anthropology 743

703. Conservation Biology: Theory and Practice. An overview of biological diversity, its patterns, and the current extinction crisis. Historical and theoretical foundations of conservation, from human values and law to criteria and frameworks for setting conservation priorities; island biogeography theory, landscape ecology, and socioeconomic considerations in reserve design; management of endangered species in the wild and in captivity; managing protected areas for long term viability of populations; the role of the landscape matrix around protected areas; and techniques for conserving biological diversity in semiwild productive ecosystems like forests. Three field trips. Prerequisite: one ecology course or consent of instructor. Instructor: Pimm. 3 units.

705L. Ecological Management of Forest Systems (Silviculture). The aim of the course is to equip future resource managers and environmental consultants with knowledge allowing them to propose lower impact practices to individuals and organizations who need to balance wood production with maintenance of environmental quality. Underlying principles of growth, from seed to mature trees, and stand dynamics are explored. Various alternative methods of manipulating growth, stand structure and development, ranging from little to large perturbations of forest systems, are presented and assessed in terms of their effect on resource quality. Includes laboratory. Instructor: Palmroth. 3 units.

706. Wildlife Surveys. With a focus on birds, reptiles, amphibians, and mammals, this course introduces students to a wide variety of wildlife survey methods and skills through both classroom lectures and hands-on experience in the field. Design, practical application, and post-survey data analyses for conducting wildlife surveys for research as well as for management. Limitations and advantages of various field monitoring techniques; learn to identify many common birds, herps, and mammals of season for this area. Significant time spent in the field. Instructor: Swenson or Staff. 3 units.

707. Geospatial Analysis for the Human Environmental Condition. Application course focusing on spatial analysis and image processing applications to support spatial analysis of the human environment. Map representation of human and population characteristics, spatial analysis of movements and accessibility to resources, impacts of humans on the environment and impacts of environmental conditions on humans. Requires a fundamental knowledge of geospatial analysis theory and analysis tools (ENVIRON 559 or equivalent). Consent of instructor is required. Instructor: Swenson. 3 units.

708. Silviculture Prescription. Professional foresters meet management objectives through stand manipulation by using appropriate methods. Silviculture prescription is an operational plan that describes the goals, the silvicultural manipulations needed to achieve these goals, and the development of the stands over the projected period. Facing diverse management objectives and stand conditions, success in this planning process depends on understanding the underlying principles of tree growth and stand dynamics, but also relies on the intuitive knowledge that aids in assessing stand conditions and future development. Class is designed to provide the practical experience needed for developing the intuitive knowledge. Instructor: Palmroth. 2 units.

710. Applied Data Analysis for Environmental Sciences. Graphical and exploratory data analysis; modeling, estimation, and hypothesis testing; analysis of variance; random effect models; regression and scatterplot smoothing; generalized linear models; resampling and randomization methods. Concepts and tools involved in data analysis. Special emphasis on examples drawn from the social and environmental sciences. Students to be involved in applied work through statistical computing using software, STATA or R. Instructor: Albright or Poulsen. 3 units.

711. Energy and Environment. Overview of the challenges confronting humanity as a consequence of our reliance on energy. Challenges include dwindling supplies, rising demand and environmental degradation. Realistic responses require an understanding of the complexity of the energy system, including energy resources, uses, and impacts, in the context of social, political and economic imperatives. Lectures will be augmented by presentations from guest speakers from industry, government and non-profit organizations. Instructor: Pratson. 3 units. C-L: see Energy 711

712A. Hydrocarbons: Production to Policy Seminar. Field study of hydrocarbons production in and around Houston, Texas, with first-hand perspective of oil and gas from industry experts. Includes a field trip with a required fee for the trip. Instructor: Pratson. 1 unit.

713A. Clean Energy Field Trip. Field study of the clean energy industry around the San Francisco Bay area, California, with first-hand perspective from renewable energy experts. Includes a field trip with a required fee for the trip. Instructor: Pratson. 1 unit. C-L: Energy 713A

714. Landscape Ecology. Landscape ecology is concerned with spatial heterogeneity (pattern) on landscapes what generates pattern, its characteristic scaling in space and time, and why it matters for populations, communities and ecosystem processes. As essentially all agencies that manage land now profess an aim to manage functional, resilient and sustainable landscapes, this course provides the foundational knowledge to support these applications in conservation planning and ecosystem management. The course consists of lectures, small-group exercises and discussions with an emphasis on understanding key concepts and applying these to real-world applications mgmt scenarios. Prerequisite: ecology; statistics preferred. Instructor: Urban. 3 units.

715L. Understanding Energy Models and Modeling. Course aims to nurture basic modeling literacy by focusing on widely-used class of “bottom-up,” optimization-based, energy models commonly used for economic, environmental, and technology assessments. Students will gain practical experience searching for relevant modeling data, constructing scenarios, and running an energy model. Will gain a working knowledge of model mechanics and experience asking the type of questions needed to evaluate quality of modeling results. Instructor: T.
716K. **Modeling for Energy Systems.** Introduction to the use of computer models and the methods of optimization and simulation for students interested in the analysis of energy systems; emphasis in the formulation of optimization problems and simulation models, and in the identification of the available methods to solve them. Students should also be familiar with capital-sigma (\( \sum \)) notation for compactly representing summation of similar terms, and know the basics of Excel. Taught in China at Duke Kunshan University. Recommended prerequisite: college-level calculus (including partial derivatives of functions of several variables), probability theory, and basic linear algebra (how to write—and solve—systems of linear equations in matrix form). Instructor: Patiño-Echeverri. 3 units.

716L. **Modeling for Energy Systems.** Introduction to computer programming and operations research in energy systems analysis with emphasis on formulation of optimization problems and simulation models. Applications and case studies dealing with energy systems problems, their externalities, and government policies that affect them. Data analysis, spreadsheet modeling, VBA programming in Excel; linear programming (lp), post-optimality and sensitivity analysis, multi-period lp, stochastic lp, network models for minimum path, maximum flow and optimal planning problems; probabilistic analysis Monte Carlo simulation, including generation of independent and correlated random variables, and goodness of fit tests. Instructor: Patiño-Echeverri. 3 units. C-L: see Energy 716L

717. **Markets for Electric Power.** Examines basic concepts and tools in economics and engineering necessary to understand the operation of power markets. Includes physical systems; industry structure and economic models to understand the supply side; operational reliability; long-term reliability; and integration of renewables. Instructor: Patiño-Echeverri. 3 units.

718K. **Environmental Sciences.** This course introduces students to the core concepts and topics of environmental sciences. It will give an in-depth overview of main themes in the field of environmental studies: global environmental challenges, human population trends, global atmospheric changes, air, land and water resources and pollution, the ocean and fisheries, key ecosystems (forests, grasslands, wetlands, freshwater and marine environment), biodiversity and conservation, non-renewable and renewable energy, agriculture and sustainable production. Quantitative and qualitative research methods will be introduced with case studies. Taught at Duke Kunshan University. Instructor: Johnson. 3 units.

719. **Aquaculture.** The major environmental, social and economic drivers of increasing global aquaculture, with a focus on marine systems. Quantitative evaluation and comparison of the range of species for aquaculture, locations where operations occur, operational aspects including environmental impacts and management considerations. Investigation of alternative approaches and potential future areas for aquaculture expansion as well as social, economic and technical barriers to implementation. Instructor: Johnson. 3 units.

720S. **Land Conservation in Practice.** Provides an overview of the applied skills and techniques currently used to conserve land in the land trust movement. Covers a variety of topics from setting priorities for conservation, completing land transactions, working with private landowners, fundraising, land monitoring and stewardship, evaluating conservation success, etc. Course leverages the experience of guest speakers from regional land trust and conservation organizations to provide working examples of how land conservation is done. Instructor: Swenson. 1 unit.

721. **Soil Resources.** Emphasis on soil resources as central components of terrestrial ecosystems, as rooting environments for plants, and as porous media for water. Soil physics and chemistry provide the basis for the special problems examined through the course. Laboratory emphasizes field and lab skills, interpretive and analytical. Instructor: Richter. 3 units.

722. **Hydrologic and Environmental Data Analysis.** Course will focus on acquisition of skills necessary to extract information from observations of hydrological and environmental processes, connect the extracted information with the physical processes generating the data, and estimate physical quantities at ungauged location/times. Emphasis on process understanding via data analysis techniques. Applications used as a way to understand the general concepts, with examples drawn from water science. Prerequisites: Basic computer skills, Algebra, Calculus are required. Experience with computational software (e.g., Matlab or R) is helpful but not required. Instructor: Marani. 3 units. C-L: see Earth and Ocean Sciences 722; also C-L: Civil and Environmental Engineering 761

724. **Landscape Analysis & Management.** This course presents a task-oriented perspective on landscape ecology, by introducing the fundamental tasks of landscape analysis and management. These tasks include habitat classification and species distribution modeling; sampling designs for landscapes; inventory and monitoring; site prioritization; change detection and forecasting landscape change; inferences on landscape data (an introduction to the analysis of multivariate and spatial data); and integrated assessment. The course consists of lectures and computer labs. Prerequisites: Environment 714 and Environment 710 or equivalent, or consent of instructor. Instructor: Urban. 4 units.

7255. **Protected Areas, Tourism, and Development.** Investigates issues of establishing and managing national parks, biosphere reserves, and other protected areas in situations where local populations compete for the same resources. Tourism is considered as a possible source of negative impacts on the protected area and as a source of local economic development. Includes consideration of tourism policy, resource protection strategies, microenterprise development, sustainable agriculture, and forestry. Instructor: Staff. Variable credit.

727. **Forests in the Public Interest Seminar.** Discussion and analysis of current forestry issues of concern to the public, both in US and abroad. Students propose discussion topics by identifying forest-related news stories reported in leading print or online sources during the current calendar year. The topics are discussed in two parts. First, students review the information reported in the news stories and generate a series of questions for additional analysis. Each student then investigates one of the questions before the next class meeting and reports his or her findings to the group. Particular themes (e.g., forest health, wildlife) might be highlighted in particular years. May be taken up to three times for credit. Instructor: Vincent or Richter. 1 unit.

728. **Fire Ecology and Management Seminar.** A wide range of wildland and forest fire seminars are organized for students to interact with leaders in the wide variety of environmental fields that work with fire issues: ecological science of fires, prescribed, fire, fire behavior, fire on federal and state public lands, fire economics, fire and restoration, and fire in history and in the future. Instructor: Richter. 1 unit.

731. **Dendrology.** This course aims to familiarize students with the secret lives of trees. We begin by learning to identify over 130 woody plants of the Piedmont. To do this, we will also grapple with dichotomous keys and plant systematics to help us identify plants anywhere in the world. We also address topics like the chemical communication of trees, the relationships among wildlife and trees, and the value of
trees. Most of this course will be outside. Instructor consent required. Instructor: Cagle. 2 units.

733. Risk Regulation in the United States, Europe, and Beyond. Advanced, integrated analysis of the law, science and economics of societies’ efforts to assess and manage risks of harm to human health, safety and the environment. Course examines the regulation of a wide array of risks, such as those from medical care and drugs, food, automobiles, drinking water, air pollution, energy, global climate change, and terrorism. The course explores the treatment of several basic issues confronting any regulatory system: risk assessment, risk management (including the debate over “precaution” versus benefit-cost analysis), risk evaluations by experts vs. the public, and risk-risk tradeoffs. Instructors: Wiener and Bennear. 2 units.

734L. Watershed Hydrology. Introduction to the hydrologic cycle with emphasis on the influence of land use, vegetation, soil types, climate, and land forms on water quantity and quality and methods for control. Development of water balance models. Analysis of precipitation patterns, rainfall and runoff, and nonpoint source impacts. Statistical handling and preparation of hydrologic data, simulation and prediction models, introduction to groundwater flow, laboratory and field sampling methods. Instructor: Katul. 4 units.

736K. Planetary Health and Environmental Epidemiology. Study the human health impacts of accelerating environmental change through interdisciplinary approaches including environmental science, political science, public health and social science; engage in diverse materials from many types of examples of planetary health research, from nutrition and mental health, to infectious and non-communicable diseases. A special emphasis will be placed on environmental epidemiology. Taught in China at Duke Kunshan University. Recommended prerequisite: one quantitative methodology class (statistics, biostatistics, epidemiology, or econometrics). Instructor: Ji. 3 units.

738. US Water Governance. This course examines the governance systems that manage freshwater resources in the United States. American water policy is densely institutionalized, constrained by historical systems of rights and long-established patterns of water usage. It is also organizationally complex, with authority fragmented among myriad agencies and authorities at all jurisdictional levels. Our task will be first to understand current governing structures as a consequence of historical, functional, and political forces, and second to analyze contemporary efforts to promote collaboration, adaptive management, and market solutions within the framework of existing governance systems. Instructor: Mullin. 1.5 units.

739. Atmospheric Chemistry: From Air Pollution to Climate Change. A broad overview of the science of oxidant chemistry in the atmosphere. Basic physical and chemical concepts relevant to the understanding of atmospheric chemistry; several contemporary topics discussed from a process-level perspective. Topics include atmospheric structure and chemical composition; atomic structure and chemical bonds; chemical thermodynamics and kinetics; atmospheric radiation and photochemistry, tropospheric and stratospheric ozone chemistry; aqueous-phase atmospheric chemistry; atmospheric aerosols; and air quality modeling. Prerequisites: one college-level course each in chemistry and calculus. Instructor: Kasibhatla. 3 units. C-L: Civil and Environmental Engineering 665

740. Water Resources Planning and Management. This half-credit course is intended to give students a first exposure to ideas of planning and management of organizations related to water resources. The course will develop a very basic framework for strategic planning for environmental organizations with specific applications to water resources. It will provide some tools for forecasting future water conditions, as well as emerging tools for forecasting uncertain water conditions. Finally, it will expose students to approaches in water management, particularly adaptive management and scenario forecasting. Instructor: Doyle. 1.5 units.

741. Water Resources Finance. This half-credit course is intended to provide students with applications of project finance to water assets, particularly municipal water/wastewater systems and irrigation infrastructure, financed primarily through municipal bonds. The primary concepts will be forecasting demand, revenue-generation, pricing effects, debt financing, and emerging alternative finance. Instructor: Doyle. 1.5 units.

742. Forestry and Conservation Finance. This course focuses on the growing practice of utilizing private capital to help fund the costs of a variety of environmental projects, including examples from conservation and mitigation banking, as well as fisheries. We consider potential future trends in the role of private capital as a tool to help solve environmental problems, drawing in part from the broader experience of development finance. Students should emerge with a basic grasp of primary finance instruments as well as specific considerations underlying conservation finance deals and projects. Examples include more mature cases such as forestry and to a lesser extent mitigation banking in the US, to emerging areas such as tropical fisheries. Instructor: Doyle. 1.5 units.

744. Ecology and Conservation of Streams and Rivers. Overview of ecological processes in flowing waters and application to conservation and management of these ecosystems. Lecture and discussion formats to integrate basic principles governing physical, chemical, and biological structure of streams and rivers with anthropogenic drivers of change and policy and management tools. Laboratories will provide hands-on experience in collection and analysis of physical, chemical, and biological data. Field and literature projects will enable students to focus on either basic or applied analysis techniques. Prerequisite: general ecology recommended. Instructor: Heffernan. 3 units.

750. Genomics of Microbial Diversity. Graduate seminar explores the use of genomic approaches to illuminate microbial diversity and to clarify mechanisms generating variation within and among microbial lineages and communities. Course is targeted to Ph.D. students in the areas of genomics, genetics, environmental sciences, ecology, and/or computational biology. Discussions will focus on case studies from the primary literature, followed by computer labs allowing hands-on use of current programs. Instructor: Wernegreen. 3 units. C-L: Science & Society 750

752. Sustainability and Renewable Resource Economics. Economic theories of sustainability, contrasted with other scientific views. Focus on renewable resource economics, modeling, and management. Prerequisite: Environment 520. Instructor: Smith. 3 units. C-L: Economics 752

754. Species Distribution Modeling and Habitat Classification. This is a tools course that covers the most popular statistical methods for modeling species distributions. The techniques include generalized linear models, generalized additive models, tree-based models (random forests), and maximum entropy methods. The course also attends model evaluation methods, mapping models in a GIS, and ensembling techniques. Prerequisite: Environment 710 or equivalent course or consent of the instructor. Instructor: Urban. 4 units.

755. Community-Based Environmental Management. Goal of the course is to provide students with fundamental theory and methods that will allow them to identify some of the potential problems and pitfalls associated with community-based environmental management
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756. Spatio-Temporal Environmental Models. Spatio-temporal models are now being widely used for inference on environmental data. This course will consist of weekly topics with readings of new literature and application of models and software to data sets. We will specifically focus on spBayes in R. Students will each volunteer to lead one week, track down and distribute a data set, set up a model and provide a short demo on computation. Instructor: Shapiro. 3 units.

757. Current Issues in Protected Area Management. Principles of management of protected areas. Topics vary and include wilderness, national park, or international protected areas. Focus on legal and historical frameworks, ecological and social issues, and development and practical application of terrestrial protected area management techniques. Lecture and class discussion of topics. Required 1-day field trip to NC wilderness area. Undergraduates may enroll by permission of instructor. Prerequisite: introductory ecology. Instructor: Swenson. 3 units.

759K. Environmental GIS. Core concepts and latest application of geographic information system in environment area; an in-depth overview of the key data types (raster and vector files) in this area, data collection and entry, data management, data analysis and output using ArcGIS; introduction of application of GIS in real world problem solving, such as species habitat mapping and conservation planning. Students will be exposed to Google Earth, QGIS and other open source GIS tools. Taught in China at Duke Kunshan University. Instructor: Li. 3 units.

760A. Western Field Trip. One-week trip to observe land management and utilization practices in the western United States. Exposure to ecological, economic, and policy issues, as well as wilderness, wildlife, and land use questions. May be repeated for credit. Consent of instructor required. Instructor: Staff. 1 unit.


762. Environmental Mega-Trends. Course investigates major, over-arching trends in environmental science, policy, thought, and practice and likely trajectories for the coming 25 years. Goal is to understand these trends and assess how changes in the environment might impact—and be impacted by—society, from the scale of individual decisions to global economies. Individual topics driven by emerging issues that are of most pressing interest but also that may not have immediately obvious connections to contemporary environmental discussions. Instructor: J. Clark. 2 units.

763. Forest Management Traveling Seminar. Covers current topics in the broad field of forest management. Taught as a set of coordinated field trips with expert contacts in sites in the Carolina piedmont, coastal plain, and mountains. Topics of past seminars include fiber utilization, best management practices, forest regeneration, the chip mill issue, forest-pest management, and forest preservation management. May be repeated for credit. Instructor: Richter. 1 unit.

