

**University of Waterloo**  
**Department of Economics**  
**Economics 255**  
**Introduction to the Economics of Natural Resources, Fall 2017**  
**2:30 – 3:50, MW, MC2017**

**Instructor Information**

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Office Hours:

Mon/Wed 4-5 pm, or by appointment

**Course description**

Humanity depends on natural resources for survival; yet increasing population and economic growth have put pressure on key natural resources such as forests, fisheries, and water. In addition, the economies of the world's wealthier countries are highly dependent on depletable natural resources which are major sources of carbon emissions – coal, oil and natural gas, in particular. In this course we will use the theory and tools of economics to explore key issues of natural resource use and management. We will seek to understand the meaning and implications of natural resource scarcity and how the insights of economics might be used to promote a more sustainable path for our future. We begin with basic economic concepts such as static and dynamic efficiency, property rights and market failure. We then apply these concepts to the management of key natural resources such as energy resources, fisheries, forests and water.

**Course objectives and learning outcomes**

The objective of the course is to apply the normative economic concepts of static and dynamic efficiency to questions concerning society's exploitation of natural resources.

Upon completion of the course students should be able to:

- Explain the determination of the efficient level of extraction over time for renewable and non-renewable resources and distinguish between efficiency and equity
- Explain the importance of property rights in the management of natural resource use
- Explain the significance of discounting in economic decisions about natural resources and the associated ethical dilemmas
- Analyze market failures and the need for government intervention to support a more efficient allocation of natural resources in specific examples
- Evaluate government natural resource policies for efficiency, equity and societal welfare.

**Textbook**

Tom Tietenberg and Lynne Lewis (**T&L**), Environmental and Natural Resource Economics, Pearson, tenth edition, 2015. It is available on-line through the library (3 copies) and also from the bookstore.

## Other References

(Some of these are required readings, as indicated in the course schedule below. **Note that some of the links will only work if you are on campus or logged into your library account from home.** Articles without links are available through the library.)

Acheson, James; Spencer Apollonio; and James Wilson (2015) '[Individual transferable quotas and conservation: a critical assessment](#)', *Ecology and Society*, 20(4):7.

Arnason, Ragnar (2012) 'Property Rights in Fisheries: How much can individual transferable quotas accomplish?,' *Review of Environmental Economics and Policy*, 6(2), 217-236. [http://journals1.scholarsportal.info.proxy.lib.uwaterloo.ca/pdf/17506816/v06i0002/217\\_prifhmcitqa.xml](http://journals1.scholarsportal.info.proxy.lib.uwaterloo.ca/pdf/17506816/v06i0002/217_prifhmcitqa.xml)

Arrow K.; B. Bolin; R. Costanza; *et al* (1995) '[Economic growth, carrying capacity, and the environment](#)', *Ecological Economics*, 15, 91-95.

Bergstrom, Theodore (2010) 'The Uncommon Insight of Elinor Ostrom,' *Scandinavian Journal of Economics*, 112(2), 245-261. [https://journals-scholarsportal-info.proxy.lib.uwaterloo.ca/details/03470520/v112i0002/245\\_tuioeo.xml](https://journals-scholarsportal.info.proxy.lib.uwaterloo.ca/details/03470520/v112i0002/245_tuioeo.xml)

Cropper, M (2013) '[How should benefits and costs be discounted in an intergenerational context?](#)' *Resources Magazine*: 183, Resources for the Future.

Darmstadter, Joel. (2012) '[Meeting the World's Natural Resource Needs: Confrontation Ahead?](#)' *Resources Magazine*: 179, Resources for the Future.

*The Economist*, (2016) 'Unbalancing the Scales,' Print edition, July 16, 2016. Available on LEARN.

Environmental Protection Agency (2014) '[Guidelines for Preparing Economic Analyses](#)', National Center for Environmental Economics, Office of Policy, U.S. Environmental Protection Agency, Chapter 6.

Gillingham, Kenneth, Richard Newell, and Karen Palmer (2009) 'Energy Efficiency Economics and Policy,' *Annual Review of Resource Economics*, 1, 597-619.

Hardin, Garrett (1968) 'The Tragedy of the Commons', *Science*, 162, 1243-1248.

