ACKNOWLEDGEMENT

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xwməθkwəy̓əm (Musqueam) people. The land it is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site.

COURSE INFORMATION

Course Title	Course Code Number	Credit Value
Advanced Food and Resource Economics	FRE 521R	3

PREREQUISITES

Intermediate levels of calculus and microeconomics.

CONTACTS

Course Instructor(s)	Contact Details	Office Location	Office Hours
Frederik Noack	Email: frederik.noack@ubc.ca Phone:	MCML331	By appointment

LEARNING OBJECTIVES

By the end of the course, you will be able to

- Define the optimal use of renewable and non-renewable resources such as forests, fisheries, and fossil fuels from society's perspective.
- Compute the optimal use of renewable resources using tools of dynamic optimization.
- Formulate an efficient policy for dynamic environmental problems such as climate change.
- Discuss the distributional consequences of environmental and resource policies within and across generations.

Course Description

What is the best use of renewable and non-renewable resources from society's perspective? How much fish should we harvest now, and how much should we leave in the oceans to grow and reproduce? How much oil should we use now, and how much should we leave for the future? Should our decisions change if we consider our impact on the oceans or the climate system? After this course, you will be able to answer these questions. To do so, I will first introduce the fundamental mathematical tools for resource economics and dynamic systems. We then discuss how these tools are used to derive the most important results in resource economics. Finally, we will apply these tools to current environmental and resource problems to formulate policies that ensure optimal use from a societal perspective. This course is complementary to a graduate-level environmental economics class and does not cover traditional topics in environmental economics such as air pollution or environmental valuation. The course focuses on topics in resources (including stock pollutants such as greenhouse gases), conservation and agriculture.

Course Structure

- The course will be composed of in person lectures, student presentations and discussions.

Learning Activities

- Exercises in R.
  - Bring your laptop to each class.
  - Have R and RStudio installed.
- Assignments related to the mathematical foundations of the course.
- Midterm exam that covers the basic principles of food and resource economics.
- Presentation of one foundational and one article at the frontier of food and resource economics.
- Discussion of the presentations.

Assessments of Learning

- **Assignments (15 %):** There will be several assignments during the first section of the term. Each of them will be due the following week after posting. These problem sets test your knowledge of the material and help you to prepare for the midterm exam. Only your three best assignments will be used to determine your final grade. Each of these three assignments will receive equal weight. No late assignments will be accepted. You may discuss the problems with other students, but you must hand in your individual solutions.
- **Midterm Exam (25 %):** There will be one midterm exam that covers the first part of the course's topics, especially the foundations of resource economics. It will be conducted in class.

- **Presentations (50 %):** You will present one foundational article and one article at the frontier of food and resource economics. I will randomly assign the topic of both articles but you can choose the article within each topic. The topics and articles are listed below. I will take the level of difficulty of the article for the evaluation into account. Your presentation should cover a) the background and relevance of the article, b) the methods used for the theoretical as well as numerical or empirical part, c) the results, and d) a critique of the article especially how well it reflects the dynamics of the resources. The presentations will take place after the midterm. Each presentation will be 30 minutes.
- **Participation (10 %):** We will discuss each presentation. Your contribution to the discussion will be evaluated.

READINGS

The main textbook for this course is

- **[Conrad]** Conrad, J.M. and D. Rondeau. (2020) Natural Resource Economics: Analysis, Theory, and Applications. Cambridge: Cambridge University Press.

A good alternative is

- Conrad, J. M. (2010). Resource economics. Cambridge university press.

Additional resources:

- **[Karp]** Karp, L (2017) Natural Resources as Capital. MIT Press. Available on Larry Karp's website. This book is a good introduction but does not cover dynamics very well.
- [**Karp & Traeger**] Karp, L. and Traeger, C. (2021) Dynamic Methods in Environmental and Resource Economics. Available online. This is a good reference for dynamic methods. Available on Christian Traeger's website: traeger.eu/pdf/KarpTraegerDraft.pdf

Mathematical ecology:

- Gotelli, N. J. (2008). A primer of ecology. Sunderland, MA: Sinauer Associates. Simple and intuitive introduction to biological dynamics.