764. Applied Differential Equations in Environmental Sciences. General calculus and analytic geometry review; numerical differentiation and integration; analytic and exact methods for first and second order ordinary differential equations (ODE); introduction to higher order linear ODE, numerical integration of ODEs and systems of ODEs; extension of Euler’s method to partial differential equations (PDE) with special emphasis on parabolic PDE. Example applications include population forecasting, soil-plant-atmosphere water flow models, ground water and heat flow in soils, and diffusion of gases from leaves into the atmosphere. Prerequisite: Mathematics 21 or equivalent or consent of instructor. Instructor: Katul. 3 units.

765. Geospatial Analysis for Coastal and Marine Management. Application course focusing on spatial analysis and image processing applications to support coastal and marine management. Covers benthic habitat mapping, spatial analysis of marine animal movements, habitat modeling, optimization of marine protected areas. Requires fundamental knowledge of geospatial analysis theory and analysis tools. Consent of instructor required. Prerequisite: Environment 559. Instructor: Halpin. 4 units.

766A. Ecology of Southern Appalachian Forests. Field trips to various forest ecosystems in the southern Appalachian Mountains. Species identification, major forest types, field sampling, and history of effects of human activities. Instructor: Richter. 1 unit.

768. GIS for Water Quantity and Quality Assessment. Spatial analysis and image processing applications to support water resources management: water quality, flooding, and water supply primarily at watershed scale. Topics include water resources data modeling, terrain modeling and processing, river and watershed network analysis, and geospatial modeling of hydrologic processes. Knowledge of geospatial analysis theory and analysis tools. Instructor: Kumar. 3 units.

769. Hydrologic Modeling for Water Quantity and Quality Assessment. Hydrologic modeling concerns itself with understanding and prediction of different components of the hydrologic cycle by solving abstract representations of respective hydrologic processes. Students acquire an in-depth understanding of how and where hydrologic models can be used, and will be prepared to address water quantity and quality problems using computer models. Course will discuss in detail the assumptions, limitations and uncertainty associated with different modeling strategies. Course addresses both surface and ground water processes. Models discussed in course include TopModel, Stanford Watershed Model, HEC-HMS, SWAT, HSPF, RUSLE, SPARROW, PIHM, etc. Instructor: Kumar. 3 units. C-L: Civil and Environmental Engineering 687

771L. GIS Field Skills. Covers integration of GPS and GIS technology for field data collection. Data is set up in ArcGIS in lab, exported to GPS units, field data to be collected, and imported back to GIS system. ArcGIS Personal Geodatabase is the fundamental data structure. Course covers data accuracy and precision and how to use base stations to correct data differentially for highest possible accuracy. Will discuss how to determine what GPS unit is necessary for project accuracy needs. Prerequisite: Environment 559. Instructor: Harrell. 2 units.
774. One Health: From Philosophy to Practice. Interdisciplinary course introducing construct of One Health as increasingly important to a holistic understanding of prevention of disease and maintenance of health. Includes discussion of bidirectional impact of animal health on human health, impact of earth's changing ecology on health. Learning objectives include 1) to describe how different disciplines contribute to the practice of One Health, 2) to creatively design interdisciplinary interventions to improve Global Health using a One Health model. Course will include weekly 2-hour multi-campus seminar off-site at NC Biotechnology Center with on-campus discussion session using case studies to supplement the seminar. Instructor: Staff. 3 units. C-L: see Global Health 771

775. Ocean and Coastal Law and Policy. Explores law, policies and attitudes that affect US ocean and coastal resources. Using case studies and other materials, examines use, management and protection of coasts and oceans. Government and private sector approaches to ocean and coastal resources such as, wetlands, estuaries, beaches, reefs, fisheries, endangered species and special areas. Instructor consent required. Instructor: Roady. 3 units.

776. Marine Mammals. Ecology, social organization, behavior, acoustic communication, and management issues. Focused on marine mammals in the southeastern United States (for example, bottlenose dolphin, right whale, West Indian manatee). The biology of cetaceans, pinnipeds, sirenians, and sea otters. Detailed consideration given to the adaptations that allow these mammals to live in the sea. Evaluation of the scientific, ethical, and aesthetic factors influencing societal attitudes toward these animals and of their conservation management in light of domestic legislation and international treaties. Instructor: Read. 3 units.

780. Environmental Exposure Analysis. Course will explore different routes by which people are exposed to contaminants through daily behaviors including exposure factors, inhalation exposure, dietary exposure, water exposures, statistical methods. Various experimental techniques used to measure exposure will be introduced, reviewed and discussed; will also explore statistical approaches used to evaluate variables contributing to exposure. Students will gain thorough understanding of how to develop an effective exposure assessment experiment and how to use various mathematical models to quantify this exposure. Prerequisites: ENVIRON 710 statistics; college level general chemistry, or consent of instructor. Instructor: Zhang and Stapleton. 3 units.

781K. Narrating Nature: Documentaries For Environmental Studies. Evaluate and illustrate how film documentary media can help communicate, critique, and educate the public about the complex environmental and social issues of our times. Taught in China at Duke Kunshan University. Instructor: Rojas-Sotelo. 3 units.

782. Marketing for Environmental Professionals. Focus of course is foundations of entrepreneurial activity within the context of environmental sciences and policy. Course concentrates on new enterprises based on substantial technology innovations with potential for high growth and funding by venture capitalists. Format is readings, lectures and case discussion with practical exposure to all basic operational tools required to start up and operate a company. Instructor: von Windheim. 3 units.

786. Marine Policy. Formal study of policy and policy-making concerning the coastal marine environment. History of specific marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Topics explored through use of theoretical and methodological perspectives, including political science, sociology, and economics. Instructor: Murray. 3 units.

790. Special Topics. Content to be determined each semester. May be repeated. Instructor: Staff. Variable credit.

791. Independent Studies and Projects. Directed readings or research at the graduate level to meet the needs of individual students. Consent of instructor required. Units to be arranged. Instructor: Staff. Variable credit.

792. Wetlands of Coastal North Carolina. This field based course explores the ecology and management of coastal wetlands North Carolina. Wetlands included in the course include Pocosin bogs, bottomland hardwoods, cedar swamps, freshwater marshes and coastal saltmarshes. Field measurements are taken for water quality, soils and vegetation. Analysis includes the effects of sea level as well as urban coastal development, farming and forestry rise on coastal wetland communities. Students are required to be enrolled in or have taken a wetland or aquatic ecology course. Instructor consent required. Instructor: Richardson. 1 unit.

795. Community-Based Environmental Management Practicum. Course is designed for students who wish to learn theory, skills and tools necessary for working with communities to manage their own environment. Course includes in-class lectures, discussions of readings, guest speakers and an in-depth client project with a local community-based environmental organization. Topics will include: community organizing; assessing and capturing resources; participatory planning and evaluation; participatory monitoring; outreach and social marketing; and political action for environmental change. Second of two required courses for the Community-Based Environmental Management certificate (NSOE only). Prerequisite: Environment 755. Instructor: Shapiro. 3 units.

798. Communicating Outside the Box: Effective Science Communications and Research Translation Skills. Course primarily aimed at late-stage doctoral students who wish to translate their own research to audiences outside of the academy. Students will develop skills to effectively communicate science and research to non-academic audiences using a variety of methods and will develop and implement a research translation/communication strategy for their own research. Specific topics include underlying theories and frameworks, science and advocacy, environmental justice/community-based research, science and K-12 education, expert testimony, communicating with media, and communicating with policy makers. Prerequisite: consent of instructor. Instructor: C. Clark. 2 units.

799S. Topics in Ecological Genomics. This graduate seminar explores how genomic approaches are impacting research in ecology and environmental biology. The course is targeted to PhD or research-active masters students interested in genomics, genetics, ecology, ecotoxicology, conservation genetics, environmental sciences, and/or computational biology. Discussions will focus on case studies from primary literature, and computer labs will allow hands-on use of current programs. May be repeated. Wernegreen. 1 unit. C-L: Science & Society 799S

800. Professional Communications for MEM and MF Students. Skills-building in professional communication, emphasizing visual communication and speaking. Oral presentations, written document design, graphic display of information, presentation software, and giving and receiving constructive feedback on projects in these areas. Open only to MEM and MF students. Instructor: Vidra. 1 unit.

801. Topics in Experiential Learning for Environmental Management. Field trips, short courses, guest lectures series and other learning experiences that bring students into practice of environmental management and bring environmental managers to students. Example of
Courses of Instruction

802. Program Management for Environmental Professionals. Overview of principles of program management, with application to diverse environmental professions. Lectures, case studies and discussion focus on topics including leadership, organizational structures, managing complex systems, adaptive management, risk and uncertainty, and advocacy within an organization. MEM and MF students only. Instructors: Staff. 3 units.

803K. Environmental Policy Process. This course provides an introduction to and overview of the environmental policy process. The first part of the course introduces the environmental policy process with case studies from different countries exemplifying regional differences. The second part of the course introduces various aspects and challenges in the design and formation of environmental policies. The third part of the course focuses on implementation and tools to evaluate the impact of environmental policies. The fourth part of the course discusses the formation of international environmental policies and their impact on national priorities. Taught at Duke Kunshan University. Instructor: Furst. 3 units.

805K. Environmental Economics. An overview of environmental economics by introducing analytical methods and tools to analyze environmental problems and identify policy solutions; including 1) a microeconomic foundation of environmental economics, with a focus on market efficiency and market failures; 2) environmental policy decision tools, such as benefit-cost analysis and cost-effectiveness criterion; 3) environmental regulation, with topics covering command-and-control regulation, market-based approaches, and behavioral interventions. Instructor: Zhang. 3 units.

806. Duke Forest Practicum. Designed to focus on practical skills required of land managers in a variety of settings, including conservation organizations, government, and industrial and non-industrial forestland ownerships. The management plan of the Duke Forest will serve as a guide and example for specific resource and administrative considerations. Classroom and field settings provide hands-on experience with range of topics, including elements of a forest management plan, certification and best management practices, timber sales planning and administration, conservation easements, wildlife management, and recreation management. Open only to MEM and MF students. Instructor: Vincent. Variable credit.

806K. Environmental Economics II. This course provides for continued development and practice of skills learned in Statistics and Program Evaluation and Environmental Economics. Students develop conceptual and professional skills related to environmental policy evaluation. The goal is to stimulate critical thinking about today’s environmental problems and the public policies designed to improve them by implementing the theories and principles acquired in class. Prerequisites: Public Policy 870K and Environment 805K or instructor consent. Taught at Duke Kunshan University. Instructor: Kim. 3 units.

808. Aquatic and Wetland Field Skills. Introduces students to basic techniques of data collection and application of field indicators in wetlands. In the course students will monitor wetland hydrology, soils and plant communities for research purposes and for jurisdictional determination of wetland boundaries using US Army Corps of Engineers protocols. Instructor: Flanagan. 3 units.

809. Wetland Restoration Ecology. Restoration of wetlands requires understanding of wetland hydrology, biogeochemical processes, decomposition, community habitat requirements and soil processes. Factors are discussed in an ecosystem context along with current restoration techniques. Course utilizes newly constructed wetlands in Duke Forest to explore wetland restoration principles. Students teamed together to develop restoration plan for a restored wetland. Final report and oral presentation required. Instructor: Richardson. 3 units.

810. Topics in Environmental and Ecological Statistics. Project-based course on environmental and ecological statistics for PhD/MS students. Students work on specific data analysis projects associated with current research. Class consists of modules based on specific topics. Students required to complete introduction module and one additional module. Presentation and discussion of projects after introduction module required. Objective of class to provide statistical guidance in students' thesis research work. Instructor: Staff. 3 units.

811. Business and Environment. Theoretical grounding on Sustainable Systems (SS) thinking and overview of national and international frameworks that have led to development and use of sustainable systems modeling, life cycle analysis and policy decision models. Topics include socio-metabolic consumption, sustainability as a field of inquiry, systems thinking, industrial ecology, earth systems engineering, complexity and resiliency. Explore current drivers and implications of sustainable systems with specific focus on nexus of industry and environmental systems including examining cumulative impacts and benefits resulting from shifting supply chains, green engineering, technological designs and consumer behavior. Instructor: Golden. 3 units. C-L: see Energy 811

812. Wetlands Ecology and Management. The study of bogs, fens, marshes, and swamps. Emphasis on processes within the ecosystem: biogeochemical cycling, decomposition, hydrology, and primary productivity. Ecosystem structure, the response of these systems to perturbations, and management strategies are discussed. A research project is required. Prerequisites: one course in ecology and chemistry. Instructor: Richardson. 3 units.

813. Advanced Environmental Toxicology. Discussion of current issues. Topics vary but may include chemical carcinogenesis in aquatic animals; biomarkers for exposure and sublethal stress in plants and animals; Discussion of current issues. Topics vary but may include chemical carcinogenesis in aquatic animals; biomarkers for exposure and sublethal stress in plants and animals; techniques for ecological hazard assessments; and means of determining population, community, and ecosystem level effects. Lectures and discussions led by instructor, guest speakers, and students. Prerequisite: Environment 501. Instructor: Di Giulio. 3 units.

814. Integrated Case Studies in Toxicology. Students are assigned topics relative to their chosen research discipline in toxicology and are asked to develop case studies to present at a roundtable workshop. Emphasis on review and analysis of toxicological problems from a holistic (multidisciplinary) viewpoint. Offered on demand. Instructor: Abou-Donia. 1 unit. C-L: see Pharmacology and Cancer Biology 814

815. Focused Topics in Toxicology. A contemporary advanced toxicology research area covered with readings from the current primary
literature. An integrative review of the topic prepared as a collaborative effort. Consent of instructor required. Prerequisites: Pharmacology 533 and 847S. Instructor: Levin. 1 unit. C-L: Pharmacology and Cancer Biology 815

816. International Climate Change Negotiations Practicum. Climate change promises to impact almost every aspect of life on earth across the globe. It is an issue that, because of the diffuse nature of its causes and solutions, will require a global solution. Since the Rio Earth Summit in 1992, the United Nations Framework Convention on Climate Change (UNFCCC) has been the primary forum for the negotiation of international agreements concerning climate change. Students will learn about primary issues involved in negotiation of international climate change agreements under UNFCCC and train them to take part as a stakeholder with the intention of developing students’ analytical thinking through experiential learning at international level. Instructor: Shapiro. 3 units.

819. Mechanisms in Environmental Toxicology. Provides an in-depth examination of key molecular and biochemical mechanisms by which organisms defend themselves against environmental pollutants. Cellular mechanisms by which chemicals produce toxicity when the defense systems are overwhelmed will be addressed. Includes examinations of "state of the art" approaches for experimentally elucidating these phenomena. Course format will be that of a graduate seminar, with lectures given and discussions led by the instructors, guest speakers, and course participants. Prerequisites: one course in biochemistry and one course in toxicology. Instructors: DiGiulio. 3 units.

820S. Conservation Ethics. Students will delve into the tension between science and advocacy through the lens of environmental ethics. Students will gain a strong foundation in principles of environmental ethics, drawing from the rich literature on this topic from the fields of philosophy and ethics, environmental communications and education, and conservation ecology. Seminar-style course requires students to actively lead and participate in weekly discussions, write a series of essays and collaboratively design and initiate a semester project. Ultimately, the course is about reflecting on not just the academic literature and individual scenarios but seriously considering the role our own values play in our work. Instructor: Vidra. 3 units.

821. Advanced Readings in Soil Science. An advanced discussion course based on readings that concern current critical topics in the soil sciences. Readings are selected from both basic and applied aspects of the field. Instructor: Richter. 1 unit.

823. Ecological Resilience and Ecosystem Management. Course provides an introduction to concepts of ecological resilience and its application to the management of ecological systems, and is intended for both PhD and MEM students. The course does not require formal mathematical training, but students are expected to engage the models used in this field. Course consists of lectures, discussion, and a group research project. Lectures will address fundamental theory, case studies, and empirical approaches used to understand the resilience of basic ideas, observations, and approaches to understanding the ecology of flowing water systems. Instructor: Heffernan. 3 units.

826. Global Environmental Politics. Course examines how states and non-states actors cooperate to resolved global environmental problems. Central focus is on the creation of international environmental regimes, their implementation, and effectiveness. Case studies include climate change, ozone depletion, water sharing and dams, fisheries, biodiversity, forestry, oil pollution, sustainable development, environmental security, and trade and the environment. Instructor: Weinhart. 3 units.

827. Principles of Management. Provides introduction to business terminology and practices for environmental professionals. Introduce students to foundational concepts and language associated with the different functional areas of the firm and to some of the processes and tools available to organizational managers to enhance organizational effectiveness. Areas covered include finance and accounting, management and leadership, and organizations and strategy. Permission of instructor required. Instructor: Emery. 3 units.

829. Natural Resource Economics. Addresses questions about natural resource scarcity using modern capital theory and optimal control theory to derive core results. Two objectives: provide students with a solid foundation in theory of natural resource economics, emphasizing tools and theoretical breadth to enhance research and teaching. Second objective to highlight contemporary themes in theoretical and empirical resource economics. Designed for PhD students in economics, finance, agriculture and resource economics, or public policy (with economics concentration). Prerequisite: one year PhD-level microeconomic theory and econometrics; review of differential equations recommended. Consent of instructor required. Instructor: Smith. 3 units. C-L: Economics 753

830. Building Energy on Campus: Evaluating Efficiency and Conservation Measures at Duke. Buildings use more than 40% of the energy consumed in the US, and are a natural target of energy efficiency and conservation measures. Building owners and facility managers, as well as the policy community, are therefore interested in identifying means of reducing energy consumption in the current building stock and taking advantage of the embodied energy already sunk into its construction. Using the campus as a laboratory, course examines energy use in existing Duke buildings. Students will learn about the relationship between building design and energy use, and gain hands-on experience conducting energy audits and evaluating energy saving measures in campus facilities. Instructor: Johnson. 3 units. C-L: Energy 830

831. Sustainable Business Strategy. Businesses are increasingly applying strategic management tools to incorporate consideration of sustainability into decision-making and operations. While some businesses incorporate sustainable practices because of ethical convictions, most businesses are motivated to do so to address pressures from stakeholders such as regulators, shareholders, customers and neighbors and to exploit knowledge and experience for long term competitive advantage. Students will learn how businesses develop and implement strategies to promote sustainability by examining roles and responsibilities of sustainable strategic managers and applying tools of strategic business management to problems of sustainability. Permission of instructor required. Instructor: Gallagher. 3 units.

832. Environmental Decision Analysis. Quantitative methods for analyzing environmental problems involving uncertainty and multiple, conflicting objectives. Topics include subjective probability, utility, value of information, multi-attribute methods. Students will apply these tools to an environmental policy decision in a group project. Prerequisite: introductory applied statistics or equivalent. Instructor: Maguire. 3 units.