Hepburn, Cameron; and Alex Bowen (2012) '[Prosperity with growth: Economic growth, climate change and environmental limits](#),' Centre for Climate Change Economics and Policy, Working paper no. 109.

Kroetz, Kailin; and James N. Sanchirico (2015) '[The Costs of Competing Goals in Fishery Management](#),' *Resources Magazine*: 190, Resources for the Future, September 2015.

- McGlade, Christophe; and Paul Ekins (2014) '[Un-burnable oil: An examination of oil resource utilisation in a decarbonised energy system](#),' *Energy Policy*, 64, 201-112.
- National Energy Board (NEB) (2017) 'Canada's Adoption of Renewable Power Sources Energy Market Analysis,' May 2017. <https://www.neb-one.gc.ca/nrg/sttstc/lctrct/rprt/2017cnddptnrnwblpwr/2017cnddptnrnwblpwr-eng.pdf>
- Olmstead, S.; and R. Stavins (2009) '[Comparing price and nonprice approaches to urban water conservation](#),' *Water Resources Research*, 45.
- Ostrom, Elinor (2009) 'Design principles of robust Property Rights Institutions: What have we learned?' in *Property Rights and Land Policies*, Gregory Ingram and Yu-Hung Hong, eds., Lincoln Institute of Land Policy, Cambridge, Massachusetts.
- Pearce, D.; B. Groom; C. Hepburn; and P. Koundouri (2003) '[Valuing the future: recent advances in social discounting](#),' *World Economics* 4(2): 121-41.
- Smith, James (2009) '[World oil: market or mayhem?](#),' *Journal of Economic Perspectives*, **23**(3): 145-164.
- Smith, James (2012) '[Does speculation drive oil prices?](#),' *Resources Magazine*, 181, Resources for the Future.
- Solow, Robert M. (1991) '[Sustainability: An Economist's Perspective](#),' *Economics of the Environment, Selected Readings*, Robert Stavins, ed., Norton.
- Sustainable Prosperity (2011) '[Economic instruments for water management in Canada: Case studies and barriers to implementation](#),' Policy Brief, Sept. 2011.
- Tollefson, Jeff (2015) '[Stopping deforestation: Battle for the Amazon](#),' *Nature*, 520, April 2, 2015, 20-23.

## Course Assessment

Evaluation	Percent of final grade	Date
Participation	5%	In-class and on-line participation in assigned exercises throughout the term
Assignment 1	15%	Friday, October 13
Midterm	20%	Monday October 30
Assignment 2	15%	Wednesday, November 22
Final Exam	45%	Scheduled by the registrar

## Outline of topics to be covered

1. Introduction
  - 1.1. Scarcity and limits to growth
  - 1.2. Natural resources and the economy
2. Static efficiency: a normative criteria for decision making
  - 2.1. Review of basic concepts: willingness-to-pay, marginal and total cost, consumer and producer surplus, Pareto optimality
  - 2.2. Property rights and efficient market allocations
  - 2.3. Externalities as a source of market failure
  - 2.4. Public goods
  - 2.5. Public policy and the pursuit of efficiency
3. Discounting, dynamic efficiency, and sustainable development
  - 3.1. Dynamic efficiency and sustainable development
  - 3.2. How should the discount rate be chosen for public policy decisions?
4. Non-renewable resource management
  - 4.1. Characterizing the resource stock
  - 4.2. Efficient allocations over time
  - 4.3. The efficiency of market allocations
5. Transition in energy markets from depletable to renewable resources
  - 5.1. Oil markets: Running out of reserves or running out of the environment
  - 5.2. Transitioning energy sources for electricity
  - 5.3. Energy efficiency
6. Fisheries
  - 6.1. Introduction
  - 6.2. A model of the fishery
  - 6.3. Dynamics of open access
  - 6.4. Determining the socially optimal harvest level
  - 6.5. Extinction in a steady state model
  - 6.6. Regulation of the fishery
  - 6.7. Case study: Pacific halibut

7. Forest economics
  - 7.1. Characterizing the forest resource
  - 7.2. A single rotation forest model
  - 7.3. Faustmann rule for determining optimal harvesting age
  - 7.4. Numerical example of determining optimal harvest age
  - 7.5. Including non-timber values
  - 7.6. Sources of inefficiency in forest management
8. Water economics
  - 8.1. Introduction
  - 8.2. Efficient water allocation
  - 8.3. Property rights
  - 8.4. Sources of inefficiency
  - 8.5. Water pricing in practice

### Tentative course schedule

Note: I will not follow this schedule rigidly, but will adapt the timing of topics as needed to best make use of class time. Additional readings may be assigned throughout the term. Check LEARN regularly for an up-to-date reading list.