Mathematics:

- Acemoglu, D. (2009). Introduction to modern economic growth Princeton University Press Princeton. (Good chapters on optimal control and dynamic programming)
- Sydsæter, K., Hammond, P., Seierstad, A., & Strom, A. (2008). Further mathematics for economic analysis. Pearson education. (One of many books on mathematics for economists that also cover optimal control and dynamic programming).

ARTICLES FOR PRESENTATIONS AND REPLICATION STUDIES

TOPIC: DISTRIBUTION, RISK AND DISCOUNTING

Foundations

- Arrow, Kenneth J. and Anthony C. Fisher. 1974. "Environmental Preservation, Uncertainty, and Irreversibility." Quarterly Journal of Economics, 88(2):312-319.
- Banzhaf, H. S., Ma, L., & Timmins, C. (2019). Environmental justice: Establishing causal relationships. *Annual Review of Resource Economics*, *11*, 377-398.
- Christian Gollier and James K. Hammitt, "The Long-Run Discount Rate Controversy," 2014, Annual Review of Resource Economics 6: 273-95.

- Hartwick, J.M. (1977), "Intergenerational Equity and the Investing of Rents from Exhaustible Resources," American Economic Review 67:972-4.
- Robert S. Pindyck, 2007, "Uncertainty in Environmental Economics," REEP 1(1): 45-65.
- Solow, R.M. (1974), "Intergenerational Equity and Exhaustible Resources," Review of Economic Studies 0, Symposium, 29-45.

Frontier

- Feir, D., Gillezeau, R., & Jones, M. E. (2019). The Slaughter of the Bison and Reversal of Fortunes on the Great Plains (No. 1-2019). Federal Reserve Bank of Minneapolis.
- Ge, M., Edwards, E. C., & Akhundjanov, S. B. (2020). Irrigation investment on an American Indian reservation. *American Journal of Agricultural Economics*, *102*(4), 1083-1104.
- Kellogg, R. (2014). The effect of uncertainty on investment: evidence from Texas oil drilling. *American Economic Review*, *104*(6), 1698-1734.
- Sanchez et al. (2022) The Long-Term Outcomes of Recognizing Indigenous Property Rights to Water. Federal Reserve Bank.
- Timmins, C., & Vissing, A. (2021). Environmental Justice and Coasian Bargaining: The role of race and income in lease negotiations for shale gas (No. w29487). National Bureau of Economic Research.

AGRICULTURE AND WATER

Foundations

- Babcock, B. A. (1992). The effects of uncertainty on optimal nitrogen applications. *Applied Economic Perspectives and Policy*, *14*(2), 271-280.
- Eckstein, Z. (1984) A Rational Expectations Model of Agricultural Supply. *Journal of Political Economy.*
- Rosenzweig, M. R., & Binswanger, H. P. (1993). Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments. *The Economic Journal*, *103*(416), 56-78.
- Just, R. E., & Pope, R. D. (1978). Stochastic specification of production functions and economic implications. *Journal of econometrics*, *7*(1), 67-86.
- Chambers, R. G., & Pieralli, S. (2020). The sources of measured US agricultural productivity growth: Weather, technological change, and adaptation. *American Journal of Agricultural Economics*, *102*(4), 1198-1226.

Frontier

Agriculture

- Adamopoulos, T., Brandt, L., Leight, J., & Restuccia, D. (2022). Misallocation, selection, and productivity: A quantitative analysis with panel data from china. *Econometrica*, *90*(3), 1261-1282.
- Fink, G., Jack, B. K., & Masiye, F. (2020). Seasonal liquidity, rural labor markets, and agricultural production. American Economic Review, 110(11), 3351-92.

