FISHERIES AND WILDLIFE SCIENCES 5514

FISH POPULATION DYNAMICS AND MODELING

CATALOG DESCRIPTION

This course is designed to introduce quantitative fish population dynamics. Students will learn the background of diverse fisheries models, how to use appropriate quantitative methods in analyzing data collected from fisheries, to apply and develop appropriate population dynamic models, to estimate vital parameters for fisheries, to quantitatively describe the dynamics of fish populations, to evaluate current status of a fishery and alternative management strategies through formal stock assessment processes, and to understand and interpret uncertainties associated with assessment in managing fisheries resources. Topics covered include population and fish growth, mortality estimation, matrix models, stock recruitment relationship, per-recruitment models, surplus production models, and age-structured population analysis.

Pre- or co-requisite: FiW 5894 (Advanced Fisheries Management). Stat 5616 or equivalent courses, (3H, 3L, 4C).

MEETING TIMES AND CLASSROOM

Monday and Wednesday 2:30-3:45PM (Lecture time);
Friday 9:05AM-12:05PM (Lab time)
Classroom: Cheatham Hall 133 (Lecture) and CEARS (lab, Cheatham 217)

INSTRUCTOR

Yan Jiao, 110 Cheatham Hall, 231-5749, yjiao@vt.edu
Office hours: Friday 1:00-3:00PM or contact me for an appointment; students are encouraged to ask questions during the lab time.

RECOMMENDED REFERENCE BOOKS

Haddon, M. 2001. Modeling and Quantitative Methods in Fisheries. Chapman & Hall/CRC, New York.
King, M. 2007. Fisheries Biology, Assessment and Management. Second Edition. Blackwell.

OTHER RECOMMENDED REFERENCE BOOKS

Quinn, T.J. and Deriso, R.B. 1999. Quantitative Fish Dynamics. Oxford University Press.
Hilborn, R. and Walters, C. 1992. Quantitative Fisheries Stock Assessment, Choice, Dynamics, & Uncertainty. Chapman and Hall

GOALS AND EXPECTATIONS

1) Students will be able to understand population, biological and fisheries processes and how they are related to basic population dynamics models.
    a) Understand that models have to fit to biological and/or fisheries processes;
    b) Understand the relationship between biological/fisheries processes and mathematics/statistics, and how they function in population dynamics.
2) Students will be able to apply a basic level mathematical model that simulates population dynamics in a realistic fashion based on existing data and knowledge of organisms.
    a) Apply basic level mathematical models for growth, mortality, recruitment, and yield to stocks or populations with specific characteristics, environment, problems etc.
    b) Write computer spreadsheets, or other software that the students are familiar with.
    c) Predict outcomes from mathematical models and develop general expectations based on different input parameter values.

3) Students will be able to devise a basic level data collection and model construction plan appropriate for a particular population (exploited, excessively abundant, rare or at risk; freshwater or marine; large or small spatial scale) for the purpose of assessing the current and future status of the population.
    a) Recognize which analysis techniques are appropriate.
    b) Correctly apply formulas.
    c) Check accuracy of peer calculations.
    d) Analyze errors associated with data collection.
    e) Estimate vital parameters of population dynamics and management.

4) Students will be able to read and understand recent journal articles on basic level population dynamics models and estimation methodology that may contain previously unfamiliar equations and/or symbols.
    a) Read and discuss contemporary articles recommended by the instructor and selected by the students themselves.
    b) Evaluate potential contributions and possible improvement in these journal articles.

LECTURE TOPICS (the % of time and cases used for each topic may be changed based on the students' backgrounds; guest lectures schedule may change later)