WEEK	LECTURE	SCHEDULE NOTES	TOPIC	READINGS
1	11-Sep		1.1 Scarcity and the limits to growth 1.2 Natural resources and the economy	T&L, Ch 1*; K. Arrow <i>et al</i> (1995)*; Darmstadter(2012)*
	13-Sep		2.1 Review of basic concepts	T & L, Ch 2* ; T & L, Ch 3*,pp 46-52 ; Your Ec101 textbook as needed
2	18-Sep		2.1 continued	
	20-Sep		2.2 Property rights and efficient market allocations	Hardin*, pp 1243-1245 and p 1248; Bergstron*; Ostrom
3	25-Sep		2.3 Externalities as a source of market failures	
	27-Sep		2.3 continued 2.4 Public goods	
4	2-Oct		2.5 Public policy and the pursuit of efficiency	
	4-Oct		3.1 Dynamic efficiency and sustainable development	T & L, Ch 3, pages 51-71

No classes	9-Oct	Thanksgiving Holiday		
	11-Oct	Study Day		
5	13-Oct	Friday class to make up for study break;  <b>Assignment 1 due</b>	3.2 Determining the discount rate for public policy decisions	Pearce <i>et al</i> (2003)*; Cropper (2013)*; Environmental Protection Agency (2014), Chapter 6.
	16-Oct		4.1 Characterizing the resource stock 4.2 Optimal extraction over time	T & L, Ch 6*
6	18-Oct		4.3 Efficiency of market allocations	
	23-Oct		5.1 Oil markets: Running out of reserves or running out of the environment	T&L, Ch 7, pp 150-154* McGlade and Ekins (2014)*  Smith (2009) Smith (2012)
7	25-Oct		5.2 Transitions in electricity generation	T&L, Ch 7, pp 160 -67*; NEB (2017)*
	30-Oct	<b>Midterm</b>		
8	1-Nov		5.3 Energy efficiency	T&L, Ch 7, pp 167 -171*; Gillingham et al (2009)*
	6-Nov		6.1 Introduction to fisheries; 6.2 A model of the fishery	T&L, Chapter 12*
9	8-Nov		6.3 Dynamics of open access	Economist (2016)*
	13-Nov		6.4 Determining the socially optimal harvest level; 6.5 Extinction in a steady state model	
10	15-Nov		6.6 Regulation of the fishery  6.7 Case study: Pacific halibut	Kroetz and Sanchirico (2015)* ; Arnason (2012)* ; Acheson et al (2015)*
	20-Nov		7.1 Characterizing the forest resource 7.2 A single rotation forest model 7.3 Faustmann rule for determining the optimal harvest age	T&L, Ch 11*

11	22-Nov	<b>Assignment 2 due</b>	7.4 Numerical example of determining optimal harvest age 7.5 Including non-timber values 7.6 Sources of inefficiency in forest management	
	27-Nov		8.1 Introduction to water economics 8.2 Efficient water allocation 8.3 Property rights	T&L, Ch 9*
12	29-Nov		8.4. Sources of inefficiency in water allocation 8.5 Water pricing in practice	Olmstead and Stavins (2009)* Renzetti (2017) *
	4-Dec		Review	

### Required Background

- The prerequisite is Econ101.
- Students are expected to be competent with skills in basic algebra, such as solving two linear equations in two unknowns, and working with exponents and logarithms.

### Readings and notes on LEARN

- Course notes, announcements etc can be found on LEARN.
- The course notes provide an outline of important points, but leave out many details. It is recommended that you bring the relevant notes to class each week so that you can fill in missing sections.

