NATURAL-RESOURCE ECONOMICS, ECON 405B, Winter 2022

This course and its evaluations will be online

Monday and Wednesday, 1:00 to 2:30 pm
Three (3) credits.
Prerequisites: ECON 230 or equivalent.

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Office hour: Please contact me by email.
Please communicate with me on questions about course content in class.

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In the *Journal of Economic Literature*'s system of classifications of economics subjects, Natural-Resource Economics is a part of classification Q. Other parts of classification Q are Agricultural Economics and Environmental and Ecological Economics.
Loosely speaking, Natural-Resource Economics studies what we take out of nature. As in other fields of economics, property rights are sometimes considered to be well defined, with the market being the main institution for allocation. A major difference from other fields of economics is the central role of timing or of what is known in mathematics as dynamics. Resources are exploited through time. Valuation through time is central to the subject, and much of capital theory has developed using natural resources as familiar examples. Natural-Resource Economics also considers ill-defined property rights and contains many of the analytical notions used in Environmental Economics.
Again loosely speaking, Environmental Economics and Ecological Economics study what we put into nature. Externalities and their internalization by various policies are studied. An important example is climate. The evaluation of the far future is vital in climate economics and is controversial.
Agricultural Economics is something of a combination of them. Technology is comparatively advanced, however, and the application of technology is a main concern.

In addition to the material covered in intermediate microeconomics, you will need strong facility with algebra and geometry for the class, as well as mathematical skills for discounting, which is used throughout. Calculus and its dynamic progeny (calculus of variations, control theory and dynamic programming) are avoided in the lectures. They are, however, used in almost all writing on the subject.

TOPICS

1. Discounting. The role of the interest or discount rate is an overriding issue throughout the course. The interest (discount) rate is used to relate flows and stocks (capital goods). Understanding capital requires having a facility for manipulating the formula for net present value. There is no textbook for it, just practice.
2. The fishery. The fishery is in some ways a concrete prototype for Environmental

or Ecological Economics because the effects of externalities (of ill-defined property rights) in a fishery have many analogies in other types of environmental problem. The externalities are studied in simplified models and the implications for corrective policies are discussed.

3. Non-renewable resources. Non-renewable resources are a main vehicle for studying the success or failure of the market over time. Allocations in abstract models are studied and then the organization of markets.
4. The forest. Historically, the forest provided the foundation for capital theory. The fact that rotations in a plantation forest recur through time makes the analysis subtle. A forest can also provide environmental benefits during a rotation and their role is considered with reference to a classic cost-benefit study.

TEXTBOOK:
In my lectures I do not follow a textbook.
There are a small number of textbooks in the field. If you have access to one, it may be a help. I can suggest the following.
If you plan to do graduate work in economics or finance or have a background in mathematics, I recommend *The Economics of Natural Resource Use*, first or second edition, by J. Hartwick and N. Olewiler, Addison-Wesley. Its approach is conceptually close to that of the course but mathematically more demanding.
A book that is just above the mathematical level of the course is by Jon Conrad, *Resource Economics*, 1999; second edition 2010. The first edition is available online from the McGill Library. It is useful if you have some calculus or are willing to put up with minor use of it. It uses Excel to do examples, and some may find this approach helpful. Conrad includes a terse section of a chapter on the interest rate.
Two books are quite good and have minimal use of calculus but are out of print. If either were in print, I would recommend it as a textbook.
Natural Resources in Canada: Economic Theory and Policy by F.J. Anderson.
The Economics of the Environment and Natural Resources by R.Q. Grafton *et al*.
These or any of several other textbooks may be a good but limited reference, suggesting a framework for thinking and further references.

The chapters in any textbook usually correspond to the topics above or some obvious variation. It should be fairly easy to read in parallel with the topics of the lectures. I have my own opinions on some of the issues.

EVALUATION
Evaluation timing and methods are subject to change in circumstances outside the university's control.

Evaluation consists of four tests, to be given in class time on January 31, February 23, March 23, and either April 6 or April 11. The first three will count for 30% and the last for 10% of the final mark.

Answers are to be typed double-spaced in Word (no pdf or other form) using font-size 12 with one-inch margins around and submitted electronically through MyCourses. No title

page; please put your name and student number at the top of page 1.

While the questions themselves may appear innocuous, I am looking for economic sophistication in the answers. It is vital that you have at least the economic background required by the prerequisite, ECON 230D.

Please note that if you have a complaint about a mark on a test question or paper or assignment, first take the question up with the TA. If you still disagree with the mark, I ask for a succinct, typed, one-page statement of why it should be adjusted. The whole paper will be re-marked and the statement itself will form part of the re-evaluation. There is a risk that the total mark for the paper will be reduced.

COURSE DESCRIPTION

Natural resources are used over long periods of time. The decision maker has to determine how much is to be extracted in each time period, looking ahead to the future. Unlike in static microeconomics, we study not only the prices and quantities of goods at a given point in time but also at future times. The main problem is to determine a temporal path of output and of prices. Periods are linked by the prices and the choices of the output rates. Working out the time path gives the type of thinking required for balancing the interests of the present and the future.

In essence, resources are a type of capital. The course introduces notions of capital theory and economic dynamics. It has a considerable reliance on understanding developed from finance, which is itself a branch of economics.

Placing economic concepts in a context of time is central to understanding dynamic decisions, including decisions about resources. The ingredients are microeconomics and compound interest. You should be fully familiar with static micro but can fill gaps in your preparation or recollection by referring to any micro textbook. Compound interest is discussed in algebra, engineering, accounting and some economics textbooks, and will be introduced in class through a series of lectures on interest and capital. A simple discussion of the interest rate that gives the basics is found in *Environmental Economics and Policy* by T. Tietenberg and L. Lewis, 6th or later edition.

