Course Description

This course is a second-year PhD class that will make use of micro-economic theory and mathematical modeling tools to develop a rigorous understanding of the use and management of natural resources over space and time. We will use mathematical techniques including optimal control and dynamic programming to analyze problems related to renewable resources (e.g., fish, forests) and nonrenewable resources (e.g., coal, oil). The course will develop mathematical and numerical tools while exploring how the tools are applied in the natural resource economics literature.

Course Objectives

My goal is to expose students to the major natural resource economics modeling techniques while developing the ability to extend and apply them to your research area of interest. Importantly, we will develop solution techniques while at the same time emphasizing the economic intuition driving model results. This course will provide an introduction to optimal control theory, dynamic programming and other optimization tools that can be broadly applicable in economics research. It will also provide an introduction to the academic literature on natural resource economics topics. At the end of the course, students should have the tools to read the current natural resource economics literature as well as develop and solve a model to inform dissertation research.

Prerequisites

According to the DARE website, prerequisites include AREC/ECON 540 (environment and natural resource economics) 635 (econometrics), and ECON 706 (microeconomic theory). I will assume everyone is comfortable with differential calculus and the basics of static optimization. We will extend these to a dynamic setting.
**Recommended Texts and Readings**

There will be no single book for this course so I will make required readings available online or in class (see list below for readings). In addition, I recommend several books as references for the class and for your future research:


**Grading**

Grades will come from a mid-term (15%), a final (20%), a presentation* (10%), homework assignments (20%), a proposal sketch (9%), rough draft proposal (9%) and final draft proposal (12%), and participation (5%). The mid-term and final will be take-home exams. I will hand out a homework assignment about every 2-3 weeks and specify a due date (you will have approximately 2 weeks per homework). You can collaborate on homework and turn in one problem set per 2 people but exams must be done entirely independently. I encourage you to come to office hours if additional help is needed. Homework answer keys will be available for most problem sets and should help in preparing for the mid-term and final.

I will give grades based on a percentage score but use a curve to ensure that the average grade is approximately a B+.

*Students will present a paper from the recent NR economics literature on the topic of their choice. We will assign dates for presentations so they fit in the topics of the class. The paper can be one on the syllabus or one of your own choosing but please coordinate with me. Please choose your paper and coordinate the presentation date with me by Friday, September 8th.*
# Course Outline (tentative)

<table>
<thead>
<tr>
<th>Section</th>
<th>Sub-Section</th>
<th>Reading</th>
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<tr>
<td>Introduction to NR Economics (~1 week)</td>
<td>Summary of big questions in the field; topics to cover in the class</td>
<td>Lichtenburg, Shortle, Wilen, and Zilberman 2010</td>
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<td>Herfindahl’s What is Conservation?</td>
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<td>Ch 2 The Experimental Ideal</td>
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<td>Static optimization theory review, envelope theorem, implicit function theorem, Natural resource rent (static)—the example of land, rent dissipation an open access</td>
<td>Schlenker, Hanemann, and Fisher, 2006 Gordon 1954 Hornbeck 2010 Ostrom 2002 Ostrom 2009</td>
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<td>Homans and Wilen 1997</td>
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<td>Homework 1 Due September 10th, in class</td>
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<td>Analytical Dynamic Optimization (~2 Weeks)</td>
<td>Optimal Control</td>
<td>Caputo text, Clark 1990</td>
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<td>K-theory example</td>
<td>Dorfman 1969</td>
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<td>Homework 2 due September 28th, in class</td>
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<td>Proposal Sketch Due September 28th in class</td>
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<tr>
<td>Numerical Methods (~4 weeks)</td>
<td>Programming intro: Solvers, function approximation, and ODEs</td>
<td>M&amp;F, Judd Nolan et. al., 2009</td>
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<td>Optimal Control</td>
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<td>Dynamic Programming</td>
<td>Howitt et. al., 2002, Bond and Loomis 2009</td>
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## Homework 3 Due October 17th, in class (date subject to change for my parental leave)

**Mid Term Exam (Take-home)**
**Due November 2nd**

**NR Topic 2: The Fishery (~1 week)**
- Population dynamics
- Optimal control
- Institutions
- Clark and Munro 1975
- Smith and Wilen 2000
- Smith et. al. 2009, Manning and Uchida 2016

**NR Topic 3: NR Resources and Energy (~2 weeks)**
- Hotelling 1934, Stiglitz 1974, Hartwick 1977

**Proposal rough draft due November 16th**
- Hydraulic Fracturing, Renewable energy
- Novan 2011, Muehlenbachs et. al. 2012

**Fall Recess: November 21st and 23rd**

**Homework 4 due November 28th**

**NR Topic 4: Forestry (~1 week)**
- Timing
- Space
- Hartman, Van Kooten et. al. 1995
- Nalle et. al. 2004

**NR Topic 5: Water economics (~1 week)**
- Optimal control of GW
- Gisser and Sanchez (1980)
- Knapp et. al. 2003, Brozovic et al. 2010

**Homework 5 due December 7th**

**Final Proposal Due December 7th**

**Final Exam, Due December 12th, noon**