FISH 645: Bioeconomic Modeling and Fisheries Management (3 credits)

Instructor:	**Dr. Keith R. Criddle**		
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Office hours:	TR 10-12 or by appointment		

Time/Location: TR 3:40-5:10 Juneau (LP 212) and by video conference to Fairbanks and other sites as demand warrants.

Course Description: An introduction to analytic and computational models of discrete-time representations of bioeconomic systems, including comparative static and optimal control approaches to optimizing unitary and multiple criteria subject to deterministic and stochastic dynamic processes. Particular attention is given to bioeconomic models of optimal management of exploited populations of fish and shellfish. *Prerequisites: STAT F401 and MATH F200, MATH F262, or MATH F272; graduate standing or permission of instructor.* (3+0)

Course Goals and Learning Objectives: Students who successfully complete this course will have a basic background in the development of analytic and computational bioeconomic models. In particular, students will be trained in the development of discrete-time simulation models of deterministic and stochastic processes from the perspective of comparative static and dynamic frameworks evaluated under unitary and multiple criteria. Students who successfully complete this course will:

- Be familiar the differences between renewable, recyclable, and exhaustible resources and the conditions that could lead to extinction of renewable resources.
- Be familiar with use, option and vicarious use benefits provided by biological resources and the ecosystems that sustain them.
- Be familiar with the sources of and consequences of market failure and governance failure.
- Understand differences between continuous and discrete time models, deterministic and stochastic models, static and dynamic models, stationary and nonstationary models, and optimization under unitary and multiple criteria.
- Understand the difference between consumption and capital value and the causes and consequences of stock externalities.
- Know how to structure simple single species deterministic discrete-time bioeconomic models, including parameter estimation, simulation, and sensitivity analysis.
- Understand the theory and practice of modeling the dynamics of natural populations.
- Understand the characteristics and implications of alternative resource governance regimes and how to represent those regimes in bioeconomic simulations.
- Be familiar with the principles of dynamic optimization and optimal control theory.
- Know how to structure single species deterministic discrete-time bioeconomic models with multiple competing users, including parameter estimation, simulation, and sensitivity analysis.
- Be familiar with methods used to estimate the value of recreation and other noncommercial uses and how to incorporate models of nonmarket demand into bioeconomic models.
- Be familiar with extensions of the basic bioeconomic model to account for multiple species, multiple optimization criteria, and risk aversion.

Course Readings: Seminal articles from the refereed literature will serve as the texts for this class. (See course outline for a list of articles to be reviewed. Required readings are denoted with asterisks.) Many of these articles are available through UAF's electronic journal collection; others are available for download from publisher's websites.

Instructional Method: A combination of lectures, facilitated discussions, and work sessions. UAF's Electronic Blackboard will be used to post readings, data sets, examples, and exercises.

Evaluation: Evaluation will be based on 6 computer modeling exercises (14% each) designed to reinforce topics covered in lectures and to allow you to demonstrate your ability to work with the analytic methods introduced in class. In addition, there will be a final exam (16%) designed to assess your ability to retain and integrate material covered in the lectures and homework assignments. Each modeling exercise is worth 100 points and will require several hours of effort. The final is worth 100 points and will include short answer and essay questions. Course grades will be assigned based on a weighted sum of scores on the

exercises and exam: ≥90 = A; ≥80 but <90 = B; ≥70 but <80 =C; ≥60 but <70 =D; and < 60 = F.