834S. Environmental Social Science Research Workshop. Seminar format designed to give graduate students in environmental social sciences a venue to present research proposals and preliminary work. Emphasis is on application of social science research methods. Includes presentations by faculty and students. Intended for doctoral students in environmental social sciences. Students wishing to earn more than one credit will prepare an additional separate paper on topic with approval of instructor. Permission of instructor required. Instructor: Kramer or Smith. Variable credit.

835. Environmental Law. Examination of rapidly growing body of law concerned with interrelationships between human activities and the
835K. Environmental Law. Emphasizing the practical use and application of legal concepts within the context of pollution control and resource management; exploring the role of law, regulation and governance in protecting, managing and restoring the environment and natural resources. Taught in China at Duke Kunshan University. Instructor: Furst. 3 units.

836A. Seabird Survival and Dispersal Analysis. Client-inspired class held at the Dry Tortugas National Park (near Key West). The principal field activity will be catching, ringing and measuring sooty terns as part of a National Park Service effort. The graduate version of this course has close similarities to the undergraduate class. Both classes will travel together and be expected to catch, ring and process the same numbers of birds. The graduate version differs in the written expectations. These vary somewhat, but have included very extensive documents that eventually comprised the student’s master’s project and considerable post-trip involvement with the professor and Park Service personnel—such projects are encouraged but not guaranteed. Instructor consent required. Prerequisite: Environment 703. Instructor: Pimm. 2 units.


840. Ecology and Conservation of Gabon. Field course to study environmental problems, challenges and aspirations of Gabon, W. Africa. Goal is to expose students to Gabon’s natural ecosystems and its development challenges and to think critically about development trade-offs. Study of coastal ecosystems & interior tropical forests including drivers of environmental degradation & destruction: subsistence agriculture, large-scale logging, industrial agriculture, mining & hunting/poaching. Field research & evaluation of environmental policy options, examining role of human and industrial impacts on the environment. Prerequisite: graduate course in Tropical Ecology or Conservation Biology/Management. Course may be repeated. Instructor consent required. Priority to students with French language skills. Instructor: Poulsun. 1 unit.

841. Ecological Perspectives: Evolution to Ecosystems. This course surveys core concepts in evolutionary and ecosystems ecology, and it challenges students to develop intersections and creative syntheses across those disciplines. Instructor: Staff. 4 units. C-L: see University Program in Ecology 701; also C-L: Biology 841, Evolutionary Anthropology 741

842. Ecological Perspectives: Individuals to Communities. This course surveys core concepts in Physiological/Behavioral/Population Ecology and Community Ecology, and it challenges students to develop intersections and creative syntheses across those disciplines. Instructor: Staff. 4 units. C-L: see University Program in Ecology 702; also C-L: Biology 842, Evolutionary Anthropology 742

8475. Seminar in Toxicology. A weekly research seminar throughout the year is required of participants in the Toxicology Program. Students, faculty, and invited speakers present their findings. Instructor: Meyer. 1 unit. C-L: Pharmacology and Cancer Biology 8475

8485. Seminar in Toxicology. A weekly research seminar throughout the year is required of participants in the Toxicology Program. Students, faculty, and invited speakers present their findings. Instructor: Levin. 1 unit. C-L: Pharmacology and Cancer Biology 8485

850. Program Evaluations of Environmental Policies. Designed to give students foundation in methods and applications of quantitative program evaluation in environmental policy. Program evaluation seek to identify casual effect of program/regulation/policy on some outcome of interest using statistical methods. Students will learn major empirical methods in program evaluation and apply them to current environmental policies. Instructor: Bennear. 3 units.

8515. Environment and Development Economics. Readings course surveys range of important natural resource and environmental issues in developing countries. Emphasizes use of economic principles to understand these issues and to formulate effective policy responses to them. Course has theoretical content, but deals with theory more qualitatively than mathematically. Provides an opportunity for learning how economic theory taught in other courses can be applied to natural resource and environmental issues in developing countries. Course objective: familiarize students with key portions of literature on environment and development economics and foster students’ abilities to read this literature critically and after graduation. Instructors: Vincent or Pattanayak. 1.5 units. C-L: Public Policy 827S

852. Spatial Analysis for Ecologists. Descriptive and inferential statistics for spatial data as encountered in community and landscape ecology. Course covers spatial point patterns (e.g., clustering in plant communities), geostatistical samples (e.g., species-environment relationships inferred from spatially distributed samples), and lattices (e.g., maps, networks). Emphasis on hands-on applications with ecological data sets. Students may analyze their own datasets as a term project. Prerequisites: Introductory statistics, basic ecology, or consent of instructor. Taught in alternate, odd-numbered years, spring semester. Instructor: Urban. 3 units.

853. Advanced Topics in Landscape Ecology. Small groups of students working together to complete a project in landscape analysis integrating remote sensing, geographic information systems, spatial analysis, and simulation modeling. Expectation is that each student will have experience in at least one of these areas. Consent of instructor required. Offered on demand. Instructors: Halpin and Urban. Variable credit.

854. GIS Analysis for Conservation Management. This course explores applications of geographic and spatial analysis to conservation management issues such as habitat analysis, biodiversity protection assessments, and nature reserve design. The primary goals of the course are: (1) to critically assess the theoretical underpinnings of conservation analysis techniques; and (2) to develop a high level of proficiency in the application of geographic and spatial analysis techniques for conservation management problems. Prior experience with GIS systems and consent of instructor required. Instructors: Halpin and Urban. 3 units.

856. Environmental Fluid Mechanics. Introduction to turbulent fluid flow and Navier Stokes equations; basic concepts in statistical fluid mechanics; development of prognostic equations for turbulent fluxes, variances, and turbulent kinetic energy; Monin and Obukhov similarity theory for stratified turbulent boundary layer flows; applications to CO2, water vapor, and heat fluxes from uniform and nonuniform surfaces; the local structure of turbulence and Kolmogorov’s theory; turbulent energy transfer and energy cascade between scales; turbulence measurements in the natural environment. Prerequisite: Civil Engineering 301L, Mathematics 230, or equivalent. Instructor: Katul. 3 units.
857L. Remote Sensing for Environmental Analysis. Environmental analysis using satellite remote sensing. Theoretical and technical underpinnings of remote sensing (corrections/pre-processing, image enhancement, analysis) with practical applications (land cover mapping, change detection e.g., deforestation mapping, forest health monitoring). Strong emphasis on hands-on processing and analysis. Will include variety of image types: multi-spectral, hyper-spectral, radar and others. Prerequisite: familiarity with GIS. Instructor: Swenson. 4 units.

858. Multivariate Analysis for Ecologists. All of nature is multivariate, and this course embraces this richness. Two general approaches include classification (creating discrete groups) and ordination (emphasizing continuous trends in data). Ecological applications include habitat classification and species distribution modeling, clustering (i.e., community classification), and ordination-based approaches to integrated assessment. Prerequisites: Introductory statistics, basic ecology, or consent of instructor. Taught alternate (even-numbered) years, spring semester. Instructor: Urban. 3 units.

859. Advanced Geospatial Analysis. Provide training in more advanced skills such as: GIS database programming, modeling applications, spatial decision support systems and Internet map server technologies. The course requires a fundamental knowledge of geospatial analysis theory, analysis tools, and applications. Consent of instructor required. Prerequisite: Environment 559 and Environment 761, 765, or 789. Instructor: Fay. 3 units.

860. Natural Resources Law. Focus on constitutional, statutory, and common law governing the legal status and management of federal lands and natural resources. Instructor: Faculty. 2 units. C-L: see Law 368

862. Professional Communications. This is the first of two half credit courses in professional communications. To be taken in the first fall of enrollment in the MEM or MF degree, this course focuses on skills-building in professional communication, emphasizing visual communication and speaking. Oral presentations, written document design, graphic display of information, presentation software, and giving and receiving constructive feedback on projects in these areas. Open only to Master of Environmental Management or Master of Forestry students. Instructor: Gallagher, Lovelace. 1 unit.

868. Environmental Law Clinic. Under Law faculty supervision, students work on interdisciplinary teams to solve nonprofit clients’ legal and policy problems. Students gain hands-on, skills-based professional experience. Clinic follows Law School’s academic calendar. Minimum 100 client work hours plus weekly seminar; mandatory, all-day intensive, typically 2nd Friday of semester; no dropping after 1st class. Nicholas School students may enroll starting in their second semester. Suggested corequisite: Environment 835. More information is available at: https://law.duke.edu/envlawpolicy/. Instructor: Longest, Nowlin. 4 units.

870. Fire Ecology and Management. Principles underlying field of fire ecology and skilful application of fire to meet land management objectives are explored through guest lectures, training sessions, readings and assignments. Specific topics range from history of fire in America, to role of fire in landscape change, to relationship of fire to climate change. Prescribed burning and use of fire in the contemporary landscape are important topics in the class. Instructor: Richter. 1 unit.

871. Fish As Models For Disease Research. Fish serve as models for disease research in genetic regulation of development, aging, cancer and high throughput screening of drugs and toxins. Due to their importance in human nutrition, fish are a central part of resource assessment following oil spills. To better appreciate fish as models and sentinels, this course will include coverage at all levels of biological organization and will acquaint the student with current methods, approaches and analyses. Instructor: Fay. 3 units.

872L. Environmental Data Analytics. Environmental data analytics introduces fundamental data skills needed to conduct research. We explore a variety of techniques and technologies for obtaining, re-formating, managing, and visualizing diverse data sets with an emphasis on developing reproducible workflows and sharing both methods and results. We will use actual environmental data (hydrologic, demographic, energy, etc.) in class exercises, but students will have the opportunity to involve their own data sets. Instructor consent required. Instructor: Fay. 3 units.

886. Current Topics in Marine Conservation. Discussion of a topic of interest chosen by students with guidance from instructors. Topic is discussed from a social and natural science perspective. Open only to PhD students. Instructor: Staff. 2 units.

891. Topics in Environmental Regulation. In-depth analysis of current issues in environmental regulation. Topics vary. Course may be repeated. Instructor: Bennear. 1.5 units. C-L: see Energy 891

894. Writing, Publishing and Reviewing Scientific Papers. Grad students in ecology, biology, forestry & related disciplines who desire skills in the language of science and how info is disseminated. To learn to write clearly & concisely for effective communication for publication; to express scientific ideas & results and persuade others by the merits of scientific writing in peer-review & eventual publication; to find relevant articles in citation databases, to understand the publication system from the point of view of author/editor/reviewer; what impact factors represent; how to write a convincing letter accompanying your submission & the stages of review; and develop the students’ abilities to read/write/present & critique scientific literature. Instructor: Domec. 1 unit.

895. Master of Environmental Management/Forestry Internship/Project. Students gain practical environmental management or forestry experience by participating in a project-based internship. Focus areas include in energy, conservation, advocacy, policy, research or other environmental management and/or forestry practical opportunities. Open only to Master of Environmental Management or Master of Forestry students. Instructor: Gallagher, Lovelace. 1 unit.

896. Professional Communications. This is the first of two half credit courses in professional communications. To be taken in the first fall of enrollment in the MEM or MF degree, this course focuses on skills-building in professional communication, emphasizing visual communication and speaking. Oral presentations, written document design, graphic display of information, presentation software, and giving and receiving constructive feedback on projects in these areas. Open only to MEM and MF students. Instructor: Cagle. 0.5 units.

897. Writing a Master’s Project. This is the second of two half credit courses in professional communications. To be taken in the second fall of enrollment in the MEM or MF degree, this course addresses different aspects of writing a master’s project. Course will include a mixture of lecture and in-class workshopping of written materials. Course covers writing introductions, background sections, methods, writing results, discussion, conclusions, executive summaries and developing a professional website. Open only to MEM and MF students. Instructor: Cagle. 0.5 units.

898. Program Area Seminar. Required symposium in each program area. Students present master’s project research. Pass/Fail grading only. Instructor: Staff. 1 unit.

898K. Master’s Project I. Designed to help students develop a master’s project (MP). Guide students in conceptualizing an idea, identifying key environmental policy question, writing a prospectus, finding an advisor, finding a client, designing an analytical approach, data
Duke Environmental Leadership (DEL) Courses (ENVIRON)

The following courses are offered to students enrolled in the Duke Environmental Leadership program. Other MEM/MF students can take these courses numbered 900-939 only with permission of the instructor and if space is available. Courses are held primarily online, using web-conferencing technology.

905. DEL: Environmental Communication for Behavior Change. Course provides environmental professionals with a practical introduction to the strategies, methods, and tools of environmental communication that effectively lead to changes in behavior. Emphasis on practical, field-based tools. Executive Education short course. Consent of instructor required. Instructor: Day. 1 unit.

906. DEL: Social Media for Environmental Communication. Introduces the basic features and functions of popular social media tools. Students will understand and be comfortable communicating through various social media tools and be able to incorporate these tools into a larger communication plan. Open to Duke Environmental Leadership Master of Environmental Management students only. Executive Education short course. Online course. Instructor: Thaler, Besch, Nevius. 1 unit.

907. DEL: Writing for Environmental Professionals. Writing in environmental fields encompasses many genres, from policy memos to manuals, blog posts to interpretive signs. This course will allow you to refine and reflect on your writing process. For some, the course may serve as a tune-up; for others, a significant remodeling. Through six modules, on-line discussion, and a series of writing assignments, we will examine the most important aspects of any piece of professional writing: organization, use of evidence, clarity and cohesion, and incorporating feedback during the revision process. The goal is for your writing to become more powerful as a result of this work. Open to Duke Environmental Leadership Master of Environmental Management students only. Executive Education short course. Online course. Instructor: Cagle and Besch. 1 unit.

909. Survey of Environmental Leadership at Duke and Beyond. Introduces the basic features and functions of popular social media tools. Students will understand and be comfortable communicating through various social media tools and be able to incorporate these tools into a larger communication plan. Open to Duke Environmental Leadership Master of Environmental Management students only. Executive Education short course. Online course. Consent of instructor is required. Online course. Instructor: Vidra. 1 unit.

924. DEL: Agriculture and Sustainability. Introduces agroecology through basic scientific knowledge of plant physiology and growth for crop production, crop diversity and breeding, and comparison of agricultural practices (industrial, subsistence, organic, sustainable). Covers resources needed for whole-plant growth, biomass output for human use including bioenergy, and impacts on ecosystems. Examines environmental sustainability through assessment of drawbacks and benefits of agricultural practices for human food and biofuel production. Includes management plan for sustainable agroecosystems and forecast of crop agricultural practices in need of a future altered environment. Prerequisites: Intro Biology or Ecology. Instructor consent required. Instructor: Reid. 3 units.

935. DEL: Social Science Research Methods & Design. Provides students with introduction to theory and practice of social science research methods and design. Intended for students who wish to learn both qualitative and quantitative research methods or who wish to combine natural and social science questions and methods into their research. Through lecture, discussion of readings and case studies, and review of research proposals of their peers, students will become proficient at not only social science theory, but at producing a sound and well-designed research proposal. Instructor consent required. Instructor: Shapiro. 3 units.
955. DEL: Community-Based Environmental Management. Course combines analysis of potential problems and pitfalls involved in community-based environmental management with discussion of the tools necessary to create and manage these projects. Focus is on discussion of academic literature with presentations of specific case studies and analysis of a community program in students’ proximity. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Shapiro. 3 units.

956. DEL: Restoration Science, Policy and Leadership in South Florida. One of the largest restoration efforts in the US, both in terms of area and funding, is the Everglades Restoration Project. This project provides a framework for us to explore how restoration science, policy and leadership come together to create innovative solutions, for some issues, and quagmires for others. This field course involves meeting with leaders in the restoration community and participating in restoration efforts. We will develop a framework for restoration science and policy. We will develop a comprehensive picture of the larger Everglades Restoration Project and make connections between lessons learned in Florida and in other areas. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Instructor: Vidra. 1 unit.

958. DEL: Applied Qualitative Research Methods. Broadly covers qualitative and mixed methods research design, analysis, and interpretation. Students gather a limited amount of their own data and produce a pilot research project throughout the semester. Students learn to use NVivo10, a qualitative research software program. Instructor consent required. Instructor: Clark, Charlotte. 3 units.


961. Duke Environmental Leadership: Ecosystem Science and Management. This course will explore the challenges of managing ecosystems by focusing on both structure (i.e. species, populations, communities) and function (i.e. ecosystem services), grounded in the best available science. We will examine how humans have transformed landscapes and evaluate management strategies for both terrestrial and marine systems. Students will gain the scientific grounding and the practical skills necessary to evaluate the use of science in mgmt efforts through a semester-long case study project, mini-presentations, and writing assignments. Discussions will focus on current controversies in conservation science. Open to DEL-MEM students only. Online course. Instructor: Vidra. 3 units.

962. Duke Environmental Leadership: Economics of Environmental Management. An economic perspective on the management of env. resources. Conceptual topics emphasized include env. externalities, market failure, public goods, sustainability, and benefit-cost analysis. Applications illustrate the role of price signals in energy choices, managing renewable resource use over time, use of marketable pollution permits to encourage voluntary reductions in air and water pollution, and the political economy of env. policy formulation. Case studies examine carbon trading and taxes to address climate change, and economic incentives and values for biodiversity conservation. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Holmes. 3 units.

963. DEL: Program Management for Environmental Professionals. In the private and public sectors, as well as not-for-profit organizations, managerial effectiveness is central to environmental leadership. This course will focus on the development of management skills including decision-making, motivation, working in teams, organizational cultures, organizational design, learning organizations and change management. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Shapiro. 3 units.

964. Duke Environmental Leadership: Environmental Law and Policy. Environmental policies have evolved from strict reliance on command and control systems to experimentation with alternative approaches. In this course students study this evolution by first examining the history and context of US policy development processes and institutions. Command approaches to air and water pollution and waste management are considered along with alternative approaches, such as market-based programs, public-private partnerships and voluntarism. Policies for managing land, natural resources, species protection and addressing transnational and global environmental problems are examined. Policy implementation and devolution of responsibilities to state and local governments and the private sector is stressed. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Shapiro. 3 units.

965. DEL: Environmental Leadership Module. One of the driving themes of the DEL-MEM Program is leadership. We believe that leadership is cultivated by each individual and requires time and effort; it is a process. Participation in the DEL-MEM Program will put students one step closer in their leadership pursuit by providing opportunities to assess and enhance leadership skills, building confidence in critical and creative thinking, communication, collaboration and conflict resolution. This course is designed to orient students towards these goals. More specifically, to provide a framework and point of reference for students’ leadership development. During the three-day session, we will explore leadership in a variety ways, including individual meetings with prominent leaders in the field, discussions, and case study project. Students will also experience Washington, D.C. through a tour of the Capitol, meetings with Congressional members and staff, and time on the Mall. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Gallagher. 3 units.