### Midterm

- A student who misses the midterm due to illness or other extenuating circumstances may seek approval from me to have the weighting of the test shifted to the final exam. Approval will be granted only if appropriate documentation is submitted. If the student does not receive my approval, then a mark of zero will be assigned for the missed midterm. Appropriate documentation in the case of illness is the University's Verification of Illness Form completed by the University of Waterloo Health Services or an Ontario physician. **Students must submit their documentation within one week of the missed midterm.**
- Students with a concern about the marking of a midterm must consult with me **within two weeks** of the date that it is returned in class. After two weeks I will not make any adjustments to a midterm mark.

### Assignments

- Assignments will involve problem solving as well as essay questions requiring reading and analysis.
- Assignments may be completed individually or in groups of two. For group assignments, each student will receive the same mark. It is very important that each student in a group contributes equally to the assignment and understands the solutions. Exam questions will draw on assignment materials.

## Participation

- Participation marks will be based on a student's contributions to discussions of topics that will be assigned during the term. This will include in-class discussions of specific articles as well as on-line discussions in LEARN.

## Policy on late assignments

- A deduction of 5% per day will be applied to an assignment handed in late.

## Final Exam

- The final exam is cumulative.
- Students are responsible for material covered in lectures and assigned readings.

## Electronic Device Policy

Students are welcome to bring laptop computers or other electronic devices to class for note taking. Browsing the internet during class is not permitted. Please turn off cell phones during class time.

## Attendance Policy

Consistent attendance is highly recommended. Course notes available on LEARN are intended as an aid to understanding, not a substitute for classes.

## Economics Department Deferred Final Exam Policy

The Deferred Final Exam Policy is found at <https://uwaterloo.ca/economics/undergraduate/resources-and-policies/deferred-final-exam-policy>

## Statements and links to be included on all course outlines

### Cross-listed course

Please note that a cross-listed course will count in all respective averages no matter under which rubric it has been taken. For example, a PHIL/PSCI cross-list will count in a Philosophy major average, even if the course was taken under the Political Science rubric.

### Academic Integrity

**Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo are expected to promote honesty, trust, fairness, respect and responsibility. See the [UWaterloo Academic Integrity webpage](#) and the [Arts Academic Integrity webpage](#) for more information.

**Discipline:** A student is expected to know what constitutes academic integrity, to avoid committing academic offences, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71 – Student Discipline. For information on categories of offenses and types of penalties, students should refer to [Policy 71 - Student Discipline](#). For typical penalties check [Guidelines for the Assessment of Penalties](#).

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read [Policy 70 - Student Petitions and Grievances](#), Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

**Appeals:** A decision made or penalty imposed under Policy 70 - Student Petitions and Grievances (other than a petition) or Policy 71 - Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to [Policy 72 - Student Appeals](#).

### **Accommodation for Students with Disabilities**

**Note for students with disabilities:** The [AccessAbility Services](#) office, located on the first floor of the Needles Hall extension (1401), collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AS office at the beginning of each academic term.

### **Mental Health Support**

All of us need a support system. The faculty and staff in Arts encourage students to seek out mental health supports if they are needed.

#### **On Campus**

- Counselling Services: [counselling.services@uwaterloo.ca](mailto:counselling.services@uwaterloo.ca) / 519-888-4567 xt 32655
- [MATES](#): one-to-one peer support program offered by Federation of Students (FEDS) and Counselling Services
- Health Services Emergency service: located across the creek from Student Life Centre

#### **Off campus, 24/7**

- [Good2Talk](#): Free confidential help line for post-secondary students. Phone: 1-866-925-5454
- Grand River Hospital: Emergency care for mental health crisis. Phone: 519-749-433 ext. 6880
- [Here 24/7](#): Mental Health and Crisis Service Team. Phone: 1-844-437-3247
- [OK2BME](#): set of support services for lesbian, gay, bisexual, transgender or questioning teens in Waterloo. Phone: 519-884-0000 extension 213

Full details can be found online at the Faculty of ARTS [website](#) Download

[UWaterloo and regional mental health resources \(PDF\)](#)

Download the [WatSafe app](#) to your phone to quickly access mental health support information

### **Territorial Acknowledgement**

The Department of Economics acknowledges that we are living and working on the traditional territory of the Attawandaron (also known as Neutral), Anishinaabe and Haudenosaunee peoples. The University of Waterloo is situated on the Haldimand Tract, the land promised to the Six Nations that includes six miles on each side of the Grand River.