Course policies: Academic dishonesty cannot be excused; at best it represents indolence, at worst it is a willful and unconscionable act of intellectual theft. Students enrolled in this class are expected to conform with the UAF Student Code of Conduct (www.uaf.edu/catalog/current/academics/regs3.html). Plagiarism and cheating are particularly heinous forms of academic dishonesty and will not be tolerated. If you plagiarize you will receive an F in this course and you may face additional disciplinary actions initiated by UAF. Plagiarism includes representing another person's work as one's own by paraphrase or direct quotation. It also includes the unacknowledged use of materials prepared by anyone engaged in the selling of term papers or other academic materials. You are welcome to discuss the homework assignments with one another but you are expected to do your own work. You are expected to do your own statistical analysis to obtain estimates of parameter values and you are expected to write your own computer code (in Excel, R, or another modeling platform) to solve the computer modeling exercises. If you cheat on the final exam you will receive an F in this course and you may face additional disciplinary actions initiated by UAF. The computer modeling exercises are due at the start of class on the assigned day. Unless prior permission has been granted by the instructor, late assignments will be docked 10 points for each day after the due date. That is, an assignment turned in within 24hrs of the deadline is worth, at most, 90 points; an assignment turned in more than 24 hours late but less than 48 hours late is worth, at most, 80 points; etc. The final exam is due at the end of the scheduled examination period. Late exams will not be accepted.

Disabilities Services: The office of Disability Services implements the Americans with Disabilities Act (ADA), and insures that UAF students have equal access to the campus and course materials. I will work with the Office of Disabilities Services (208 WHIT 474-5665) to provide reasonable accommodation to students with disabilities.

Other Support Services: The Writing Center (www.alaska.edu/english/writing-center/) offers tutorial and fax-tutorial assistance with grammar, composition, and style. Students connected to the UAF network (Ethernet or wireless on-campus or through VPN off-campus) have access to UAF Library catalogs, electronic journal holdings, and interlibrary loan resources. Miscellaneous support services (e.g., tutorial services, instruction in mathematics skills, academic advising, mentoring and personal support, cultural and social engagement, use of laptop computers, labs, and other technology resources, and direct financial assistance to qualified low-income participants) are available through UAF Student Support Services (www.uaf.edu/sssp/index.html).

Registration: Registration can be completed at: uaonline.alaska.edu.

COURSE OUTLINE & READING ASSIGNMENTS:

1. The economics of production from natural resources — Weeks 1&2
   a. Types of Natural Resources: Exhaustible, Recyclable, Renewable
   b. Types of Benefits Derived from Natural Resources: Use, Option, Vicarious
   c. Market Failure: Externalities, Public Goods, Asymmetric Information, Market Power
      * Coase RH. 1960. The problem of social cost. *Journal of Law and Economics* 3: 1-44.
      Buchanan JM Stubblebine WC 1962. Externality. *Economica* 29: 371-384.
      Demsetz H. 1967. Toward a theory of property rights. *American Economic Review* 57: 347-359.
      * Anderson TL & PJ Hill. 1975. The evolution of property rights; a study of the American west. *Journal of Law and Economics* 18: 163-179.
      * Akerlof GA 1970. The market for "lemons": quality uncertainty and the market mechanism. *Quarterly Journal of Economics* 84: 488-500.
      Randall A 1983. The problem of market failure. *Natural Resources Journal* 23:131-148
   d. Governance Failure: Special Interests, Shortsightedness, Rent- Seeking, Inefficiency
      * Krueger AO. 1974. The political economy of the rent-seeking society. *American Economic Review* 64: 291-303
   e. Allocation Systems: Voluntary vs. Involuntary Exchange: markets, queues, lotteries, etc.

2. A taxonomy of optimization models — Week 3
   a. Continuous vs. Discrete time
   b. Deterministic vs. Stochastic
   c. Static vs. Dynamic
   d. Stationary vs. Nonstationary
   e. Singular vs. Multiple Criteria

3. The economics of production from natural resources — Week 4
   a. Consumption value vs. capital value
      * Jarvis LS. 1974. Cattle as capital goods and ranchers as portfolio managers: an application to the Argentine cattle sector. *Journal of Political Economy* 82:489-520.
   b. Stock externalities
      * Boyce JR. 1992. Individual transferable quotas and production externalities in a fishery. *Natural Resource Modeling* 6:385-408

4. A simple bioeconomic simulation/optimization model — Week 5
   * Criddle KR. 1993. Economics of resource use: a bioeconomic analysis of the pacific halibut fishery. In Shaw (editor), *Proceedings of the Fourth International Symposium of the Conference of Asian and Pan-Pacific University Presidents*, Alaska Sea Grant, Fairbanks, AK

   Homework 1 is due at end of this module.