Dates	Topics	Reading for the corresponding lecture	Discussion leadership [*1]
1/21	No lecture because Jiao is away for a SSC meeting		
L1	A general review of concepts of population and stock, types of fishery resources	King 2007 Ch 1.3, 2; syllabus	
1/26	Fisheries data (types, quality and availability), survey methods	King 2007 Ch 4.2	
2/2	Basic biostatistics	Shepherd 1988	
L2	Individual growth models	King 2007 4.3.1-4.3.4;	
2/4	Other nonlinear models on life history or fishery processes: maturity, discarding, selectivity modeling	Haddon 2001 Ch 8	
	Assignment 1:	Due 2/23	
2/11	Individual growth curve comparison and the non-linear parameter estimation method; fitting models to data (OLS, MLE, Model error structure)	Haddon 2001 Ch 3	
L3	*Guest Lectures:*		
2/16	*Population genetics and its application in fisheries stock assessment (Eric Hallerman)*		
2/18	*Guest lecture: Bioenergetics Analysis (Don Orth)*		
L4	Abundance Estimation based on surveys	King 2007 Ch 4	
2/23	Discuss papers (accuracy and uncertainty of mortality)	King 2007 Ch 4.4; Quinn and Deriso 1999 Ch 8.3;	
3/2	Basic population dynamics and Mortality estimation (age/length composition, tagging)		
L5	Elementary population growth (exponential, logistic)	King 2007 Ch1.3	
3/4	With and without catch data	Haddon 2001 Ch2;	
L6	Production models with parameter estimation method;	King 2007 Ch5.2;	Discussion
3/16		Haddon 2001 Ch6	leadership
3/18	Discuss papers on dynamic production models	and 10.1-10.5;	
	Production model with parameter estimation method;		
	Assignment 2	Due 3/25	
L7	Species interactions (competition and predator-prey models, NPZ	Quinn and Deriso	Discussion
3/23	models)	1999 Ch 1.1.4;	leadership
	Discuss papers on species interaction and implication in fisheries		
3/25	population dynamics and management		
L8	Stock-Recruitment Theory and Practice	King 2007	Discussion
		Ch4.3.6; Haddon	leadership
3/30	Discuss papers on Stock-Recruitment Theory and Practice	2001 Ch 9;	
4/1	Advanced modeling method on SR analysis, a quick introduction		
L9	per-recruit models (YPR, EPR, BPR, SPR)	King 2007	Discussion
4/6		Ch5.4.2; Haddon	leadership
4/8	Discuss the use of per-recruit models	2001 Ch2.8;	
	YPR, EPR, BPR, SPR		

	Assignment 3	Due 4/16	
L10 4/13 4/15	Life history theory and Matrix models (age, size and stage structured models); Sensitivity/elasticity analysis for matrix models; Discuss papers on elasticity analysis for matrix model	Jensen 1974 ; introduction handout ;	Discussion leadership
L11 4/20	*Guest Lecture: Freshwater fisheries management using weight-length relationship as an indicator*		
L12 4/22 4/27	Catch-at-age analysis (Virtual Population Analysis, cohort analysis) Catch-at-age analysis (Sequential Population Analysis, ADAPT)	King 2007 Ch 5.4.1; Haddon 2001 Ch 11.2; Haddon 2001 Ch11.3;	
	Assignment 4	Due 4/30	
L13 4/29	Biological reference points and alternative management strategies; a review and a further step beyond BRP estimation	King 2007 Ch 6;	
L14 5/4 5/6	**Case review** in fisheries stock assessment Student presentation of project plans Or one flexible topic based on the ***week 1 discussion of what students want to learn from this course*** Other branches in population dynamics and quantitative ecology if there is time left.	**Project plan due 5/8**	

***1: students who want to provide/recommend other reference papers are welcome to talk with the instructor.**
***2: Lecture outlines** are provided at least two days before each class. The objectives of lecture outlines are to sketch the information that students will learn, guide the students through the corresponding materials from the recommended textbook or other primary literature, and aid the students with reviewing the corresponding content after class.

LAB TOPICS (Excel spreadsheet will be used for all these models; however, students are encouraged to code them using MATLAB or R or other programs that are suitable for further computation)

Topics	Other
Individual growth models and parameter estimation method (objective function of OLS, error types) Mortality/survival estimation Basic population dynamics models (spreadsheets, forward and backward projection) Population growth models (exponential, logistic, time lag) Production model and parameter estimation Stock-recruitment modeling (models, error types, estimation methods) Per recruitment models YPR Matrix model (Leslie) Cohort analysis ADAPT	Ready-to-use software (such as ASPIC, ADAPT) will be introduced but is not the focus of the lab

Northeast Fisheries Science Center software toolboxes http://nft.nefsc.noaa.gov.

