

## NATURAL-RESOURCE ECONOMICS, ECON 405B, Winter 2023

Tuesday and Thursday, 1:00 to 2:30 pm  
Three (3) credits.  
Prerequisite: ECON 230 or equivalent.

In addition to the material covered in intermediate microeconomics (ECON 230), you will need facility with economic terms, assumptions, approaches and analytic results, as well as algebra and geometry. 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 literature on the subject.

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Office hour: Tuesday, 2:30 – 3:45 pm.

Please communicate with me on questions about course content in class.

TA: TBA

### SOME BACKGROUND

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 usually considered to be well defined, with the market being the institution for allocation. A major difference from other fields 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.

Again loosely speaking, Environmental Economics and Ecological Economics study what we put into nature. Externalities and their internalization by various policies are studied. Through the study of the fishery, Natural-Resource Economics also considers ill-defined property rights and contains many of the analytical notions used in Environmental Economics.

Agricultural Economics is something of a combination of them. Technology is comparatively advanced, however, and the application of technology is a main concern.

### 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.
2. Forestry. 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.
3. 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.
4. 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.

#### 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.

A simple discussion of the interest rate that gives the basics is found in *Environmental Economics and Policy* by T. Tietenberg and L. Lewis, 6<sup>th</sup> or later edition.

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 components.

- Two in-class tests to be on Monday 30 January worth 30%, and Monday 9 April worth 10%.
- In addition, two assignments are to be announced during the term, worth 30% each. The assignments are to be handed in on Thursday 22 February and Tuesday 26 March. *They are to be written up in class, without any aides and under a time constraint.* Please do not ask me or the TA for help on the assignments other than for clarification.

It is important to be aware of the format of these components.

- The two tests ask for short answers, requiring only a few lines of response that must be on lines provided on a test paper. The test paper is one page long and is to be handed in. Conciseness is at a premium. I suggest that you first read a question attentively and then formulate your answer by making notes on the back of the paper. (This material will not be marked.) Write the answer itself carefully and legibly. The method can be unforgiving if you are not careful. Numerical questions may be asked but there is no need for a calculator.
- The two assignments, too, are on a one-page paper with answers to be on lines provided. Again, conciseness is at a premium and the back of the paper may be a valuable tool. It is vital to have a strong grasp of the findings of research on the assignments in order to write up the answer succinctly and well.

Once the papers are marked, I bring them to class twice before I discard them.

If you have a complaint about a mark on a test question, first take the matter up with the TA. If you still disagree with the mark and wish to come to me, I ask for a succinct, typed, one-page statement of why it should be adjusted. The entire paper will be re-marked and the statement will form part of the re-evaluation. There is a risk that the total mark for the paper will be reduced in such cases.

*While the questions themselves may appear innocuous, I am looking for economic sophistication in the answers.*

## 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 problem is to determine temporal paths of output and prices. Periods are linked by the prices and the choices of the output rates. Working out the time path balances 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 familiar with static micro and fill gaps in your preparation or recollection by referring to any micro textbook. Compound interest is discussed in some algebra, engineering, accounting and economics textbooks. It will be introduced through a series of lectures on interest and capital.

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) 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. 2) Traditionally, the underlying problem for nonrenewable resources has been exhaustibility. What is taken at one time is not available at another. 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) In the fishery, a lack of property rights to the resource can lead to deterioration of the value of the resource. If rights cannot be established, policy may be difficult. As the discussion for each topic progresses, assumptions are relaxed to increase the sophistication of the analysis. The properties of the equilibrium change as the model is made less restrictive. Calculus is not used; algebra and geometry are the main vehicles for presenting the subject matter. These tools are vital and must come readily to hand. Equations 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 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 basic 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 SO<sub>2</sub> 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)

Conformément à [la Charte des droits de l'étudiant](#) de l'Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté, sauf dans le cas des cours dont l'un des objets est la maîtrise d'une langue.

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the [Code of Student Conduct and Disciplinary Procedures](#)." (Approved by Senate on 29 January 2003) (See McGill's [guide to academic honesty](#) for more information.)

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](#)).

In the event of circumstances beyond the University's control, the content and evaluation scheme in this course are subject to change.