5. The dynamics of natural populations — Week 6
   * Quinn TJ. 2003. Ruminations on the development and future of population dynamics models in fisheries. *Natural Resource Modeling* 16:341-392.
   * Larkin PA 1977. An epitaph for the concept of Maximum Sustained Yield. *Transactions of the American Fisheries Society* 106: 1-11.
   Criddle KR & AM Havenner. 1991. An encompassing approach to modeling fishery dynamics: modeling dynamic nonlinear systems. *Natural Resource Modeling* 5: 55-90.

   Homework 2 is due at end of this module.

6. Alternative Governance Regimes for Common Pool Resources — Weeks 7&8
   Crutchfield JA. 1979. Economic and social implications of the main policy alternatives for controlling fishing effort. *Journal of the Fisheries Research Board of Canada* 36: 742-752
   * Schlager E Ostrom E 1992. Property-rights regimes and natural resources. *Land Economics* 68: 249-262
   Grafton RQ et al. 2006. Incentive-based approaches to sustainable fisheries. *Canadian Journal of Fisheries and Aquatic Science* 63: 699–710
   a. Common Property
      * Gordon HS. 1954. The economic theory of a common property resource: the fishery. *Journal of Political Economy* 62:124-142.
      * Hardin G 1968. Tragedy of the commons. *Science* 162:1243-1248.
      Berck. P. 1979. Open access and extinction. *Econometrica* 47: 877-882.

* Higgs R. 1982. Legally induced technical regress in the Washington salmon fishery. *Research in Economic History* 7:55-86.
* Anderson TL Hill PJ 1990. The race for property rights. *Journal of Law and Economics* 33: 177-197
* Dietz T Ostrom E Stern PC 2003. Struggle to govern the commons. *Science* 302: 1907-1912

b. Limited Entry

*JE Wilen. 1988. Limited entry licensing: a retrospective assessment. *Marine Resource Economics* 5: 313-324.

c. IFQs

*Hannesson R 1996. On ITQs. *Reviews in Fish Biology and Fisheries* 6:91-96.

National Research Council. 1999. *Sharing the Fish: Toward a National Policy on Individual Fishing Quotas*, National Research Council, National Academy Press. Washington DC. 422p.

d. TURFS

* Acheson JM. 1975. Lobster fiefs—economic and ecological effects of territoriality in the Maine lobster industry. *Human Ecology* 3: 183-207.

Gonzalez E. 1996. Territorial use rights in Chilean fisheries. *Marine Resource Economics* 11: 211–218.

* Criddle KR, M Herrmann & JA Greenberg. 2001. Territorial use rights: a rights based approach to spatial management. Pages 573-590 in M Dorn, S Hills, G Kruse, & D Witherell (Editors). *Spatial Processes and the Management of Marine Populations*, Alaska Sea Grant, Fairbanks AK.

e. CO-OPS/Enterprise Allocations

* Criddle KR & S Macinko. 2000. A requiem for the IFQ in US fisheries? *Marine Policy* 24: 461-469.
* Sylvia G, H Munro-Mann & C Pugmire. 2008. Achievements of the Pacific whiting conservation cooperative: rational collaboration in a sea of irrational competition. Pages 361-368 in R Townsend, R Shotton and H Uchida (editors). *Case Studies in Fisheries Self-Governance*. FAO Fisheries Technical Paper. No. 504. Rome, FAO
* Wilen JE & EJ Richardson. 2008. Rent generation in the Alaskan pollock conservation cooperative. Pages 361-368 in R Townsend, R Shotton and H Uchida (editors). *Case Studies in Fisheries Self-Governance*. FAO Fisheries Technical Paper. No. 504. Rome, FAO.

Homework 3 is due at end of this module.