- Foster, A. D., & Rosenzweig, M. R. (2022). Are There Too Many Farms in the World? Labor Market Transaction Costs, Machine Capacities, and Optimal Farm Size. *Journal of Political Economy*, *130*(3), 636-680.
- Gollin, D., Hansen, C. W., & Wingender, A. M. (2021). Two blades of grass: The impact of the green revolution. *Journal of Political Economy*, *129*(8), 2344-2384.
- Hagerty, N. (2021) "Adaptation to water scarcity in irrigated agriculture." Working paper
- Hornbeck, Richard, and Suresh Naidu. 2014. "When the Levee Breaks: Black Migration and Economic Development in the American South." *American Economic Review* 104(3): 963-990
- Jones, M., Kondylis, F., Loeser, J., & Magruder, J. (2020). *Factor market failures and the adoption of irrigation in Rwanda* (No. w26698). National Bureau of Economic Research.
- Kantor, S., & Whalley, A. (2019). Research proximity and productivity: long-term evidence from agriculture. *Journal of Political Economy*, *127*(2), 819-854.
- Manysheva, K (2021) Land Property Rights, Financial Frictions, and Resource Allocation in Developing Countries. Mimeo
- Marijn A. Bolhuis, Swapnika R. Rachapalli, and Diego Restuccia 2021 Misallocation in Indian Agriculture. NBER Working Paper No. 29363 October 2021 JEL No. O11,O13,
- Taylor, C. (2021). Cicadian Rhythm: Insecticides, Infant Health and Long-term Outcomes. CEEP WP, 9.

Water

- Ayres, A. B., Meng, K. C., & Plantinga, A. J. (2021). Do environmental markets improve on open access? Evidence from California groundwater rights. *Journal of Political Economy*, *129*(10), 2817-2860.
- Taylor, C., & Heal, G. (2021). Algal Blooms and the Social Cost of Fertilizer. Mimeo.
- Keiser, D. A., & Shapiro, J. S. (2019). Consequences of the Clean Water Act and the demand for water quality. The Quarterly Journal of Economics, 134(1), 349-396.
- Burling et al (2021) Energy, groundwater and crop choice
- Ryan et al (2021) Rationing the Commons

CLIMATE CHANGE

Foundations

- Harstad, B. (2012) Buy Coal! A Case for Supply-Side Environmental Policy. Journal of Political Economy 120(1), 2012: 77-115
- Martin, I.W. and Pindyck, R.S., 2015. Averting catastrophes: the strange economics of Scylla and Charybdis. The American Economic Review, 105(10), pp.2947-2985.
- Nordhaus, W. D. (2007). A review of the Stern review on the economics of climate change. *Journal of economic literature*, *45*(3), 686-702.
- Nordhaus, W.D., and Z. Yang (1996). A regional dynamic general-equilibrium model of alternative climate-change strategies. American Economic Review, 86, 741–765.
- Pindyck, R.S., 2011. Fat tails, thin tails, and climate change policy. Review of Environmental Economics and Policy, 5(2), pp.258-274.

- Weitzman, M. L. (2009). On modeling and interpreting the economics of catastrophic climate change. *The review of economics and statistics*, *91*(1), 1-19.
- William Nordhaus, 2014, "Estimates of the Social Cost of Carbon: Concepts and Results from the DICe-2013R Model and Alternative Approaches," JAERE
- Mendelsohn, Robert, William D Nordhaus, and Daigee Shaw. 1994. The Impact of Global Warming on Agriculture: The Ricardian Approach. American Economic Review 84(4): 753–71
- Deschênes, Olivier, and Michael Greenstone. 2007. The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather. American Economic Review 97(1): 354–85.

Frontier

- Deryugina, T., & Hsiang, S. (2017). *The marginal product of climate* (No. w24072). National Bureau of Economic Research.
- Desmet, K., Kopp, R.E., Kulp, S.A., Nagy, D.K., Oppenheimer,M., Rossi-Hansberg, E. and Strauss, B.H., 2021. Evaluating the Economic Cost of Coastal Flooding. American Economic Journal: Macroeconomics, 13(2), pp.444-486.
- Nath, I.B., 2020. The Food Problem and the Aggregate Productivity Consequences of Climate Change (No. w27297). National Bureau of Economic Research.
- Rudik, I., Lyn, G., Tan, W. and Ortiz-Bobea, A., 2021. Heterogeneity and Market Adaptation to Climate Change in Dynamic-Spatial Equilibrium.
- Golosov, M., Hassler, J., Krusell, P., & Tsyvinski, A. (2014). Optimal taxes on fossil fuel in general equilibrium. Econometrica, 82(1), 41-88.
- Lemoine, D., & Rudik, I. (2017). Steering the climate system: using inertia to lower the cost of policy. American Economic Review, 107(10), 2947-57.
- Waldinger, M. (2022). The economic effects of long-term climate change: evidence from the Little Ice Age. Journal of Political Economy, 130(9), 000-000.