966. DEL: Professional Writing Course. This course teaches skills and strategies to make the writing process less intimidating and written work more clear and powerful. Comprised of online writing modules that provide examples of excellent nonfiction writing with the goal of identifying what makes the writing successful. Students develop and sharpen their own writing skills through incorporating feedback from a series of drafts. Student writing is reviewed in various forums—including writing workshops, peer reviews, and teacher conferences—to provide detailed feedback, allowing students to rethink and revise their writing. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Cagle. 1 unit.

972. DEL: Making Environmental Decisions. In environmental management, things don’t always turn out as expected. You must address multiple goals, even when those goals themselves conflict. You must respond to diverse stakeholders, with varying worldviews. The tools of decision analysis help you to—going beyond unaided intuition—organize and analyze difficult environmental management decisions. This
course covers quantitative methods for analyzing environmental problems involving uncertainty and multiple, conflicting objectives. Topics include subjective probability, utility, value of information, and multiattribute methods. Students will apply these tools to an environmental policy decision in a group or individual project. Open to Duke Environmental Leadership Master of Environmental Management students only. Online course. Instructor: Albright. 3 units.

973. DEL: Business Strategy for Environmental Sustainability. Businesses are increasingly applying strategic management tools to incorporate considerations of sustainability into decision-making and operations. Course focuses on the development and implementation of strategies to promote environmental sustainability. Students examine roles and responsibilities of sustainable strategic managers and learn how to apply the tools of strategic management: external analysis, forecasting and stakeholder management to problems of sustainability. Business case studies are used. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Gallagher. 3 units.

974. DEL: Seeing the Big Picture: Lessons from Watershed Management in California. This course is an exploration of the interdisciplinary and often controversial nature of watershed management in California using examples from arguably the most manipulated and well-studied watershed in the US. These problems and their solutions are relevant to all watersheds. Topics include: host factors governing fish and wildlife responses and effects; fate, transport, and biogeochemistry of agricultural chemicals; exotic species introduction; economics considerations governing water allocations storage; transport, and conservation; and conflict resolution efforts between competing interest groups. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Hinton. 3 units.

975. DEL: Community Based Environmental Management in Mexico. Class offers students a focused introduction to the general history of rural common property governance and resource politics and management in Mexico and to the specific history and current context of community environmental management in Oaxaca. Requires participation in week long field trip (spring break) to Oaxaca (additional costs involved). Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Instructor: Shapiro. 2 units.

976. DEL: Restoration Ecology: Practice and Principles. Class explores the fundamental principles of ecological restoration, environmental history, and social context. Faculty and students will use the restoration process as a framework and will focus on how the science informs the practice and vice versa. Requires participation in week long field trip over spring break to Hawaii. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Instructor: Vidra. 2 units.

977. DEL: Classic Environmental Literature. Classic environmental literature shapes contemporary discourse about environmental issues. These texts also reveal our relationships with nature and offer new approaches to living with our environment. In this class, we will consider six classic works: Walden, A Sand County Almanac, Silent Spring, Limits to Growth, Small is Beautiful, and Our Common Future. Using close reading, discussion, and written reflection, we will analyze both the social and environmental context, as well as the enduring impact, of each work. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Vidra. 2 units.

978. DEL: Energy and Environment Today. This course will provide students with a broad overview of why and how we use energy, the complex system that has evolved for furnishing energy, the challenges that our energy use has spawned, specifically with respect to the environment, and possible paths to a sustainable energy future. The course is designed to give students a framework for thinking about why energy-related events are happening, what that means for future energy uses and societal well-being, and how we might change the system moving forward. Instructor consent required. Online course. Instructor: Pratson. 1 unit.

979. DEL: The Science of Climate Change. This course will provide students with a broad, policy-relevant overview of contemporary scientific understanding of climate change. The recently released IPCC Fourth Assessment Report (IPCC AR4) titled 'Climate Change 2007' will provide the framework for discussion of various aspects of climate change, including the fundamental physical science basis, potential impacts and vulnerability, and mitigation of climate change. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online course. Instructor: Kasibhatla. 1 unit.

980. DEL: California Water Management Field Trip. California has long been the poster child for conflict over water management and appropriation. Much of that conflict has focused on the diversion of water from the Sierra Nevada and the Great Central Valley. In this 5-day field course we will provide an overview of the hydrology and history of water development of the Central Valley, and focus on three case studies: Hetch Hetchy, the Californian Aquaduct, and the re-watering of the San Joaquin River. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Instructor: Christensen and Hinton. 1 unit.

982. DEL: Sustainable Development in Chile. In this 5-day field and online course we will provide an overview of international sustainable development in Chile, while focusing on environmental management at the government level, sustainable forestry, fisheries, and wineries, and eco-tourism. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Instructor: Gallagher. 2 units.

983. DEL: Green Development. This course will cover green building, smart cities, and related cleantech innovations. Students will explore these topics through the lenses of business strategy, corporate sustainability drivers, challenges and risks, global megatrends, investor perspectives, entrepreneurship, measures of success, and implementation tools. Teaching methods will include case studies, practice-oriented assignments, readings from industry and thought leaders, structured group discussions, and skill building such as professional memo writing. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Instructor: Wedding. 3 units.

985. DEL: Energy, Environment and the Law. Examines legal framework governing energy production and consumption in US, environmental issues associated with the nation’s energy sectors, and policy approaches for balancing energy needs with environmental protection. Three main sections: state utility regulation; energy resources for electricity generation; petroleum. Open to Duke Environmental Leadership Master of Environmental Management students only. Department consent required for all other students. Online
89S. First-Year Seminar. Topics vary each semester offered. Instructor: Staff. 1 unit.

101. The Dynamic Earth. Introduction to the dynamic processes that shape the Earth and the environment and their impact upon society. Volcanoes, earthquakes, seafloor spreading, floods, landslides, groundwater, seashores and geohazards. Emphasis on examining the lines of inductive and deductive reasoning, quantitative methods, modes of inquiry, and technological developments that lead to understanding the Earth's dynamic systems. Instructors: Klein or Glass. 1 unit.

102. The Dynamic Oceans. The oceans and their impact on the Earth's surface, climate, and society. Topics include seafloor evolution, marine hazards, ocean currents and climate, waves and beach erosion, tides, hurricanes/cyclones, marine life and ecosystems, and marine resources. Emphasis on the historical, society and economic roots of oceanography, the formulation and testing of hypotheses, quantitative assessment of data, and technological developments that lead to understanding of current and future societal issues involving the oceans. Instructor: Glass. 1 unit. C-L: Biology 157


202. Atmosphere and Ocean Dynamics. Introduction to the dynamics of ocean and atmospheric circulations, with particular emphasis on the global climate cycle. Prerequisite: Mathematics 21 and 122, Physics 141L or consent of instructor. Instructor: Lozier or Li. 1 unit.

203. The Surface of the Earth. Fundamental earth surface processes involving weathering, soils, hillslopes, rivers, wind, glaciers, and tectonic activity. Humans as agents of landscape change. The future of landscape. Prerequisite: Earth and Ocean Sciences 101 or 102. Instructor consent required. Instructor: Murray or Baker. 1 unit.

204L. The Evolving Earth and Life. Evolution of the earth and life through time. Weekend field trip to Appalachian Mountains.
Courses of Instruction

2265. Field Methods in Earth and Environmental Sciences. Introduction to basic field methods used in the earth and environmental sciences. Field investigations focus on topics such as groundwater and surface water movements, soil chemistry and identification, topographic and geologic mapping, the atmosphere/soil interface, and plant identification and distributions. Design of a field investigation, collection of data to address a specific goal, and interpretation and reporting of the results. Emphasis on learning to report field results in the format of scientific publications. Visits to five local field sites. Open only to juniors and seniors. Instructor: Klein or Dwyer. 1 unit. C-L: Environment 2265

231. Energy and the Environment. Overview of the challenges confronting humanity as a consequence of our reliance on energy. Challenges include dwindling supplies, rising demand and environmental degradation. Realistic responses require an understanding of the complexity of the energy system, including energy resources, uses, and impacts, in the context of social, political and economic imperatives. Lectures will be augmented by presentations from guest speakers from industry, government and non-profit organizations. Instructor: Pratson. 1 unit. C-L: see Environment 231; also C-L: Energy 231

239. Introduction to Atmospheric Chemistry: From Air Pollution to Climate Change. Integrated scientific background for the impact of humans on the natural environment. Topics covered include greenhouse gases and climate, local and regional ozone pollution, long-range pollution transport, acid rain, atmospheric particulate matter pollution, and stratospheric ozone depletion. Prerequisite: Chemistry 101DL. Instructor: Kasibhatla. 1 unit. C-L: see Environment 239


315. Waves, Beaches, and Coastline Dynamics. Oceanographic and geologic processes responsible for the evolution of nearshore features; fluid motions of many time scales in the nearshore environment, including waves and currents. Conceptual basis for models of how fluid motions interact with the shape of the beach and bed in the surf zone, giving rise to features such as beach cusps, bars, channels, and barrier islands. Various attempted engineering and coastal management solutions to the global retreat of shorelines. Instructor: Murray. 1 unit.

316A. Beach and Island Geological Processes. Field seminar on the evolution of beaches and barrier islands with emphasis on the interactions between nearshore processes and human development. Prerequisite: Earth and Ocean Sciences 315/515 or consent of instructor. Also taught as Earth and Ocean Sciences 716A. Instructor: Murray. 0.5 units.

323. Landscape Hydrology. Introduction to hydrology examining how rainfall and snowmelt become streamflow, groundwater and atmospheric water, with emphasis on hydrological processes inside watersheds. Topics include: the hydrologic cycle and water balances, evapotranspiration and snow energy balances, vadose zone hydrology, hydrogeology, hyporheic zones, riparian zones, streamflow generation mechanisms, biogeochemical budgets, and field measurement techniques. Linkages between physical hydrology and broader ecological and environmental sciences will be highlighted. Instructor: Salk-Gundersen. 1 unit.

325. The Anthropocene: The Next Epoch of Geologic History. Introduction to the next epoch of geologic history. The evolution of the technosphere, the global human-technological system that increasingly dominates biology, hydrology, and other major natural earth systems. The future of the earth and humanity. Instructor consent required. Prerequisite: Earth and Ocean Sciences 101 or 203. Instructor: Staff. 1 unit.

341. Dinosaurs with Feathers and Whales with Legs: Major Evolutionary Transitions in the Fossil Record. Focus on the fossil record of the differentiation of the major vertebrate groups. Study and critical evaluation of the paleontological and neontological evidence for four major macroevolutionary transitions in the history of life: fish to tetrapods, the reptile/mammal differentiation, the evolution of birds from dinosaurs, and the origin of whales. Stresses the importance of the fossil record in the reconstruction of transitions but also covers genetic, physiological, and developmental evidence gathered from living representatives. Prerequisite: Prior course work in Earth and Ocean Sciences or Biology or consent of instructor. Instructor: Glass. 1 unit. C-L: Biology 345

355. Global Warming. Broad, interdisciplinary course on the observations, causes, and consequences of climate change. Course will cover modern and paleoclimate observations, human and natural drivers, and links between drivers and responses. Building on this physical science base, course will then analyze how socioeconomic choices affect future climate as well as the factors influencing those choices, including risk analyses, geoengineering proposals, climate metrics and the media. Instructor: Glass or Shindell. 1 unit.

359. Fundamentals of GIS and Geospatial Analysis. Fundamental aspects of geographic information systems and satellite remote sensing for environmental applications. Concepts of geographic data development, cartography, image processing, and spatial analysis. Consent of instructor is required. Instructor: Harrell. 1 unit. C-L: see Environment 359

364S. Changing Oceans. Our oceans are under severe stress. This seminar will explore human disturbances of marine environments, including ocean warming, sea level rise, melting of ice caps and sea ice, ocean acidification, coastal eutrophication, changes in primary production and food web dynamics, invasive species, overfishing, increased subsurface hypoxia, changes in circulation, stratification, and physical, chemical (e.g., oil spills) and noise pollution. Instructor: Cassar. 1 unit. C-L: Environment 362S

365. Introduction to Weather and Climate. Introduction to weather and climate. Topics include atmospheric structure, composition, circulation and energy properties; severe weather events such as cyclones, hurricanes, and tornadoes; ozone depletion; natural climate variability; climate change and global warming. Instructor: Li. 1 unit.

390. Special Topics in Earth and Ocean Sciences. Content to be determined each semester. Consent of instructor required. Instructor: Staff. 1 unit.

391. Independent Study. Directed reading or individual projects. Term paper required. Open only to qualified students by consent of director of undergraduate studies and supervising instructor. Instructor: Staff. 1 unit.

392. Independent Study. See Earth and Ocean Sciences 391. Term paper required. Open to qualified students by consent of director of undergraduate studies and supervising instructor. Instructor: Staff. 1 unit.
Courses of Instruction

393. Research Independent Study. Individual research in a field of special interest under the supervision of a faculty member, the central goal of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to qualified students by consent of director of undergraduate studies and supervising instructor. Instructor: Staff. 1 unit.

394. Research Independent Study. See Earth and Ocean Sciences 393. Open to qualified students by consent of director of undergraduate studies and supervising instructor. Instructor: Staff. 1 unit.

402S. Volcanology: Geology of Hawaii. Geology of volcanic processes and the benefits and hazards they present to society. Lectures, discussion and student presentations of independent research reports. Required field trip to Hawaii during spring break. Prerequisite: Earth and Ocean Sciences 101 recommended. Consent of instructor required. Instructor: Boudreau. 1 unit.

403. Geology and Natural History of the Yellowstone Region. This course is a laboratory and field-trip based examination of the geological history of Yellowstone Country. We will look at the formation and deformational history of the Wyoming Thrust Belt, the volcanic history of the Absaroka Range, the dramatic activity and influence of the arrival of the Yellowstone Hotspot during the Pleistocene (and present day), the complex tectonic and world-famous glacial history of the Grand Tetons, and learn about the unique Eocene lacustrine and fluvial settings of the Wyoming Fossil Basin. Instructor: Glass. 1 unit.

410S. Senior Capstone Experience. Senior capstone field trip course. Field location varies. Topics in geology, hydrology, biology, climate, and other environmental subjects as appropriate for field area, especially human impact on the earth and the role of earth scientists as observers and teachers of earth-system change. Course content partially determined by students. Prerequisites: Open only to senior Earth and Ocean Sciences majors. Department consent required. Instructor: Dwyer. 1 unit.

507S. The Amazon: Geology, Climate, Ecology, and Future Change. This course will study the natural history of the Amazon including its biodiversity, geological evolution, and modern climate and hydrology. The present development of the Amazon and best strategies for its future conservation will be discussed. Instructor: Baker. 3 units.


509S. Paleoclimate. Nature and mechanisms of climate variability throughout Earth history. Topics include general theory of climate, paleoclimate modeling and comparisons with observations, methodologies of reconstructing past climate variations, the observational record of paleoclimate extending from the Precambrian through the Ice Ages and Holocene to present, and the impact paleoclimate on biotic evolution/paleogeography and human cultural history. Consent of instructor required. Instructor: Baker. 3 units.

510S. Paleoenvironmental Analysis. Methods of paleoenvironmental and paleoclimatic analysis. Includes radiometric and other methods of dating, stable isotopes, trace elements, paleobiotic and other methods of reconstructing climate, hydrology and environment of the past. Also includes approaches to modeling paleoenvironmental data. Instructor: Baker. 3 units.

511. The Climate System. Components of the climate system: observed climate change, concept of energy balance, basic circulation of the atmosphere and ocean, introduction to climate models, sample applications of climate models, interactions between the atmosphere/ocean/and biosphere, land surface, cryosphere (snow and ice), and chemistry of the atmosphere. Prerequisite: consent of instructor. Instructor: Li. 3 units.

512. Climate Change and Climate Modeling. Course aims to provide knowledge and understanding of physics of climate system and Earth system modeling for scientists, engineers and policy students with physics and mathematics background. Fundamental principles controlling physical and dynamic structure of climate system; discussion of relative roles of natural climate variability and external forces and anthropogenic influences. Explore numerical methods, develop computing skills, and deal with data handling as a means to an end of quantifying climate system behavior. Prerequisite: Earth and Ocean Sciences 511. Instructor: Li. 3 units.

513. Groundwater and the Environment. An introduction to the principles of groundwater flow, development, and protection, with an emphasis on aquifer and groundwater evaluation and management. Topics include: baseflow analyses; stream-groundwater interactions; aquifer and vadose zone characterization; groundwater hydraulics and recharge; field hydrogeological data; groundwater modeling; water quality; and groundwater management. Open only to students who have taken at least one college-level natural science course (e.g., earth science, chemistry, physics, biology). Instructor: Staff. 3 units. C-L: Environment 513

515. Mountain Ecohydrology Field Course - Montana. Study of watershed ecohydrology and the interactions and feedback among hydrological and ecological processes in the western United States. Includes required pre-semester week-long field trip to Montana (with required fee), where participants visit active research watersheds, some of the most intensively instrumented ecohydrological research sites in the country. Students learn techniques to collect hydrologic and ecological field data and work with instructors to collect a comprehensive suite of ecohydrological data, to be interpreted and presented during series of follow-up class meetings. Prerequisite: General background in Earth and Environmental Sciences. Instructor: McGlynn. 3 units.

520. Introduction to Fluid Dynamics. Conservation equations for mass, momentum and heat, with an emphasis on large temporal and spatial scales; application to the earth, ocean, and environmental sciences. Some background in differential equations highly recommended. Instructor: Lozier. 3 units.

524. Water Quality Health. Explore basic concepts of water quality and human health with focus on the global water cycle, global water demand and availability, chemical properties of water, contaminants in water, health implications, and environmental isotope hydrology. Highlights relationships between human activities, water scarcity, water quality degradation, and ecological and health consequences. Addresses some policy implications related to conflicts over water resources and impact of energy production on water resources. Prerequisites: prior knowledge of introductory calculus and chemistry or consent of instructor. Instructor: Vengosh. 3 units. C-L: Environment 524, Global Health 534, Energy 524

525. Fundamentals of Water Biogeochemistry and Pollution. Course is designed to present students with a comprehensive introduction to the sources and impacts of pollution in marine and freshwater environments. Fundamental concepts and principles of aquatic
biogeochemistry will first be introduced: marine and freshwater chemistry, primary production and food webs. Topics to be covered include biological (e.g., pathogens, invasive species), physical (e.g., thermal, plastics), and chemical (e.g., nutrient loading, oil, pesticides, metals) pollutants. Instructor: Cassar. 3 units.

5265. Water Forum Speaker Series. Seminar including visiting scholars covering a broad array of issues on water including water quality, hydrogeology, biogeochemistry, water management, water treatment, ecology, water economy, and water policy and law at both the national and international levels. Instructor: Vengosh. 3 units.