7. Single Criterion Optimal Control of Deterministic Dynamic Populations — Week 9

Dorfman R. 1969. An economic interpretation of optimal control theory. *American Economic Review* 59: 817-831.

Clark CW Munro GR 1975. The economics of fishing and modern capital theory. *Journal of Environmental Economics and Management* 2, 92-106.

Berck P. 1979. The economics of timber: a renewable resource in the long run. *Bell Journal of Economics* 10:447-462.

* Bjorndal T. 1988. The optimal management of North Sea herring. *Journal of Environmental Economics and Management* 15:9-29.

Williams BK. 1989. Review of dynamic optimization methods in renewable natural resource management. *Natural Resource Modeling* 3:137-216.

Homework 4 is due at end of this module.

8. Comparative Static Analysis of Stochastic Populations — Weeks 10 & 11

Criddle KR. 1996. Predicting the consequences of alternative harvest regulations in a sequential fishery. *North American Journal of Fisheries Management* 16:30-40.

* Criddle KR & AY Streletski. 2000. Multiple criterion management of a sequential fishery. *Annals of Operations Research* 94: 259-273.
* Criddle KR, M Herrmann, JA Greenberg, & EM Feller. 1998. Climate fluctuations and revenue maximization in the eastern Bering Sea fishery for walleye pollock. *North American Journal of Fisheries Management* 18: 1-10.
* Criddle KR & M Herrmann. 2008. A state space bioeconomic model of Pacific halibut. *Natural Resource Modeling* 21:29-60.

Homework 5 is due at end of this module.

9. Single Criterion Optimal Control of Stochastic Dynamic Populations — Week 12

* Criddle KR. 1993. Optimal control of dynamic multispecies fisheries. Pages 609-628 in G Kruse, D Eggers, R Marasco, C Pautzke, &TJ Quinn II (editors) *Management Strategies for Exploited Fish Populations*. Alaska Sea Grant Fairbanks, AK 99775.

Homework 6 is due at end of this module.

10. Comparative Static Analyses of Multiple Use Bioeconomic Systems — Week 13

McConnell KE & JG Sutinen. 1979. Bioeconomic models of marine recreational fishing. *Journal of Environmental Economics and Management* 6: 127-139.

Bishop RC & KC Samples. 1980. Sport and commercial fishing conflicts: theoretical analysis. *Journal of Environmental Economics and Management* 7: 220-233.

* Edwards SF 1991. Critique of 3 economics arguments commonly used to influence fishery allocations. *North American Journal of Fisheries Management* 11:121-130.

Easley JE Jr. 1992. Selected issues in modeling allocation of fishery harvests. *Marine Resource Economics* 7: 41-56.

* Criddle KR. 2004. Economic principles of sustainable multi-use fisheries management, with a case history economic model for Pacific halibut. Pages 143-171 in D.D. MacDonald and E.E. Knudson (editors), *Sustainable Management of North American Fisheries*, American Fisheries Society. Bethesda, MD.

11. Model Extensions — Week 14

a. Recreation and Other Non-commercial Uses

Henderson MM, KR Criddle, & ST Lee. 2000. The economic value of Alaska's Copper River personal-use and subsistence fisheries. *Alaska Fishery Research Bulletin* 6: 63-69.

Criddle KR, M Herrmann, ST Lee, & C Hamel. 2003. Participation decisions, angler welfare, and the regional economic impact of sportfishing. *Marine Resource Economics* 18:291-312.

b. Multiple Criterion Management

Merritt M & KR Criddle. 1993. Multiple criterion decision theory for judging management strategies and resolving conflict: a case study of the Kenai River recreational fisheries. Pages 683-704 in G Kruse, D Eggers, R Marasco, C Pautzke, & TJ Quinn II (Editors). *Management Strategies for Exploited Fish Populations*, Alaska Sea Grant College Program, Fairbanks AK, p. 683-704.

c. Risk

National Research Council. 2004. *Non-native Oysters in the Chesapeake Bay*. National Research Council, National Academy Press. Washington DC 325p.

Final Exam.