BIODIVERSITY, ECOSYSTEM SERVICES AND CONSERVATION

Foundations

- Brock, William A and Anastasios Xepapadeas, “Valuing biodiversity from an economic perspective: a unified economic, ecological, and genetic approach,” American Economic Review, 2003, 93 (5), 1597–1614.
- Geoffrey Heal, 2003, "Bundling Biodiversity," Journal of the European Economic Association
- Smith, Martin D. and James E. Wilen. 2003. "Economic Impacts of Marine Reserves: the Importance of Spatial Behavior." Journal of Environmental Economics and Management, 46(2):183-206.
- Weitzman, M. L. (1998). The Noah's ark problem. *Econometrica*, 1279-1298.
- Weitzman, Martin L, “Economic profitability versus ecological entropy,” The Quarterly Journal of Economics, 2000, 115 (1), 237–263.
- Alix-Garcia, J., & Wolff, H. (2014). Payment for Ecosystem Services from Forests. *Annual Review of Resource Economics*, *6*(1), 361-380.
- Joppa, L. N., & Pfaff, A. (2009). High and far: biases in the location of protected areas. *PloS one*, *4*(12), e8273.

- Fenichel, E. P., & Abbott, J. K. (2014). Natural capital: from metaphor to measurement. *Journal of the Association of Environmental and Resource Economists*, *1*(1/2), 1-27.
- Smith, M. D., & Wilen, J. E. (2003). Economic impacts of marine reserves: the importance of spatial behavior. *Journal of Environmental Economics and Management*, *46*(2), 183-206.

Frontier

- Bellora, C., Blanc, É., Bourgeon, J. M., & Strobl, E. (2017). Estimating the Impact of Crop Diversity on Agricultural Productivity in South Africa. *NBER Working Paper*, (w23496).
- Frank, E. (2021). *The Economic Impacts of Ecosystem Disruptions: Private and Social Costs From Substituting Biological Pest Control*. Working Paper.
- Quaas, M. F., & Requate, T. (2013). Sushi or fish fingers? Seafood diversity, collapsing fish stocks, and multispecies fishery management. *The Scandinavian Journal of Economics*, *115*(2), 381-422.

FORESTS AND FISHERIES

Foundations

- Abbott, Joshua K., and James E. Wilen. "Dissecting the tragedy: a spatial model of behavior in the commons." Journal of Environmental Economics and Management 62.3 (2011): 386-401.
- Gordon, S. 1954, "The Economic Theory of a Common-Property Resource: The Fishery," JPE 62(2): 124-42.
- Hartman, R. (1976), "The Harvesting Decision When a Standing Forest Has Value," Economic Inquiry.
- Homans, F. R., & Wilen, J. E. (1997). A model of regulated open access resource use. *Journal of Environmental Economics and Management*, *32*(1), 1-21.
- Swallow, S.K. and D. Wear (1993), "Spatial Interactions in Multiple-Use Forestry and Substitution and Wealth Effects for the Single Stand," JEEM.
- Tahvonen, O. and S. Salo (1999), "Optimal forest rotation with in situ preferences," Journal of Environmental Economics and Management 37:106-128.

Frontier

- Balboni, C., Burgess, R., & Olken, B. A. (2021). The Origins and Control of Forest Fires in the Tropics. Mimeo
- Banzhaf, H. S., Liu, Y., Smith, M., & Asche, F. (2019). *Non-parametric tests of the tragedy of the commons* (No. w26398). National Bureau of Economic Research.
- Costello, C., & Grainger, C. A. (2022). *Grandfathering with Anticipation* (No. w29798). National Bureau of Economic Research.
- Huang, L. and Smith, M.D., 2014. The dynamic efficiency costs of common-pool resource exploitation. The American Economic Review, 104(12), pp.4071-4103.
- Noack, F., & Costello, C. (2022). *Credit Markets, Property Rights, and the Commons* (No. w29889). National Bureau of Economic Research.
- Souza-Rodrigues, E. (2019). Deforestation in the Amazon: A unified framework for estimation and policy analysis. *The Review of Economic Studies*, *86*(6), 2713-2744.
- Englander, G., Karp, L. S., & Simon, L. K. (2022). The value of information in a congested fishery. *Available at SSRN*.