527. International Water Resources. Overview of the hydrology, hydrogeology, water quality, and management of major international water resources. Focus on cross-boundary international rivers and aquifers, up-stream versus down-stream water users, the politics of water sharing and disputes, the role of science in water management, and prospects and implications for future utilization of contaminated rivers and stressed aquifers. Examples from international rivers such as the Tigris, Euphrates, Nile, Jordan, Colorado, Indus, Ganges, and Mekong and international aquifer systems such as the Mountain aquifer, Gaza Strip, Disi, and Nubian basins in northern Africa. Instructor: Vengosh. 3 units.

528S. Biological-Physical Couplings in Coastal Environments; Responses to Changing Forcing. Focus on select examples of biological-physical couplings that shape coastal environments (i.e. coastal "ecomorphodynamics") and help determine how those environments respond to changing climate and land use. Environments include: barrier islands, tidal wetlands. Grading based on in-class presentations, and a final project (in the form of a research proposal). Instructor consent required. Instructor: Murray. 3 units.


542S. New Perspectives and Methods in Surface Process Studies. Nonlinear dynamics and related approaches to understanding, modeling, and analyzing physical systems, with emphasis on applications in geomorphology. Consent of instructor required. Instructor: Murray. 3 units.

551S. Global Environmental Change. Topics in the seminar will include climate change, earth surface alteration, prediction, water and carbon cycling, sea-level rise and coastal erosion, biodiversity, fossil fuels and energy resources, water resources, soil fertility, human impact on coastal zone ecosystems. Prerequisite: consent of instructor. Instructor: Baker. 3 units.


573S. Analytic Techniques. An introduction to advanced analytic procedures used in the earth sciences: such as electron microbeam techniques (scanning electron microscopy, electron microprobe analysis) and plasma emission/absorption spectroscopy. Consent of instructor required. Instructor: Boudreau. 3 units.


590. Special Topics in Earth and Ocean Sciences. Content to be determined each semester. Consent of instructor required. Instructor: Staff. Variable credit.

590S. Special Topics in Earth and Ocean Sciences. Content to be determined each semester. Consent of instructor required. Instructor: Staff. Variable credit.

710S. Bio-geomorphology: The Biophysical Processes Shaping the Earth's Surface. Course examines recent literature contributions shedding light on the two-way interactions among the biosphere, the atmosphere, the hydrosphere, and the lithosphere. Emphasis will be placed on the general emergent properties of coupled bio-physical systems, such as multistability, critical behavior, optimality, etc. Topics will include tidal bio-geomorphology, fluvial eco-hydrology, eco-hydrology of arid ecosystems, coastline dynamics, global biogeochemical cycles. Instructor: Marani. 1 unit.

711S. Cenozoic Climate, Environment, and Mammalian Evolution in the New World. Recent advances in the methodologies of molecular genetics, paleoclimate analysis and modeling, and paleoaltimetry have resulted in a host of important discoveries in their respective fields. How does the evolution of the physical environment (climate, mountain uplift, hydrology, biogeochemistry) influence or, in some cases, even control the biological evolution of mammals. The geographic focus will be on the New World. The temporal focus will extend throughout the entire Cenozoic. Course will bring together a diverse set of scholars across campus to read, discuss, and formulate strategies for future research. Instructor: Baker, Kay, Roth. 3 units. C-L: Biology 710S, Evolutionary Anthropology 711S

715. Introduction to Coastal Environmental Change Processes. Nearshore physical processes responsible for the evolution of beaches and barrier islands. Various problems and possible solutions arising from human development of retreating shorelines. Involves a field trip and research paper. Instructor: Murray. 3 units.

722. Hydrologic and Environmental Data Analysis. Course will focus on acquisition of skills necessary to extract information from observations of hydrological and environmental processes, connect the extracted information with the physical processes generating
the data, and estimate physical quantities at ungauged location/times. Emphasis on process understanding via data analysis techniques. Applications used as a way to understand the general concepts, with examples drawn from water science. Prerequisites: Basic computer skills, Algebra, Calculus are required. Experience with computational software (e.g., Matlab or R) is helpful but not required. Instructor: Marani. 3 units. C-L: Environment 722, Civil and Environmental Engineering 761

7295. The Water–Energy Nexus. Course presents emerging issues related to the water-energy nexus, including unconventional and conventional energy exploration, hydraulic fracturing, coal mining, coal combustion and disposal of coal ash, oil sand, oil shale, hydropower, and others. Reading and critically evaluating published scientific reports as part of the discussion is required. Instructor consent required. Instructor: Vengosh. 1 unit. C-L: Energy 7295

785S. Analyzing Current Contributions in Earth, Atmospheric and Ocean Sciences. Analyzing and discussing journal articles about a range of timely topics across the Earth and ocean sciences. Each paper is associated with the research to be presented by the upcoming speaker in the Earth and Ocean Sciences (EOS) seminar series. Faculty and senior graduate students rotate to provide background lectures needed to understand the paper/seminar, which will expose students to basic concepts from the wide range of research sub-fields represented within the Earth and Ocean Sciences program. Meets twice per week, with one class meeting devoted to each EOS seminar (approximately every second week). Consent of director of graduate studies required. Instructor: Murray. 2 units.

790. Special Topics in Earth and Ocean Sciences. Content to be determined each semester. Consent of instructor required. Instructor: Staff. Variable credit.

790S. Advanced Topics in Geology. Topics, instructors, and credits to be arranged each semester. Instructor: Staff. Variable credit.


890A. Advanced Topics in Earth and Ocean Sciences. To meet the individual needs of graduate students for independent study. Instructor: Staff. Variable credit.

990A. Advanced Topics in Earth and Ocean Sciences. To meet the individual needs of graduate students for independent study. Instructor: Staff. Variable credit.

Economics (ECON)

432S. Environmental Justice: The Economics of Race, Place, and Pollution. Minorities, people of color, and low-income households bear a disproportionate burden from environmental pollution. Since the Clinton Administration, addressing environmental injustice has been among the policy objectives of the Environmental Protection Agency. Course examines how environmental injustices may arise out of discriminatory behavior and/or market forces founded on individual, firm, and government incentives. We begin with the theoretical framework used to document and explain disproportionate exposures, then review existing empirical evidence through case studies and evaluate competing explanations for injustice using an economics framework. Prerequisites: Econ 201D, 205D, 208D. Instructor: Timmins. 1 unit. C-L: Environment 332S

Energy (ENERGY)

231. Energy and the Environment. Overview of the challenges confronting humanity as a consequence of our reliance on energy. Challenges include dwindling supplies, rising demand and environmental degradation. Realistic responses require an understanding of the complexity of the energy system, including energy resources, uses, and impacts, in the context of social, political and economic imperatives. Lectures will be augmented by presentations from guest speakers from industry, government and non-profit organizations. Instructor: Pratson. 1 unit. C-L: see Environment 231; also C-L: Earth and Ocean Sciences 231

310. Introduction to Energy Generation, Delivery, Conversion and Efficiency. An overall introduction to energy issues as they related to generation, delivery, conversion and efficiency. Topics include efficiencies of both new and established energy generation and conversion methods, electricity generation by fossil fuels, nuclear, solar, wind and hydropower and alternative energy technologies. Other topics include space heating and cooling by traditional methods and by solar, transportation energy in automobiles, mass transit and freight. Topics are evaluated quantitatively by modeling and using principles of fluid mechanics, thermodynamics and heat transfer. The environmental consequences of energy choices on local, national and global scales, including toxic emissions, greenhouse gases and resource depletion are also discussed in integrated throughout the course. Prerequisite: Mechanical Engineering 331L, or Mechanical Engineering 512, or Physics 311, or similar thermodynamics, or consent of instructor. One course. C-L: Energy 310. Course is not open to students who have taken Mechanical Engineering 461. Instructors: Cocks and Knight. 1 unit. C-L: see Energy Engineering 310

390. Special Topics in Energy. Topics vary by semester. Instructor: Staff. 1 unit.

395. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an ongoing research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 1 unit.

395–1. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an ongoing research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 0.5 units.
Courses of Instruction
knowledge of model mechanics and experience asking the type of questions needed to evaluate quality of modeling results. Instructor: T. Johnson. 3 units. C-L: see Environment 715L

716L. Modeling for Energy Systems. Introduction to computer programming and operations research in energy systems analysis with emphasis on formulation of optimization problems and simulation models. Applications and case studies dealing with energy systems problems, their externalities, and government policies that affect them. Data analysis, spreadsheet modeling, VBA programming in Excel; linear programming (lp), post-optimality and sensitivity analysis, multi-period lp, stochastic lp, network models for minimum path, maximum flow and optimal planning problems; probabilistic analysis Monte Carlo simulation, including generation of independent and correlated random variables, and goodness of fit tests. Instructor: Patiño-Echeverri. 3 units. C-L: see Environment 716L

727. Energy Law. The course will examine the legal framework governing energy production and consumption in the United States, and policy approaches for balancing energy needs with other societal goals. Instructor: Pickle. 3 units. C-L: see Law 327

729S. The Water–Energy Nexus. Course presents emerging issues related to the water–energy nexus, including unconventional and conventional energy exploration, hydraulic fracturing, coal mining, coal combustion and disposal of coal ash, oil sand, oil shale, hydropower, and others. Reading and critically evaluating published scientific reports as part of the discussion is required. Instructor consent required. Instructor: Vengosh. 1 unit. C-L: see Earth and Ocean Sciences 729S

790-1. Special Topics in Energy. Topics vary by semester. Instructor: Staff. 1.5 units.

795. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 3 units.

795-1. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 3 units.

796. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires substantive paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 1.5 units.

796-1. Connections in Energy: Interdisciplinary Team Projects. Teams of undergraduate and graduate students work with faculty supervisors to identify, refine, explore and develop solutions to pressing energy issues. Teams may also include postdoctoral fellows, visiting energy fellows, and other experts from business, government, and the non-profit sector. A team's work may run in parallel with or contribute to an on-going research project. Teams will participate in seminars, lectures, field work and other learning experiences relevant to the project. Requires final paper or product containing significant analysis and interpretation. Instructor consent required. Instructor: Staff. 3 units.

811. Business and Environment. Theoretical grounding on Sustainable Systems (SS) thinking and overview of national and international frameworks that have led to development and use of sustainable systems modeling, life cycle analysis and policy decision models. Topics include socio-metabolic consumption, sustainability as a field of inquiry, systems thinking, industrial ecology, earth systems engineering, complexity and resiliency. Explore current drivers and implications of sustainable systems with specific focus on nexus of industry and environmental systems including examining cumulative impacts and benefits resulting from shifting supply chains, green engineering, technological designs and consumer behavior. Instructor: Golden. 3 units. C-L: see Environment 811

830. Building Energy on Campus: Evaluating Efficiency and Conservation Measures at Duke. Buildings use more than 40% of the energy consumed in the US, and are a natural target of energy efficiency and conservation measures. Building owners and facility managers, as well as the policy community, are therefore interested in identifying means of reducing energy consumption in the current building stock and taking advantage of the embodied energy already sunk into its construction. Using the campus as a laboratory, course examines energy use in existing Duke buildings. Students will learn about the relationship between building design and energy use, and gain hands-on experience conducting energy audits and evaluating energy saving measures in campus facilities. Instructor: Johnson. 3 units. C-L: see Environment 830

835. Environmental Law. Examination of rapidly growing body of law concerned with interrelationships between human activities and the larger environment. Focus on rationales for environmental protection; risk assessment and priorities. Instructor: Wiener. 3 units. C-L: see Environment 835

891. Topics in Environmental Regulation. In-depth analysis of current issues in environmental regulation. Topics vary. Course may be repeated. Instructor: Benneker. 1.5 units. C-L: see Environment 891

Public Policy Studies (PUBPOL)

280S. Marine Science and Conservation Leadership. Course will explore the complex interactions among science, policy and economics in the use of marine resources and the role individuals play in promoting marine conservation and environmental sustainability. Utilizing case
studies ranging from fisheries to offshore energy, students will evaluate trade-offs systematically and learn to assess how different policy options affect the incentives of resource users. Serves as the capstone for the Marine Science and Conservation Leadership Certificate. Prerequisite: none. Instructor: Dunn. 1 unit. C-L: see Environment 350S

579S. Collective Action, Environment, and Development. Examines the conditions under which collective or participatory decisions may raise welfare in defined ways. Presents the growing empirical evidence for an environment and development setting including common property issues (tragedy of the commons and competing models). Identifies what evidence exists for sharing norms on a background of self-interested strategies. Definitions of and reactions to equity and/or its absence are a focus. Providing scientific information for policy is another. Experimental and behavioral economics are frequently applied. Instructor: Pfaff. 3 units. C-L: Environment 579S.

Courses Taught at the Marine Laboratory

Environment (ENVIRON)

175LA. Marine Biology. Physical and chemical aspects of estuarine and marine ecosystems and environments. Functional adaptations of marine organisms and the role of man and society on the ecosystems. Includes field trips to local environments with an emphasis on impacted environments and their relation to societal activity and policy. For students not majoring in natural sciences. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 1 unit. C-L: see Biology 175LA

270A. Conservation Biology and Policy. Introduction to the key concepts of ecology and policy relevant to conservation issues at the population to ecosystems level. Focus on the origin and maintenance of biodiversity and conservation applications from both the biology and policy perspectives (for example, endangered species, captive breeding, reserve design, habitat fragmentation, ecosystem restoration/rehabilitation). Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology; suggested: a policy and/or introductory ecology course. Instructor: Staff. 1 unit. C-L: see Biology 270A


272A. Analysis of Ocean Ecosystems. The history, utility, and heuristic value of the ecosystem; ocean systems in the context of Odum's ecosystem concept; structure and function of the earth's major ecosystems. Taught in Beaufort at Duke Marine Lab. Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor: Johnson. 1 unit. C-L: see Biology 272A; also C-L: Earth and Ocean Sciences 272A

273LA. Marine Ecology. Factors that influence the distribution, abundance, and diversity of marine organisms, including a survey of the major flora and fauna in the marine environment. Topics include physical characteristics of marine systems, adaptation to environment, species interactions, biogeography, larval recruitment, and biodiversity and conservation of communities found in rocky shores, tidal flats, beaches, marshes, mangrove, coral reefs, and subtidal areas. Lectures, field excursions, lab exercises and an independent project. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer; spring semester offering requires travel to Caribbean. Prerequisite: AP biology, introductory biology, or instructor consent; not open to students who have taken Biology 773LA. Instructor: Silliman. 1 unit. C-L: see Biology 273LA; also C-L: Earth and Ocean Sciences 374LA

275SA. Global Fisheries Conflicts: Exploring Local and Global Economic, Ecological, and Social Impacts. Interdisciplinary investigation of fisheries management. Theoretical and practical policy questions regarding resource allocation measures (e.g., quota systems, marine protected areas, seasonal closures, and gear restrictions) and place-specific conflicts (e.g., over space, regulatory measures, cultural meanings, and livelihoods). Evaluation of fisheries science and examination of economic, ecological, and social ramifications of different management scenarios. Broad overview of the state of fisheries and fishing practices around the globe; in-depth analysis of local science and policy conflicts. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 1 unit.

277LA. Comparative Physiology of Marine Animals. Physiology of marine animals with emphasis on comparisons between marine vertebrates and humans. Focus on physiological processes including gas exchange, circulation, osmoregulation, metabolism, thermoregulation, endocrine, neural control and sensory systems. Lectures and laboratories illustrate the methodology, analysis techniques, and written reporting of physiological research. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer. Prerequisite: AP biology, introductory biology, or consent of the instructor. Instructor: Wise or staff. 1 unit. C-L: see Biology 277LA

280LA. Sound in the Sea: Introduction to Marine Bioacoustics. Fundamentals of marine bioacoustics with a focus on current literature and conservation issues. Topics include: introduction to acoustics; acoustic analysis methods and quantitative tools; production and recording of sound; ocean noise; propagation theory; active and passive acoustics; hearing, sound production and communication in marine organisms, potential impacts of anthropogenic noise; and regulation of marine sound. Labs will focus on methodologies used for generating, recording and analyzing marine sounds. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology, introductory biology, or consent of instructor; Physics 141L or 161L (or equivalent Physics courses) or consent of instructor. Instructor: Nowacek. 1 unit. C-L: Electrical and Computer Engineering 384LA, Earth and Ocean Sciences 280LA, Biology 279LA

286A. Marine Policy. Policy and policy-making concerning the coastal marine environment. History of marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Use of theoretical and methodological perspectives, including political science, sociology, and economics. Taught in Beaufort at Duke Marine Lab. Instructor: Murray. 1 unit. C-L: Public Policy 281A

287A. Marine Conservation Service-Learning Course: Challenges at Sea. Introduction to marine conservation biology emphasizing community outreach at local middle schools. Material focuses on issues in marine conservation and how they are addressed. Lectures cover
principles of conservation, biodiversity, extinction risks, genetic tools, fishery by-catch, over-exploitation, habitat degradation, invasive species, climate change, and marine protected areas. Based on class discussions, students will develop and teach activities that address local conservation topics for middle school students. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Johnston and Schultz. 1 unit.

305SA. Social Impact Analysis. Course covers theoretical, methodological and applied aspects of social impact analysis. Students will think sociologically about environmental issues and social impacts they create. Course reviews key US policies and guidelines that require and inform social impact analysis. Students will understand and critique key methods and approaches used in social impact analysis to generate inclusive decisions that protect the environment and health of human communities that share its abundance and meaning. Course will compare and critique a range of national and international social impact examples, including ethical issues associated with the non-human world. Consent of instructor is required. Taught in Beaufort at Duke Marine Lab. Instructor: Murray. 1 unit.

307A. Barrier Island Ecology, Geology, and Policy. An integration of barrier island ecology with coastal physical processes and geomorphological change. Management and policy relating to impacts of human interference with natural processes including climate change are emphasized. Students conduct original research, which includes data collection in the field and lab processing, to produce a final report. Taught in Beaufort at Duke Marine Lab. Classes and research at both UNC Institute of Marine Sciences (IMS) in Morehead City and nearby Duke University Marine Labs (DUML) in Beaufort so as to maximize field site access to the iconic Outer Banks chain of barrier islands. Prerequisite: a course in ecology or geology or permission of the instructor. Instructor consent required. Instructor: Rodriguez, Fegley, Peterson. 1 unit.