Attention then turns to specific resources that exhibit different analytical features or problems for determining "the right" prices and rates of extraction, Topics 2 – 4 above. They illustrate three generic problems of resource use. 1) In the fishery, a lack of property rights to the resource can lead to a destruction of the value of the resource. If rights cannot be established, policy may be difficult. 2) Traditionally, the underlying problem for nonrenewable resources has been exhaustibility. What is taken at one time is not available at another. The dynamic path ultimately ends in no consumption of the resource. How fast should one eat up a cake, or one's life savings, or the world's oil resources? Is exhaustibility the real problem? 3) The fundamental problem of the forest is how to balance values in different time periods in order to determine "how long to wait". We study what capital is and how it is important.

For each topic, assumptions are relaxed to increase the sophistication of the analysis. The

properties of the equilibrium change as the model is made less restrictive.
This is a demanding course. Students usually succeed but success demands effort. Calculus is not used but algebra and geometry are main vehicles for presenting the issues. These tools are vital and must come readily to hand. There are many equations. They are used in deriving analytical results that are an aid to or a short-cut to economic reasoning. It bears stress that the discussion is analytical, not anecdotal: This is a 400-level course in economics, not in current events, political economy, case study or regional policy. The problems considered are stylized. Emphasis is placed on the resources themselves. Many features are abstracted away in order to stress the underlying economic issues for exploitation over time, namely, "how much" and "at what price".
My aim is to provide an intellectually consistent way of approaching resource issues and thereby to develop a deeper understanding of economic analysis. The course presents dynamic economics without the use of calculus, and, to my knowledge, no author does that. I try to present what I call an economic perception of the concepts. That is why there is no ideal textbook. Consequently, the course is based entirely on lectures.

The objective is "to think like an economist" in a dynamic setting, to understand issues and how present and future time periods fit together, rather than to solve problems.

READINGS

Current work in resource economics is quite mathematical, going far beyond even the calculus which I am striving to avoid. The following are classic references for two subjects.

Coase Theorem:
Coase, Ronald (1960), "The Problem of Social Cost", *Journal of Law and Economics*

Tragedy of the Common:
Hardin, Garret (1968), The Tragedy of the Commons", *Science* 13 Dec.

To my knowledge, there is no simple overview of fishery economics without calculus. The classic paper is quite accessible:
Gordon, H.S., "The Economic Theory of a Common-Property Resource: The Fishery", *Journal of Political Economy* 62, 2, April 1954, 124-142.
Another interesting perspective is given by
Bergstrom, T.C. (2010), "The Uncommon Insight of Elinor Ostrom", *Scandinavian Journal of Economics* 112, 2: 245-261.

In the following paper, one of the greatest economists of the twentieth century takes up the issue of forestry in an accessible way.
Samuelson, Paul A., "Economics of Forestry in an Evolving Society," *Economic Inquiry* XIV, Dec. 1976, 466-92.
You may be interested in the following:

Cairns, Robert D. (2017), "Faustmann's Formulas for Forests", Natural Resource Modeling.
The following is the source of the lecture on cost-benefit analysis of afforestation:
Pearce, David W. (1994), "*Assessing the Social Rate of Return from Investment in Temperate-Zone Forestry*", in (R. Layard and S. Glaister, Second Edition, eds.), *Cost-Benefit Analysis*, Cambridge University Press, Cambridge UK.

A paper based on a lecture on non-renewable resources by one of the greatest expositors as well as researchers is
Solow, Robert M., "The Economics of Resources or the Resources of Economics," *American Economic Review* 64, May 1974, 1-14.
Another view of the problem of nonrenewable resources de-emphasizes the notion of exhaustion:
Adelman, Morris A., Mineral Depletion, with Special Reference to Petroleum, *Review of Economics and Statistics* LXXII, 1, 1990, 1-10.
You may also be interested in
Hotelling, Harold (1931), "The Economics of Exhaustible Resources", Journal of Political Economy
Campbell, Harry (1980), "The Effect of Capital Intensity on the Optimal Rate of Extraction of a Mineral Deposit" Canadian Journal of Economics

The following papers will not be taken up explicitly but are topical and accessible.
Johnson, D.G., "Population, Food and Knowledge," *American Economic Review* 90, March 2000, 1-15.
Schmalensee, R. *et al.* (1998), "An Interim Evaluation of Sulfur Dioxide Emissions Trading," *Journal of Economic Perspectives* 12, Summer, 53-68.
Stavins, R.N. (1998), "What Can We Learn from the Grand Policy Experiment? Lessons from SO2 Allowance Trading," *Journal of Economic Perspectives* 12, Summer, 69-88.

STATEMENTS

In accord with McGill University's Charter of Student Rights, students in this course have the right to submit in English or in French any written work that is to be graded. This does not apply to courses in which acquiring proficiency in a language is one of the objectives." (Approved by Senate on 21 January 2009)

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L'université McGill attache une haute importance à l'honnêteté académique. Il incombe par conséquent à tous les étudiants de comprendre ce que l'on entend par tricherie, plagiat et autres infractions académiques, ainsi que les conséquences que peuvent avoir de telles actions, selon le

Code de conduite de l'étudiant et des procédures disciplinaires (pour de plus amples renseignements, veuillez consulter le guide pour l'honnêteté académique de McGill.
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In the event of circumstances beyond the University's control, the content and evaluation scheme in this course are subject to change.