- Li, Q., Bronnmann, J., Karasik, R., Quaas, M. F., & Smith, M. D. (2021). An Age-Structured Backward-Bending Supply of Fish: Implications for Conservation of Bluefin Tuna. Journal of the Association of Environmental and Resource Economists, 8(1), 165-192.
- Reimer, M. N., Abbott, J. K., & Haynie, A. C. (2022). Structural behavioral models for rights-based fisheries. Resource and Energy Economics, 68, 101294.

GROWTH, TRADE AND THE ENVIRONMENT

Foundations

- Bohn, Henning, and Robert T. Deacon. (2000) "Ownership risk, investment, and the use of natural resources." American Economic Review 90: 526-549.
- Cherniwchan, J. M., & Taylor, M. S. (2022). International Trade and the Environment: Three Remaining Empirical Challenges (No. w30020). National Bureau of Economic Research.
- Copeland, B. R., & Taylor, M. S. (2004). Trade, growth, and the environment. Journal of Economic literature, 42(1), 7-71.
- Copeland, Brian R. and M. Scott Taylor. "Trade, Tragedy, and the Commons." American Economic Review 99, 3 (June 2009): 725-49.
- Copeland, Shapiro & Taylor (2022) Globalization and the Environment. In: Handbook of International Economics .
- Dasgupta, P.S., Heal, G., 1974. The optimal depletion of exhaustible resources. Rev. Econ. Stud. 41, 3–28.
- López, R.E., Anríquez, G., Gulati, S., 2007. Structural change and sustainable development. J. Environ. Econ. Manag. 53 (3), 307–322.
- Polasky, S., Costello, C., & McAusland, C. (2004). On trade, land-use, and biodiversity. *Journal of Environmental Economics and Management*, *48*(2), 911-925.
- Solow, R.M., 1974. The economics of resources or the resources of economics. Am. Econ. Rev. 64 (2), 1–14.

Frontier

- Shapiro, J. S. (2021). The environmental bias of trade policy. *The Quarterly Journal of Economics*, *136*(2), 831-886.
- Donaldson, D., & Hornbeck, R. (2016). Railroads and American economic growth: A "market access" approach. *The Quarterly Journal of Economics*, *131*(2), 799-858.
- Costinot, A., Donaldson, D., & Smith, C. (2016). Evolving comparative advantage and the impact of climate change in agricultural markets: Evidence from 1.7 million fields around the world. *Journal of Political Economy*, *124*(1), 205-248.
- Riekhof, M. C., Regnier, E., & Quaas, M. F. (2019). Economic growth, international trade, and the depletion or conservation of renewable natural resources. *Journal of environmental economics and management*, *97*, 116-133.

SCHEDULE OF TOPICS

Week	Lecture	Topics	Readings

1	1-2	[1] Introduction [2] Introduction to R for food and resource economics	
2	3-4	[1] Difference and differential equations [2] Introduction to optimization	[Conrad] Chapter 2 [Conrad] Chapters 3.1-3.2
3	5-6	[1 & 2] Dynamic Optimization	[Conrad] Chapter 3.5
4	7-8	[1 & 2] Numerical optimization in R	
5	9-10	[1 & 2] Non-renewable resources and the Hotelling model	[Conrad] Chapter 5
6	11-12	[1 & 2] Renewable resources and bioeconomic models	[Conrad] Chapter 6
7	13-14	[1] Food and resource policies [2] Midterm	TBA
8	15-16	Distribution, risk, and discounting [1] Lecture [2] Student presentation	See articles
9	17-18	Agriculture and water [1] Lecture [2] Student presentation	See articles
10	19-20	Climate change [1] Lecture [2] Student presentation	See articles
11	21-22	Biodiversity, ecosystem services and conservation [1] Lecture [2] Student presentation	See articles
12	23-24	Forests and fisheries [1] Lecture [2] Student presentation	See articles
13	25-26	Growth, trade, and the environment [1] Lecture [2] Student presentation	See articles

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions.

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