308A. Oceans in Human and Environmental Health. Students will gain a grounding in marine sciences which will help them to evaluate impacts of anthropogenic activities on both marine ecosystems and the humans that rely on them. After developing an understanding of the issues facing environmental and human health and well-being in marine systems, students will travel to Duke Kunshan University in China, to better understand environmental challenges facing a rapidly developing economy. This course will embrace immersive field experiences in both North Carolina and China that will contextualize classroom learning as well as develop connections with environmental practitioners and residents. Taught in Beaufort at Duke Marine Lab. Duke Immerse course. Instructor consent required. Instructor: Hunt. 1 unit. C-L: Global Health 308A, Biology 308A

319A. Aquaculture and the Environment. The major environmental, social and economic drivers of increasing global aquaculture, with a focus on marine systems. Quantitative evaluation and comparison of the range of species for aquaculture, locations where operations occur, operational aspects including environmental impacts and management considerations. Investigation of alternative approaches and potential future areas for aquaculture expansion as well as social, economic and technical barriers to implementation. Taught in Beaufort at Duke Marine Lab. Instructor: Johnson. 1 unit.

321A. Coastal Watershed Science and Policy. Examination of coastal watersheds, their biological function, and how anthropogenic modifications impact wetlands, estuaries and near shore coastal ecosystems. Human ecosystem modifications addressed in terms of alterations caused by forestry, agriculture, highways, rural housing, suburban development, urban development and industry. Discussion of human and environmental health as well as ecosystem services provided by coastal systems (biogeochemical cycling and ‘blue’ carbon). Emphasis placed on gaining an understanding of human impacts on the biology of coastal waters through alteration of the physics, chemistry and geology of coastal waters. Taught in Beaufort at Duke Marine Lab. Instructor: Hunt. 1 unit. C-L: Biology 319A


335LA. Drones in Marine Biology, Ecology, and Conservation. Includes a full overview of past and emerging applications for ecology and biology of marine species and coastal habitats, with in-depth discussion on future of drone applications in coastal biological and ecological research. Comprehensive exploration of current drone technologies, including detection of target species, payloads, aeronautical concepts, rules and regulations, mission planning, aircraft design, maintenance, data collection, management and analysis. Lab components tailored to student interests: active participation in megafaunal or environmental research and data analysis; building, operating and maintaining aircraft, programming for manual and autonomous flight. Taught in Beaufort at Duke Marine Lab. Instructor: Johnston. 1 unit. C-L: Biology 335LA

346A. Marine Conservation Policy - A Practicum. Immersion in marine conservation biology and policy. Experiential learning in maintenance and loss of marine biodiversity; key concepts of social science and law for instituting policy; position papers and stakeholder negotiation focused on ecological, economic, cultural, and institutional complexity associated with priorities for public trust resources. Analyze values, judgments, and preferences inherent in personal and public decision-making processes and competing visions for management and governance of marine resources. Taught in Beaufort at Duke Marine Lab. Prerequisite: Public Policy 155D suggested, or instructor consent. Concurrent enrollment required in Environment 384A/Biology 384A. Instructor: Nowacek. 1 unit. C-L: Public Policy 246A

369LA. Biological Oceanography. Discusses patterns of abundance, diversity and activity of organisms in major ocean ecosystems. Identifies major physical, chemical and ecological processes that affect these patterns, and analyzes impact of biology on ecosystems. Uses a ‘flipped’ classroom for enhanced development of quantitative skills to measure these patterns, emphasizing hands-on data collection and analyses, multiple field trips aboard DUML research vessels, and participatory activities to demonstrate core concepts in biological oceanography. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP biology, introductory biology, or permission of instructor. Instructor: Johnson. 1 unit. C-L: see Biology 369LA; also C-L: Earth and Ocean Sciences 273LA

370A. Physical Oceanography. Fundamental physical principles of ocean circulation. Physical properties of seawater; forces acting on the ocean such as heat, pressure gradients, wind stress, rotation, and friction; and conservation equations for heat, mass and momentum. Applications include geostrophic balances, thermal wind, coastally trapped waves, El Nino/ENSO, and tidal circulation. Taught in Beaufort at Duke Marine Lab. Prerequisite: one year of calculus and one semester of physics, or permission of instructor. Instructor: Hench. 1 unit. C-L: Earth and Ocean Sciences 370A

373LA. Sensory Physiology and Behavior of Marine Animals. Sensory physiological principles with emphasis on visual and chemical
375A. Biology and Conservation of Sea Turtles. Essential biology of sea turtles (evolution, anatomy, physiology, behavior, life history, population dynamics) and their conservation needs; emphasis on their role in marine ecosystem structure and function. Basic ecological concepts integrated with related topics including the conservation and management of endangered species, the contributions of technology to the management of migratory marine species, the role of research in national and international law and policy, and the veterinary aspects of conservation. Taught in Beaufort at Duke Marine Lab. Field trip to Puerto Rico required. Prerequisite: introductory biology. Consent of instructor required. Instructor: Godfrey or Staff. 1 unit. C-L: see Biology 375A

375LA. Biology and Conservation of Sea Turtles. Laboratory version of Biology 375A. Includes laboratory and field experience with animals and with their habitat requirements. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Godfrey or Staff. 1 unit. C-L: see Biology 375LA

376A. Marine Mammals. The biology of cetaceans, pinnipeds, sirenians, and sea otters. Topics covered include the diversity, evolution, ecology, and behavior of marine mammals and their interactions with humans. Detailed consideration given to the adaptations that allow these mammals to live in the sea. Evaluation of the scientific, ethical, and aesthetic factors influencing societal attitudes toward these animals and of their conservation management in light of domestic legislation and international treaties. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Read. 1 unit. C-L: see Biology 376A

376LA. Marine Mammals. Laboratory version of Biology 376A. Laboratory and field exercises consider social organization, behavior, ecology, communication, and anatomy of local bottlenose dolphins. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Read. 1 unit. C-L: see Biology 376LA

377LA. Marine Invertebrate Zoology. Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Biology 777LA. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer. Instructor: Silliman or staff. 1 unit. C-L: see Biology 377LA; also C-L: Earth and Ocean Sciences 377LA

383LA. Marine Molecular Microbiology. Introduction to microbiology from a marine perspective. Topics include microbial phylogeny, evolution, symbiosis, biotechnology, genomics, and ecology. Laboratory will employ modern molecular techniques to investigate the ecology and evolution of prokaryotic and eukaryotic microbes. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology, introductory biology, or permission of instructor. Instructor: Hunt. 1 unit. C-L: Biology 380LA

384A. Marine Conservation Biology - a Practicum. Immersion in marine conservation biology basics for 21st Century society and ‘anthropocene’ epoch including two week-long current issue modules. Phenomena affecting maintenance and loss of biodiversity (climate change, habitat destruction); strategies for combating threats to biodiversity; exploration of this field’s interdisciplinary nature; introduction to key concepts of ecology relevant to conservation issues at the level of populations and ecosystems; unique capstone-position papers and stakeholder negotiation. Taught in Beaufort at Duke Marine Lab. Recommended prerequisite: AP Biology, Biology 202L or 203L, introductory ecology, or instructor consent. Concurrent enrollment required in Environment 346A/Public Policy 246A. Instructor: Nowacek. 1 unit. C-L: Biology 384A


476A. Data and Time Series Analysis in Marine Sciences. This course is designed for students in marine and environmental science disciplines to learn data analysis skills, including analysis techniques and their implementation using MATLAB or R. Topics include: discrete sampling issues, data outlier and rejection tests, interpolation and gridding, error and propagation of uncertainty, coordinate rotations and principal axes, curve fits, regression, bootstrapping, filtering, spectral and harmonic analysis, spatial analyses. Other topics may be included or substituted depending on student interests. The course is structured as mix of weekly lectures and linked workshops applying methods to marine and environmental data sets. Taught in Beaufort at Duke Marine Lab. Instructor consent is required. Instructor: Hench. 1 unit.

501A. Environmental Toxicology. An introduction to the field of environmental toxicology. Study of environmental contaminants from a broad perspective encompassing biochemical, ecological, and toxicological principles and methodologies. Discussion of sources, environmental transport and transformation phenomena, accumulation in biota and ecosystems. Impacts at various levels of organization, particularly biochemical and physiological effects. Taught in Beaufort at Duke Marine Lab. Prerequisite: organic chemistry and an upper-level biology course, or consent of instructor. Instructor: Meyer, Di Giulio. 3 units.

504A. Marine Protected Area Monitoring and Management. An interdisciplinary course that addresses concepts, issues, and approaches relevant to marine protected areas (MPAs) and their impacts on marine ecosystems and coastal people. Course will address key topics on MPA design, implementation, management, monitoring, and evaluation. Attention will be given to sensitive marine ecosystems (e.g., coral
recess) and resource-dependent fishing and tourism communities. Using real-world case studies, students will apply introduced concepts and quantitative approaches to questions on MPA monitoring and evaluating their impacts. Students will engage with the course material primarily through group discussions, problem sets, and lectures. Taught in Beaufort at Duke Marine Lab. Instructor: Gill. 3 units.

**512A. Deep-Sea Science and Environmental Management.** Explores ecosystems in the deep sea, including fundamental aspects of geology, chemistry, and biodiversity; behavioral, physiological, and biochemical adaptations of organisms (primarily invertebrate, but may include microbial and vertebrate components) to deep-sea benthic and benth-pelagic environments will be introduced. Students will gain an understanding of the ecosystem services of the deep sea; issues in deep-sea environmental management arising from exploitation of deep-sea resources will be discussed. Taught in Beaufort at Duke Marine Lab. Instructor: Van Dover. 3 units.

**528SA. Community-Based Marine Conservation in the Gulf of California.** Experiential education course on community-based conservation. Students learn first-hand about the challenges (accomplishments, failures, and promises) involved in its design and practice in developing countries of high biological diversity. Learn about the unique natural and political history, and social characteristics of the places where conservation takes place. Students link local context to broader perspectives through key readings and class discussions. Taught in Beaufort at Duke Marine Lab. Travel to biodiversity hotspots in the Gulf of California required. Consent of instructor required. Instructor: Basurto. 3 units.

**533A. Marine Fisheries Policy.** Principles, structure, and process of public policy-making for marine fisheries. Topics include local, regional, national, and international approaches to the management of marine fisheries. A social systems approach is used to analyze the biological, ecological, social, and economic aspects of the policy and management process. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 3 units.

**551DA. International Conservation and Development.** Interrelated issues of conservation and development. Topics include the evolution of the two concepts and of theories regarding the relationship between them, the role of science, values, ethics, politics and other issues in informing beliefs about them, and strategies for resolving conflicts between them. While attention will be given to all scales of interaction (i.e. local, regional, national, international), the focus will be on international issues and the ‘north-south’ dimensions of the conservation and development dilemma. Examples from marine and coastal environments will be highlighted. Consent of instructor required. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. Variable credit.

**570LA-2. Marine Ecology of the Pacific Coast of California.** Ecology of the rocky intertidal, kelp forest, and mud flat habitats. Introduction to marine mammals, fish and other large West Coast vertebrates. Taught in Beaufort at Duke Marine Lab, with preparation for fieldwork before and analysis and presentation of projects after required one-week intensive field experience on the coast of Northern California. Prerequisite: introductory course in biology or environmental science and consent of instructor. Instructor: Johnson. 2 units. C-L: see Biology 570LA-2


**573A. Coastal and Marine Pollution.** Sources, fate, and effects of organic, inorganic, and particulate pollutants in the marine environment. Topics include oil spills, coastal eutrophication, marine debris, harmful algae, sewage contamination, dredging, and emerging contaminants. Methods for measuring pollution in the marine environment and consequences for human and ecological health will be discussed. Case studies of impacted marine environments will be highlighted. Short local field trips possible. Taught in Beaufort at Duke Marine Lab. Recommended prerequisite: introductory chemistry and biology, or consent of instructor. Instructor: Ferguson. 3 units.

**579LA. Biological Oceanography.** Physical, chemical, and biological processes of the oceans, emphasizing special adaptations for life in the sea and factors controlling distribution and abundance of organisms. Four units (spring); six units (summer). Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Johnson. Variable credit. C-L: Biology 579LA, Earth and Ocean Sciences 579LA

**590A. Duke-Administered Study Away: Special Topics.** Content to be determined each semester. May be repeated. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. Variable credit.

**590LA. Duke-Administered Study Away: Special Topics.** Content to be determined each semester. May be repeated. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 4 units.

**590SA. Seminar in Ocean Sciences.** Biological, chemical, physical, and geological aspects of the ocean and their relation to environmental issues. Consent of instructor required. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. Variable credit.

**615A. Aquaculture and the Environment.** The major environmental, social and economic drivers of increasing global aquaculture, with a focus on marine systems. Quantitative evaluation and comparison of the range of species for aquaculture, locations where operations occur, operational aspects including environmental impacts and management considerations. Investigation of alternative approaches and potential future areas for aquaculture expansion as well as social, economic and technical barriers to implementation. Taught in Beaufort at Duke Marine Lab. Instructor: Johnson. 3 units.

**658A. Applied Qualitative Research Methods.** Broadly covers qualitative and mixed methods research design, analysis, and interpretation. Students gather a limited amount of their own data and produce a pilot research project throughout the semester. Students learn to use NVivo10, a qualitative research software program. Taught in Beaufort at Duke Marine Lab. Instructor: C. Clark. 3 units.

**704LA. Biological Oceanography.** Discusses patterns of abundance, diversity and activity of organisms in major ocean ecosystems. Identifies major physical, chemical and ecological processes that affect these patterns, and analyzes impact of biology on ecosystems. Uses a ‘flipped’ classroom for enhanced development of quantitative skills to measure these patterns, emphasizing hands-on data collection and analyses, multiple field trips aboard DUML research vessels, and participatory activities to demonstrate core concepts in biological oceanography. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP biology, introductory biology, or permission of instructor. Graduate section will include experimental design component. Instructor: Johnson. 4 units. C-L: see Biology 704LA; also C-L: Earth and Ocean Sciences 704LA.
Courses of Instruction

**705A. Social Impact Analysis.** This course covers the theoretical, methodological and applied aspects of social impact analysis. Students will think sociologically about environmental issues and the social impacts they create. The course reviews key US policies and guidelines that require and inform social impact analysis. Students will understand and critique key methods and approaches used in social impact analysis to generate inclusive decisions that protect the environment and the health of the human communities that share its abundance and meaning. The course will compare and critique a range of national and international social impact examples, including the ethical issues associated with the non-human world. Taught in Beaufort at Duke Marine Lab. Instructor: Murray. 3 units.

**709A. Conservation Biology and Policy.** Introduction to the key concepts of ecology and policy relevant to conservation issues at the population to ecosystems level. Focus on the origin and maintenance of biodiversity and conservation applications from both the biology and policy perspectives (for example, endangered species, captive breeding, reserve design, habitat fragmentation, ecosystem restoration/ rehabilitation). Open to undergraduates only under Biology 270A. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology; suggested: a policy and/or introductory ecology course. Instructors: Nowacek. 3 units.

**719A. Aquaculture and the Environment.** The major environmental, social and economic drivers of increasing global aquaculture, with a focus on marine systems. Quantitative evaluation and comparison of the range of species for aquaculture, locations where operations occur, operational aspects including environmental impacts and management considerations. Investigation of alternative approaches and potential future areas for aquaculture expansion as well as social, economic and technical barriers to implementation. Taught in Beaufort at Duke Marine Lab. Instructor: Johnston. 3 units.

**735A. Drones in Marine Biology, Ecology, and Conservation.** Lab-based version of Environment 735LA. Taught in Beaufort at Duke Marine Lab. Instructor: Johnston. 3 units.

**735LA. Drones in Marine Biology, Ecology, and Conservation.** Includes a full overview of past and emerging applications for ecology and biology of marine species and coastal habitats with in-depth discussion on future of drone applications in coastal biological and ecological research. Comprehensive exploration of current drone technologies, including detection of target species, payloads, aeronautical concepts, rules and regulations, mission planning, aircraft design, maintenance, data collection, management and analysis. Lab components tailored to student interests: Active participation in megafaunal or environmental research and data analysis. Building, operating and maintaining aircraft, programming for manual and autonomous flight. Taught in Beaufort at Duke Marine Lab. Instructor: Johnston. 4 units.

**745A. Climate Change in the Marine Environment.** Exploration of climate change science focusing on marine ecosystems and inhabitants—specifically ocean acidification, warming and sea level rise. Factors causing climate change, and how those vary spatially, focusing on sensitive polar ecosys and mar mammal populations. Critical examination of climate change modeling using EdGCM (research-grade Global Climate Model), focusing on how scientists use models, observations/theory to predict climate, and assumptions/uncertainty implicit in modeling. Discussion of potential human impacts, including consequences of sea level rise and potential increases in disease due to climate change. Taught in Beaufort at Duke Marine Lab. Grad students responsible for research paper. Instructor: Johnston. 3 units.

**753LA. Sensory Physiology and Behavior of Marine Animals.** Sensory physiological principles with emphasis on visual and chemical cues. Laboratories will use behavior to measure physiological processes. Only open to undergraduates under Biology 373LA. Taught in Beaufort at Duke Marine Lab. Instructor: Johnston. 3 units.

**754A. Research Design for Environmental Social Sciences.** Examination of the concept of research (philosophy, epistemology, practice) along with methods used widely in the social sciences. Focus is on qualitative methods, and related research ethics, objectives, design, data collection, analysis, and presentation. Consideration of the relevance and utility of qualitative research methods for understanding human uses, values, interactions, and beliefs about the environment. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology and chemistry. Instructor: Rittschof. 4 units.

**756A. Spatio-Temporal Environmental Models.** Spatio-temporal models are now being widely used for inference on environmental data. This course will consist of weekly topics with readings of new literature and application of models and software to data sets. We will specifically focus on spBayes in R. Students will each volunteer to lead one week, track down and distribute a data set, set up a model and provide a short demo on computation. Taught in Beaufort at Duke Marine Lab. Online course. Instructor: Clark. 2 units.

**770A. Physical Oceanography.** Fundamental physical principles of ocean circulation. Physical properties of seawater; forces acting on the ocean such as heat, pressure gradients, wind stress, rotation, and friction; and conservation equations for heat, mass and momentum. Applications include geostrophic balances, thermal wind, coastally trapped waves, El Nino/ENSO, and tidal circulation. Taught in Beaufort at Duke Marine Lab. Prerequisite: prior course work in calculus and physics or permission of instructor. Instructor: Hench. 3 units.

**773A. Marine Ecology.** Ecology from a policy and management perspective. Recitations and discussions target a policy- and management-oriented graduate audience. Lecture topics include factors that influence the distribution, abundance and diversity of marine organisms, characteristics of marine habitats, adaptation to environment, species interactions, biogeography, larval recruitment, and communities found in rocky shore, tidal flats, beached, mangrove, coral reefs and subtidal areas. Recitations and discussions cover ecological principles form a policy and management perspective. Not open to students who have taken Biology 273LA and not open to undergraduates. Taught in Beaufort at Duke Marine Lab. Recommended prerequisite: introductory biology. Instructor: Silliman or staff. 4 units. C-L: see Biology 773A

**773LA. Marine Ecology.** Factors that influence the distribution, abundance, and diversity of marine organisms. Course structure integrates lectures, field excursions, lab exercises and an independent project. Lecture topics include physical characteristics of marine systems, adaptation to environment, species interactions, biogeography, larval recruitment, and biodiversity and conservation of communities found in rocky shores, tidal flats, beaches, marshes, mangrove, coral reefs, and subtidal areas. Not open to students who have taken Biology 273LA. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer. (Spring enrollment requires travel to Caribbean.) Grad students submit literature review. Prerequisite: introductory biology. Instructor: Silliman or staff. 4 units. C-L: see Biology 773LA

**776A. Marine Mammals.** Ecology, social organization, behavior, acoustic communication, and management issues. Focused on marine mammals in the southeastern United States (for example, bottlenose dolphin, right whale, West Indian manatee). Only open to
undergraduates under Biology 376A. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Read. 3 units.

776LA. Marine Mammals. Laboratory version of Environment 776LA. Laboratory exercises consider social organization and acoustic communication in the local bottlenose dolphin population. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Read. 4 units.

777A. Biology and Conservation of Sea Turtles. Essential biology of sea turtles (evolution, anatomy, physiology, behavior, life history, population dynamics) and their conservation needs, emphasizing their role in marine ecosystem structure and function. Will integrate basic ecological concepts with related topics including conservation and management of endangered species, contributions of technology to management of migratory marine species, role of research in national and international law and policy, and veterinary aspects of conservation. Taught in Beaufort at Duke Marine Lab. Field trip to Puerto Rico is required. Instructor permission is required. Prerequisite: introductory biology. Instructor: Godfrey or staff. 3 units.

777LA. Biology and Conservation of Sea Turtles. Biology including the anatomy, physiology, behavior, life histories, and population dynamics of sea turtles linked to conservation issues and management. Focus on threatened and endangered sea turtle species, with special attention to science and policy issues in United States waters. Includes field experience with the animals and with their habitat requirements. Sea turtle assessment and recovery efforts, fishery-turtle interactions, population modeling and state/national/international management requirements. Only open to undergraduates under Biology 375LA. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Godfrey or staff. 4 units.

778LA. Comparative Physiology of Marine Animals. Physiology of marine animals with emphasis on comparisons between marine vertebrates and humans. Focus on physiological processes including gas exchange, circulation, osmoregulation, metabolism, thermoregulation, endocrine, neural control and sensory systems. Lectures and laboratories illustrate the methodology, analysis techniques, and written reporting of physiological research. Open to undergraduates only under Biology or Environment 278LA. Four units (fall, spring); six units (summer). Taught in Beaufort at Duke Marine Lab. Instructor: Wise or staff. 4 units. C-L: see Biology 778LA

784LA. Sound in the Sea: Introduction to Marine Bioacoustics. Fundamentals marine bioacoustics with focus on current literature and conservation issues. Topics include: intro acoustics; acoustic analysis methods and quantitative tools; production/recording of sound; ocean noise; propagation theory; active/passive acoustics; hearing, sound production and communication in marine organisms, potential impacts of anthropogenic noise; and regulation of marine sound. Lab focus on methodologies for generating, recording and analyzing marine sounds. Grad students responsible for additional acoustic analyses and results prep for student projects plus preparation additional lit review/critique. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP or introductory biology or consent; Physics 41L or 161L (or equivalent) or consent. Instructor: Nowacek. 4 units. C-L: see Biology 784LA, Electrical and Computer Engineering 784LA

786A. Marine Policy (A). Formal study of policy and policy-making concerning the coastal marine environment. History of specific marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Topics explored through use of theoretical and methodological perspectives, including political science, sociology, and economics. Consent of instructor required. Taught in Beaufort at Duke Marine Lab. Instructor: Murray. 3 units. C-L: Public Policy 849A, Political Science 707A

787A. Analysis of Ocean Ecosystems. The history, utility, and heuristic value of the ecosystem; ocean systems in the context of Odum's ecosystem concept; structure and function of the earth's major ecosystems. Open to undergraduates only under Biology 272A. Taught in Beaufort at Duke Marine Lab. Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor: Johnson. 3 units.

788LA. Marine Invertebrate Zoology. Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Biology 377LA or Biology 777LA. Open to undergraduates only under Biology 377LA. Four credits (fall, spring); six credits (Summer Term III); six credits (Summer Term I). Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology, introductory biology, or consent of instructor. Instructor: Van Dover or Staff. 4 units. C-L: Biology 777LA

790A. Duke-Administered Study Away: Special Topics. Content to be determined each session. Instructor: Staff. Variable credit.

790SA. Duke-Administered Study Away: Special Topics. Content to be determined each session. Instructor: Staff. Variable credit.

822A. Coastal Watershed and Policy. Examine hydrology of coastal watersheds and how watersheds modifications impact estuaries and near shore coastal ecosystems. Hydrologic functioning of natural unaltered watersheds is contrasted with changes caused by man's modification of those systems. Include discussion of efforts to remedy impacts through installation of Best Management Practices and wetlands restoration. Emphasis on gaining understanding of what the impacts of hydrologic change are on biology of coastal waters as watershed development alters the physics, chemistry, and geology of coastal waters. Includes field trips to watersheds in coastal North Carolina. Taught in Beaufort at Duke Marine Lab. Instructor: Read. 3 units.

824A. Marine Conservation Biology. Introduction to marine conservation in a small island context with an exploration of how traditional and modern methods play out in practice. Most of the course will be taught in Palau, where students will meet traditional chiefs, fishers, state governors, NGO practitioners, scientists and politicians to hear their perspectives on marine conservation. The course will focus on the theory and practice of marine conservation, as exemplified by case studies in traditional management, marine protected areas, conservation of protected species and ecotourism. Taught in Beaufort at Duke Marine Lab. Trip to Palau required. Permission required. Instructor: Read. 3 units.

825LA. Marine Molecular Microbiology. Covers a broad overview of the ecological and biogeochemical role that microbes play in marine environments. Lab exercises focus on applying molecular techniques to the study of microbial ecology. Taught in Beaufort at Duke Marine Lab. Instructor: Hunt. 3 units.

849A. Doctoral Student Seminar and Professional Development. Addresses topics of relevance to the professional development of PhD students in the Marine Science Conservation program. Topics addressed include: the nature of inter-disciplinary research, critical reading, grant writing, communicating results to the public, mentoring students, and preparing manuscripts for academic journals. Taught in Beaufort at Duke Marine Lab. Instructor: Campbell. 2 units.
860SA. Political Ecology. Seminar to examine concept of political ecology as means of conceptualizing conservation and development conflicts and solutions. Intended to engage students with political ecology to strengthen usefulness, enrich possibilities, and improve participants ongoing research, collaborations and critical inquiries. Enrollment limited to graduate students. Taught in Beaufort at Duke Marine Lab. Instructor: Campbell. 3 units.

865SA. College Teaching and Course Design. Designed for graduate students seeking to teach an independent course at Duke and beyond; topics include models of course design, syllabus construction, critical thinking, college student development, clarifying learning objectives, variety in assignments, and classroom assessment techniques. Taught in Beaufort at Duke Marine Lab. Instructor: Campbell. 3 units.

876A. Data and Time Series Analysis in Marine Sciences. Analysis of environmental time-series and other data sets. Topics include discrete sampling issues, data rejection and interpolation, coordinate rotations and principal axes, curve fits, regression, error and propagation of uncertainty, bootstrapping, filtering, spectral analysis, harmonic analysis, EOFs, wavelets. Lectures, workshops and homework assignments will apply these methods to environmental data sets. Each student will complete a final project, applying methods covered in class to data sets they choose, as part of or related to their research. Taught in Beaufort at Duke Marine Lab. Consent of instructor required. Instructor: Hench. 4 units.

878A. Current Topics in Marine Biology. PhD-level reading seminar to review current literature in marine biology focusing on basic ecological principles. Course will satisfy the "Current Topics" requirement in the Marine Biology track of the Marine Science and Conservation PhD degree. Students will rotate presenting primary literature on current week’s topic. Although based on current primary literature, relevant classic articles will be included. Discussion will place articles in the broader context of evolution, ecology and biogeochemistry. Taught in Beaufort at Duke Marine Lab. Instructor: Schultz. 1 unit.

886A. Current Topics in Marine Conservation. Discussion of a topic of interest chosen by students with guidance from instructors. Topic is discussed from a social and natural science perspective. Open only to PhD students. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 2 units.

887A. Theory and Methods for Policy Analysis of the Commons. Survey course of main theories and methods used by scholars to understand how collective action problems and different institutional arrangements affect how common-pool resources and public goods are governed. Students are asked to design a project that incorporates some of the concepts and methodological approaches learned in class. Taught in Beaufort at Duke Marine Lab. Instructor: Basurto. 3 units.


Biology (BIOLOGY)


201LA. Gateway to Biology: Molecular Biology. Introduces major concepts in biology through the lens of molecular biology. Molecular mechanisms that comprise the Central Dogma and variants. DNA structure and function, replication, transcription, and translation. Protein synthesis, folding, structure and function. Supporting topics related to the structure of cells, metabolism and energetics. Integration of physical and quantitative principles to molecular biology. Relevance to human diseases and biotechnology industry. Laboratory includes an introduction to recombinant DNA technology. Prerequisite: Chemistry 21, 21L, 101DL, 110DL, or 201DL. Not open to students who have taken or are currently enrolled in Biology 203L. Taught in Beaufort at Duke Marine Lab. Instructor: Schultz. 1 unit.


270A. Conservation Biology and Policy. Introduction to the key concepts of ecology and policy relevant to conservation issues at the population to ecosystems level. Focus on the origin and maintenance of biodiversity and conservation applications from both the biology and policy perspectives (for example, endangered species, captive breeding, reserve design, habitat fragmentation, ecosystem restoration/ rehabilitation). Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology; suggested: a policy and/or introductory ecology course. Instructor: Staff. 1 unit. C-L: Environment 270A

272A. Analysis of Ocean Ecosystems. The history, utility, and heuristic value of the ecosystem; ocean systems in the context of Odum’s ecosystem concept; structure and function of the earth’s major ecosystems. Taught in Beaufort at Duke Marine Lab. Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor: Johnson. 1 unit. C-L: Environment 272A, Earth and Ocean Sciences 272A

273LA. Marine Ecology. Factors that influence the distribution, abundance, and diversity of marine organisms, including a survey of the major flora and fauna in the marine environment. Topics include physical characteristics of marine systems, adaptation to environment, species interactions, biogeography, larval recruitment, and biodiversity and conservation of communities found in rocky shores, tidal flats, beaches, marshes, mangrove, coral reefs, and subtidal areas. Lectures, field excursions, lab exercises and an independent project. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer; spring semester offering requires travel to Caribbean. Prerequisite: AP biology, introductory biology, or instructor consent; not open to students who have taken Biology 773LA. Instructor: Silliman. 1 unit. C-L: Environment 273LA, Earth and Ocean Sciences 374LA

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278LA. Comparative Physiology of Marine Animals. Physiology of marine animals with emphasis on comparisons between marine vertebrates and humans. Focus on physiological processes including gas exchange, circulation, osmoregulation, metabolism, thermoregulation, endocrine, neural control and sensory systems. Lectures and laboratories illustrate the methodology, analysis techniques, and written reporting of physiological research. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer. Prerequisite: AP biology, introductory biology, or consent of the instructor. Instructor: Wise or staff. 1 unit. C-L: Environment 278LA

279LA. Sound in the Sea: Introduction to Marine Bioacoustics. Fundamentals of marine bioacoustics with a focus on current literature and conservation issues. Topics include: introduction to acoustics; acoustic analysis methods and quantitative tools; production and recording of sound; ocean noise; propagation theory; active and passive acoustics; hearing, sound production and communication in marine organisms, potential impacts of anthropogenic noise; and regulation of marine sound. Labs will focus on methodologies used for generating, recording and analyzing marine sounds. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology, introductory biology, or consent of instructor; Physics 141L or 161L (or equivalent Physics courses) or consent of instructor. Instructor: Nowacek. 1 unit. C-L: see Environment 280LA; also C-L: Electrical and Computer Engineering 384LA, Earth and Ocean Sciences 280LA

293A. Research Independent Study. Individual research in a field of special interest, under the supervision of a faculty member the major product of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. May be repeated. Continued in Biology 493A. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 1 unit.

293A-1. Research Independent Study. Individual research and reading in a field of special interest, under the supervision of a faculty member, resulting in a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to all qualified students with consent of supervising instructor and director of undergraduate studies. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 0.5 units.

308A. Oceans in Human and Environmental Health. Students will gain a grounding in marine sciences which will help them to evaluate impacts of anthropogenic activities on both marine ecosystems and the humans that rely on them. After developing an understanding of the issues facing environmental and human health and well-being in marine systems, students will travel to Duke Kunshan University in China, to better understand environmental challenges facing a rapidly developing economy. This course will embrace immersive field experiences in both North Carolina and China that will contextualize classroom learning as well as develop connections with environmental practitioners and residents. Taught in Beaufort at Duke Marine Lab. Duke Immerse course. Instructor consent required. Instructor: Hunt. 1 unit. C-L: see Environment 308A; also C-L: Global Health 308A

319A. Coastal Watershed Science and Policy. Examination of coastal watersheds, their biological function, and how anthropogenic modifications impact wetlands, estuaries and near shore coastal ecosystems. Human ecosystem modifications addressed in terms of alterations caused by forestry, agriculture, highways, rural housing, suburban development, urban development and industry. Discussion of human and environmental health as well as ecosystem services provided by coastal systems (biogeochemical cycling and "blue" carbon). Emphasis placed on gaining an understanding of human impacts on the biology of coastal waters through alteration of the physics, chemistry and geology of coastal waters. Taught in Beaufort at Duke Marine Lab. Instructor: Hunt. 1 unit. C-L: see Environment 321A


335LA. Drones in Marine Biology, Ecology, and Conservation. Includes a full overview of past and emerging applications for ecology and biology of marine species and coastal habitats, with in-depth discussion on future of drone applications in coastal biological and ecological research. Comprehensive exploration of current drone technologies, including detection of target species, payloads, aeronautical concepts, rules and regulations, mission planning, aircraft design, maintenance, data collection, management and analysis. Lab components tailored to student interests: active participation in meagafaunal or environmental research and data analysis; building, operating and maintaining aircraft, programming for manual and autonomous flight. Taught in Beaufort at Duke Marine Lab. Instructor: Johnston. 1 unit. C-L: see Environment 335LA

368A. Deep-Sea Science and Environmental Management. Explores ecosystems in the deep sea, including fundamental aspects of geology, chemistry, and biodiversity; behavioral, physiological, and biochemical adaptations of organisms (primarily invertebrate, but may include microbial and vertebrate components) to deep-sea benthic and benthico-pelagic environments will be introduced. Students will gain an understanding of the ecosystem services of the deep sea; issues in deep-sea environmental management arising from exploitation of deep-sea resources will be discussed. Taught in Beaufort at Duke Marine Lab. Recommended prerequisite: introductory biology (Biology 20, 20L, 202L, or 203L or equivalent). Instructor: Van Dover. 1 unit.

369LA. Biological Oceanography. Discusses patterns of abundance, diversity and activity of organisms in major ocean ecosystems. Identifies major physical, chemical and ecological processes that affect these patterns, and analyzes impact of biology on ecosystems. Uses a 'flipped' classroom for enhanced development of quantitative skills to measure these patterns, emphasizing hands-on data collection and analyses, multiple field trips aboard DUML research vessels, and participatory activities to demonstrate core concepts in biological oceanography. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP biology, introductory biology, or permission of instructor. Instructor: Johnson. 1 unit. C-L: Environment 369LA, Earth and Ocean Sciences 273LA

373LA. Sensory Physiology and Behavior of Marine Animals. Sensory physiological principles with emphasis on visual and chemical cues. Laboratories will use behavior to measure physiological processes. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology or introductory biology or consent of instructor and Chemistry 101DL. Instructor: Rittschof. 1 unit. C-L: Neuroscience 381LA, Environment 373LA
375A. Biology and Conservation of Sea Turtles. Essential biology of sea turtles (evolution, anatomy, physiology, behavior, life history, population dynamics) and their conservation needs; emphasis on their role in marine ecosystem structure and function. Basic ecological concepts integrated with related topics including the conservation and management of endangered species, the contributions of technology to the management of migratory marine species, the role of research in national and international law and policy, and the veterinary aspects of conservation. Taught in Beaufort at Duke Marine Lab. Field trip to Puerto Rico required. Prerequisite: introductory biology. Consent of instructor required. Instructor: Godfrey or Staff. 1 unit. C-L: Environment 375A

375LA. Biology and Conservation of Sea Turtles. Laboratory version of Biology 375A. Includes laboratory and field experience with animals and with their habitat requirements. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Godfrey or Staff. 1 unit. C-L: Environment 375LA

376A. Marine Mammals. The biology of cetaceans, pinnipeds, sirenians, and sea otters. Topics covered include the diversity, evolution, ecology, and behavior of marine mammals and their interactions with humans. Detailed consideration given to the adaptations that allow these mammals to live in the sea. Evaluation of the scientific, ethical, and aesthetic factors influencing societal attitudes toward these animals and of their conservation management in light of domestic legislation and international treaties. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Nowacek. 1 unit. C-L: see Environment 376A

376LA. Marine Mammals. Laboratory version of Biology 376A. Laboratory and field exercises consider social organization, behavior, ecology, communication, and anatomy of local bottlenose dolphins. Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Read. 1 unit. C-L: Environment 376LA

377LA. Marine Invertebrate Zoology. Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Biology 777LA. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer. Instructor: Silliman or staff. 1 unit. C-L: Environment 377LA, Earth and Ocean Sciences 377LA

380LA. Marine Molecular Microbiology. Introduction to microbiology from a marine perspective. Topics include microbial phylogeny, evolution, symbiosis, biotechnology, genomics, and ecology. Laboratory will employ modern molecular techniques to investigate the ecology and evolution of prokaryotic and eukaryotic microbes. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology, introductory biology, or permission of instructor. Instructor: Hunt. 1 unit. C-L: see Environment 383LA

384A. Marine Conservation Biology - a Practicum. Immersion in marine conservation biology basics for 21st Century society and ‘anthropocene’ epoch including two week-long current issue modules. Phenomena affecting maintenance and loss of biodiversity (climate change, habitat destruction); strategies for combating threats to biodiversity; exploration of this field’s interdisciplinary nature; introduction to key concepts of ecology relevant to conservation issues at the level of populations and ecosystems; unique capstone-position papers and stakeholder negotiation. Taught in Beaufort at Duke Marine Lab. Recommended prerequisite: AP Biology, Biology 202L or 203L, introductory ecology, or instructor consent. Concurrent enrollment required in Environment 346A/Public Policy 246A. Instructor: Nowacek. 1 unit. C-L: see Environment 384A

391A. Independent Study: Advanced Topics. Reading in a field of special interest under the supervision of a Biology faculty member. Intended for students interested in studying topics not offered in regularly available courses. Taught in Beaufort at Duke Marine Lab. Instructor consent is required. Instructor: Staff. 1 unit.

445A. Climate Change in the Marine Environment. Exploration of climate change science focusing on marine ecosystems and inhabitants—specifically ocean acidification, warming and sea level rise. Factors causing climate change, and how those vary spatially, focusing on sensitive polar ecosystems and marine mammal populations. Critical examination of climate change modeling using EdGCM (research-grade Global Climate Model), focusing on how scientists use models, observations/theory to predict climate, and assumptions/uncertainty implicit in modeling. Discussion of potential human impacts including consequences of sea level rise and potential increases in disease due to climate change. Taught in Beaufort at Duke Marine Lab. Instructor: Johnston. 1 unit. C-L: see Environment 445A; also C-L: Public Policy 445A

490TA. Tutorial (Topics). For junior and senior majors with consent of director of undergraduate studies and supervising instructor. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 1 unit.

490TA-1. Tutorial (Topics). For junior and seniors with consent of director of undergraduate studies and supervising instructor. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 0.5 units.

491A. Independent Study: Advanced Topics. Reading in a field of special interest under the supervision of a Biology faculty member. Intended for students interested in studying topics not offered in regularly available courses. Taught in Beaufort at Duke Marine Lab. Instructor consent is required. Instructor: Staff. 1 unit.

493A. Research Independent Study. Continuation of Biology 293A. Individual research and reading of the primary literature in a field of special interest, under the supervision of a faculty member, the major product of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to juniors and seniors only with consent of supervising instructor. Taught in Beaufort at Duke Marine Lab. Prerequisite: Biology 293A or Biology 379LA. May be repeated. Instructor: Staff. 1 unit.

570LA-1. Experimental Tropical Marine Ecology. Distribution and density of marine and semi-terrestrial tropical invertebrate populations; behavioral and mechanical adaptations to physical stress, competition, and predation using rapid empirical approaches and hypothesis testing. Taught in Beaufort at Duke Marine Lab, with preparation for fieldwork before and analysis and presentation of projects after required one-week intensive field experience on the coast of Panama. Consent of instructor required. Instructor: Diaz. 2 units.

570LA-2. Marine Ecology of the Pacific Coast of California. Ecology of the rocky intertidal, kelp forest, and mud flat habitats. Introduction to marine mammals, fish and other large West Coast vertebrates. Taught in Beaufort at Duke Marine Lab, with preparation for fieldwork before and analysis of projects after required one-week intensive field experience on the coast of Northern California. Prerequisite: introductory course in biology or environmental science and consent of instructor. Instructor: Johnson. 2 units. C-L: Environment 570LA-2

579LA. Biological Oceanography. Physical, chemical, and biological processes of the oceans, emphasizing special adaptations for life in the sea and factors controlling distribution and abundance of organisms. Four units (spring); six units (summer). Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Johnson. Variable credit. C-L: see Environment 579LA; also C-L: Earth and Ocean Sciences 579LA

773A. Marine Ecology. Ecology from a policy and management perspective. Recitations and discussions target a policy- and management-oriented graduate audience. Lecture topics include factors that influence the distribution, abundance and diversity of marine organisms, characteristics of marine habitats, adaptation to environment, species interactions, biogeography, larval recruitment, and communities found in rocky shore, tidal flats, beaches, mangroves, coral reefs, and subtidal areas. Not open to students who have taken Biology 273LA. Taught in Beaufort at Duke Marine Lab. Instructor: Johnson. Variable credit. C-L: see Biology 273LA; also C-L: Earth and Ocean Sciences 773A

773LA. Marine Ecology. Factors that influence the distribution, abundance, and diversity of marine organisms. Course structure integrates lectures, field excursions, lab exercises and an independent project. Lecture topics include physical characteristics of marine systems, adaptation to environment, species interactions, biogeography, larval recruitment, and biodiversity and conservation of communities found in rocky shores, tidal flats, beaches, marshes, mangroves, coral reefs, and subtidal areas. Not open to students who have taken Biology 273LA. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer. (Spring enrollment requires travel to Caribbean.) Grad students submit literature review. Prerequisite: introductory biology. Instructor: Silliman or staff. 4 units. C-L: Environment 773A

777LA. Marine Invertebrate Zoology. Structure, function, and development of invertebrates collected from estuarine and marine habitats. Open to undergraduates only under Biology 777LA. Four credits (fall, spring, and Summer Term II); six credits (Summer Term I). Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology, introductory biology, or consent of instructor. Instructor: Van Dover or Staff. 4 units. C-L: see Environment 778LA

778LA. Comparative Physiology of Marine Animals. Physiology of marine animals with emphasis on comparisons between marine invertebrates and humans. Focus on physiological processes including gas exchange, circulation, osmoregulation, metabolism, thermoregulation, endocrine, neural control and sensory systems. Lectures and laboratories illustrate the methodology, analysis techniques, and written reporting of physiological research. Open to undergraduates only under Biology or Environment 778LA. Four units (fall, spring); six units (summer). Taught in Beaufort at Duke Marine Lab. Instructor: Wise or staff. 4 units. C-L: Environment 778LA

784LA. Sound in the Sea: Introduction to Marine Bioacoustics. Fundamentals marine bioacoustics with focus on current literature and conservation issues. Topics include: intro acoustics; acoustic analysis methods and quantitative tools; production/recording of sound; ocean noise; propagation theory; active/passive acoustics; hearing, sound production and communication in marine organisms, potential impacts of anthropogenic noise; and regulation of marine sound. Lab focus on methodologies for generating, recording and analyzing marine sounds. Grad students responsible for additional acoustic analyses and results prep for student projects plus preparation additional lit rev/critique. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP or introductory biology or consent; Physics 41L or 161L (or equivalent) or consent. Instructor: Nowacek. 4 units. C-L: see Environment 784LA; also C-L: Electrical and Computer Engineering 784LA

791T. Tutorial. Carried out under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. Variable credit.

791TA. Tutorial. Carried out under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. Variable credit.

792. Research. To be carried on under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Instructor: Staff. Variable credit.

792A. Research. To be carried on under the direction of the appropriate faculty members. Consent of instructor required. Hours and credit to be arranged. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. Variable credit.

Chemistry (CHEM)


Earth and Ocean Sciences (EOS)

272A. Analysis of Ocean Ecosystems. The history, utility, and heuristic value of the ecosystem; ocean systems in the context of Odum’s ecosystem concept; structure and function of the earth’s major ecosystems. Taught in Beaufort at Duke Marine Lab. Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor: Johnson. 1 unit. C-L: see Biology 272A; also C-L: Environment 272A

273LA. Biological Oceanography. Discusses patterns of abundance, diversity and activity of organisms in major ocean ecosystems. Identifies major physical, chemical and ecological processes that affect these patterns, and analyzes impact of biology on ecosystems. Uses
a ‘flipped’ classroom for enhanced development of quantitative skills to measure these patterns, emphasizing hands-on data collection and analyses, multiple field trips aboard DUMIL research vessels, and participatory activities to demonstrate core concepts in biological oceanography. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP biology, introductory biology, or permission of instructor. Instructor: Johnson. 1 unit. C-L: see Biology 369LA; also C-L: Environment 369LA

### 280LA. Sound in the Sea: Introduction to Marine Bioacoustics

Fundamentals of marine bioacoustics with a focus on current literature and conservation issues. Topics include: introduction to acoustics; acoustic analysis methods and quantitative tools; production and recording of sound; ocean noise; propagation theory; active and passive acoustics; hearing, sound production and communication in marine organisms, potential impacts of anthropogenic noise; and regulation of marine sound. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology, introductory biology, or consent of instructor; Physics 141L or 161L (or equivalent Physics courses) or consent of instructor. Instructor: Nowacek. 1 unit. C-L: see Environment 280LA; also C-L: Electrical and Computer Engineering 384LA, Biology 279LA

### 370A. Physical Oceanography

Fundamental physical principles of ocean circulation. Physical properties of seawater; forces acting on the ocean such as heat, pressure gradients, wind stress, rotation, and friction; and conservation equations for heat, mass and momentum. Applications include geostrophic balances, thermal wind, coastally trapped waves, El Nino/ENSO, and tidal circulation. Taught in Beaufort at Duke Marine Lab. Prerequisite: one year of calculus and one semester of physics, or permission of instructor. Instructor: Johnson. 1 unit. C-L: see Environment 370A

### 374LA. Marine Ecology

Factors that influence the distribution, abundance, and diversity of marine organisms, including a survey of the major flora and fauna in the marine environment. Topics include physical characteristics of marine systems, adaptation to environment, species interactions, biogeography, larval recruitment, and biodiversity and conservation of communities found in rocky shores, tidal flats, beaches, marshes, mangrove, coral reefs, and subtidal areas. Lectures, field excursions, lab exercises and an independent project. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer; spring semester offering requires travel to Caribbean. Prerequisite: AP biology, introductory biology, or instructor consent; not open to students who have taken Biology 773LA. Instructor: Silliman. 1 unit. C-L: see Biology 273LA; also C-L: Environment 273LA

### 377LA. Marine Invertebrate Zoology

Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Biology 777LA. Taught in Beaufort at Duke Marine Lab. Taught fall, spring, and summer. Instructor: Silliman or staff. 1 unit. C-L: see Biology 377LA; also C-L: Environment 377LA

### 391A. Independent Study


### 393A. Research Independent Study

Marine Lab version of Earth and Ocean Sciences 393. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 1 unit.

### 394A. Research Independent Study

Marine lab version of Earth and Ocean Sciences 394. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 1 unit.

### 579LA. Biological Oceanography

Physical, chemical, and biological processes of the oceans, emphasizing special adaptations for life in the sea and factors controlling distribution and abundance of organisms. Four units (spring); six units (summer). Taught in Beaufort at Duke Marine Lab. Prerequisite: introductory biology. Instructor: Johnson. Variable credit. C-L: see Environment 579LA; also C-L: Biology 579LA

### 704LA. Biological Oceanography

Discusses patterns of abundance, diversity and activity of organisms in major ocean ecosystems. Identifies major physical, chemical and ecological processes that affect these patterns, and analyzes impact of biology on ecosystems. Uses a ‘flipped’ classroom for enhanced development of quantitative skills to measure these patterns, emphasizing hands-on data collection and analyses, multiple field trips aboard DUMIL research vessels, and participatory activities to demonstrate core concepts in biological oceanography. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP biology, introductory biology, or permission of instructor. Graduate section will include experimental design component. Instructor: Johnson. 4 units. C-L: see Biology 704LA; also C-L: Environment 704LA

### 716A. Beach and Island Geological Processes

Field seminar on the evolution of beaches and barrier islands with emphasis on the interactions between nearshore processes and human activities. Taught in Beaufort at Duke Marine Lab. Prerequisite: Earth and Ocean Sciences 315/515 or consent of instructor. Also taught as Earth and Ocean Sciences 316A. Instructor: Murray. 2 units.

### 890A. Advanced Topics in Earth and Ocean Sciences

To meet the individual needs of graduate students for independent study. Instructor: Staff. Variable credit.

### 990A. Advanced Topics in Earth and Ocean Sciences

To meet the individual needs of graduate students for independent study. Instructor: Staff. Variable credit.

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**Electrical and Computer Engineering (ECE)**

### 384LA. Sound in the Sea: Introduction to Marine Bioacoustics

Fundamentals of marine bioacoustics with a focus on current literature and conservation issues. Topics include: intro acoustics; acoustic analysis methods and quantitative tools; production/recording of sound; ocean noise; propagation theory; active/passive acoustics; hearing, sound production and communication in marine organisms, potential impacts of anthropogenic noise; and regulation of marine sound. Lab focus on methodologies for generating, recording and analyzing marine sounds. Grad students responsible for additional acoustic analyses and results prep for student projects plus preparation additional

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**Courses of Instruction** 133
English (ENGLISH)

196FSA. Literature of the Sea. Travel narratives, poetry, novels, drama, epics, and film that take place at sea, or on island shores, as well as secondary literature that theorizes on physical, political, and philosophical possibilities in supra- and transnational spaces. Emphasis on the social, cultural, and political structures that function at sea, focusing on exile, imperial travel, the Middle Passage, cosmopolitan journeys, shipwreck, and tourism. Material can include eco-criticism/fiction on Marine Lab travel sites: Singapore, Hawaii, Trinidad, Carolina islands. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 1 unit.

Global Health (GLHLTH)

308A. Oceans in Human and Environmental Health. Students will gain a grounding in marine sciences which will help them to evaluate impacts of anthropogenic activities on both marine ecosystems and the humans that rely on them. After developing an understanding of the issues facing environmental and human health and well-being in marine systems, students will travel to Duke Kunshan University in China, to better understand environmental challenges facing a rapidly developing economy. This course will embrace immersive field experiences in both North Carolina and China that will contextualize classroom learning as well as develop connections with environmental practitioners and residents. Taught in Beaufort at Duke Marine Lab. Duke Immerse course. Instructor consent required. Instructor: Hunt. 1 unit. C-L: see Environment 308A; also C-L: Biology 308A

Mathematics (MATH)

212A. Multivariable Calculus. Partial differentiation, multiple integrals, and topics in differential and integral vector calculus, including Green’s theorem, the divergence theorem, and Stokes’s theorem. Taught in Beaufort at Duke Marine Lab. Not open to students who have taken Mathematics 202 or 222. Prerequisite: Mathematics 22, 112L, 122, or 122L. Instructor: Staff. 1 unit.

Neuroscience (NEUROSCI)

381LA. Sensory Physiology and Behavior of Marine Animals. Sensory physiological principles with emphasis on visual and chemical cues. Laboratories will use behavior to measure physiological processes. Taught in Beaufort at Duke Marine Lab. Prerequisite: AP Biology or introductory biology or consent of instructor and Chemistry 101DL. Instructor: Rittschof. 1 unit. C-L: see Biology 373LA; also C-L: Environment 373LA

Physics (PHYSICS)

141LA. General Physics I. First part of a two-semester calculus-based course for students in health or life sciences. Core topics: kinematics, dynamics, systems of particles, conservation laws, statics, fluids, oscillations, waves. Other possible topics: sound, diffusion, thermodynamics, selected applications. For credit, enrollment in Physics 141LA lecture, lab and discussion sections required. Physics majors should enroll in Physics 161D/161L, 162D/162L in their first year. Closed to students with credit for Physics 151L, 152L, 161D. Prerequisite: one year of college calculus such as Mathematics 105L, 106L, 21. Mathematics 122 recommended. Open only to students in the Duke Marine Lab. Taught in Beaufort at Duke Marine Lab. Instructor: Tyndall or Brown. 1 unit.

142LA. General Physics II. The second semester of a calculus-based course for students in health or life sciences. Core topics: electric fields, circuits, magnetic fields, Faraday’s law, Maxwell’s equations, electromagnetic waves, properties of light, geometric optics, wave optics. Additional possible topics: optical instrumentation, quantum physics, selected applications. Students must enroll in Physics 142LA lecture, lab and discussion sections to receive credit. Closed to students having credit for Physics 152L, 153L or 162D. Prerequisite: Physics 141L, 141LA, 151L, or 161D. Open only to students in the Duke Marine Lab. Taught in Beaufort at Duke Marine Lab. Instructor: Brown. 1 unit.

Political Science (POLSCI)

707A. Marine Policy (A). Formal study of policy and policy-making concerning the coastal marine environment. History of specific marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Topics explored through use of theoretical and methodological perspectives, including political science, sociology, and economics. Consent of instructor required. Taught in Beaufort at Duke Marine Lab. Instructor: Murray. 3 units. C-L: see Environment 786A; also C-L: Public Policy 849A.

Public Policy Studies (PUBPOL)

246A. Marine Conservation Policy - A Practicum. Immersion in marine conservation biology and policy. Experiential learning in maintenance and loss of marine biodiversity; key concepts of social science and law for instituting policy; position papers and stakeholder negotiation focused on ecological, economic, cultural, and institutional complexity associated with priorities for public trust resources. Analyze values, judgments, and preferences inherent in personal and public decision-making processes and competing visions for management and governance of marine resources. Taught in Beaufort at Duke Marine Lab. Prerequisite: Public Policy 155D suggested, or instructor consent. Concurrent enrollment required in Environment 384A/Biology 384A. Instructor: Nowacek. 1 unit. C-L: see Environment 346A
281A. Marine Policy. Policy and policy-making concerning the coastal marine environment. History of marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Use of theoretical and methodological perspectives, including political science, sociology, and economics. Taught in Beaufort at Duke Marine Lab. Instructor: Murray. 1 unit. C-L: see Environment 286A

445A. Climate Change in the Marine Environment. Exploration of climate change science focusing on marine ecosystems and inhabitants—specifically ocean acidification, warming and sea level rise. Factors causing climate change, and how those vary spatially, focusing on sensitive polar ecosystems and marine mammal populations. Critical examination of climate change modeling using EdGCM (research-grade Global Climate Model), focusing on how scientists use models, observations/theory to predict climate, and assumptions/uncertainty implicit in modeling. Discussion of potential human impacts including consequences of sea level rise and potential increases in disease due to climate change. Taught in Beaufort at Duke Marine Lab. Instructor: Johnston. 1 unit. C-L: see Environment 445A; also C-L: Biology 445A

849A. Marine Policy (A). Formal study of policy and policy-making concerning the coastal marine environment. History of specific marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Topics explored through use of theoretical and methodological perspectives, including political science, sociology, and economics. Consent of instructor required. Taught in Beaufort at Duke Marine Lab. Instructor: Murray. 3 units. C-L: see Environment 786A; also C-L: Political Science 707A

Statistical Science (STA)

101A. Data Analysis and Statistical Inference. Introduction to statistics as a science of understanding and analyzing data. Themes include data collection, exploratory analysis, inference, and modeling. Focus on principles underlying quantitative research in social sciences, humanities, and public policy. Research projects teach the process of scientific discovery and synthesis and critical evaluation of research and statistical arguments. Readings give perspective on why in 1950, S. Wilks said "Statistical thinking will one day be as necessary a qualification for efficient citizenship as the ability to read and write." See department website for placement information. Not open to students with credit for Statistical Science 102 or higher. Taught in Beaufort at Duke Marine Lab. Instructor: Staff. 1 unit.

102A. Introduction to Biostatistics. Reading and interpretation of statistical analysis from life and health sciences. Topics include: basic concepts and tools of probability, estimation, inference, decisions analysis, and modeling. Emphasizes role of biostatistics in modern society. Taught in Beaufort at Duke Marine Lab. See department website for placement information. Not open to students who have taken Statistical Science 100 or above. Instructor: Staff. 1 unit.
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