LABORATORY ACTIVITIES

Computer-assisted activities will be assigned weekly. These include quantitative analysis of population models, spreadsheet calculations, Matlab codes (not required but encouraged), and application of population analysis techniques. Students are required to finish their lab assignment before the end of each lab.

EVALUATION

Final grades will be based on:

Task	Qty x Value	Total
Assignment 1 - 4	4 x 5%	20%
Case studies prepared for class discussion		20%
Review of a population dynamics and stock assessment case		15%
Lab assignment		10%
Discussion summary		10%
Discussion leadership		10%
Project plan (5% for the proposal rationality; 5% for the written plan and 5% for the presentation)		15%
		100%

Assignments 1-4 follow corresponding lectures. Students are encouraged to discuss assignments but are required to complete the work independently. The assignments are designed to encourage students to work on real fisheries issues. Real datasets and questions will be given for the students to apply appropriate models to the data, and answer corresponding questions related to fisheries population dynamics and/or management. Grading will be based on the accuracy of the result and logic of the answers.

Case studies should be read before the class to aid the student in developing possible hypotheses and tests for these hypotheses. Students are encouraged to discuss and work as small groups. Instructor will give lectures related to population ecology, mathematical models and estimation methods appropriate to understand the corresponding cases. No assignment or homework is required. Class participation and discussion among students and instructor are highly encouraged. Also see Attachment 1.

Reviews of population dynamics and stock assessment cases allow the students to review population dynamics and stock assessments provided by the instructor, and place themselves in the role of population ecologists and stock assessment scientists (you will be soon!). Also see Attachment 2.

Lab assignments are not required to be handed in but students are encouraged to finish all lab questions before they leave. Lab questions are usually revisions or modifications of the examples presented by the instructor during the lab. Students are free to use the computing languages of their choice do the assignments.

Discussion summary (questions will be sent to the students by the end of the previous lecture) is a short reflective summary with 3 to 5 sentences to summarize the questions. This summary will be further elaborated during the class discussion. Also see Attachment 3.

In-class discussion leadership and summary (highlighted in yellow) requires the students to read, understand, and summarize the contributions and problems in a peer-reviewed journal paper(s). Students are also required to distribute their summary to the class and lead the discussion on this specific paper(s) and/or topics with the help of the instructor. Also see Attachment 4.

The project plan can be an application of a model from your project, or a development of a new model. Suitable project plans combine traditionally used models with other factors that influence the population dynamics, such as environmental variables, prey availability, habitat information, spatial structure, special life history and physical processes; or develop a new model which can incorporate uncertainty or processes not commonly addressed in your field. Expected length is 2-3 pages, not including references. Guidance will be provided. Also see Attachment 5.

Grading

Grading will be assigned as described in the Undergraduate Catalog. Final grades will include a "+" and " –." We feel that a "C" indicates adequate performance and that a "B" or an "A" indicate "good" and "superior" work. Your grades are determined independently and you will not be competing against other students for the "curve." Grades will be assigned according to a curve no stricter than the following schedule:

Letter Grade	% of Total Points	
A	>93	Your grade will be determined by your performance on the assessments described in the above section.
A-	90-92.9	
B+	87-89.9	
B	83-86.9	
B-	80-82.9	
C+	77-77.9	
C	73-76.9	
C-	70-72.9	
D+	67-69.9	
D	63-66.9	
D-	60-62.9	
F	<60	

ABSENCE POLICY:

Students are expected to attend each class and lab. No make-up lectures and labs will be given.

CHANGES TO SYLLABUS:

The instructor reserves the right to make changes to the syllabus during the course. Any necessary changes will be announced in class and posted on the course website.

HONOR CODE STATEMENT:

"The Virginia Tech Honor Code embodies a spirit of mutual trust and intellectual honesty that is central to the very nature of the university, and represents the highest possible expression of shared values among the members of the university community. The Honor Code is the University policy which expressly forbids the following academic violations:

1. Cheating -- Cheating includes the actual giving or receiving of any unauthorized aid or assistance or the actual giving or receiving of any unfair advantage on any form of academic work, or attempts thereof.
2. Plagiarism -- Plagiarism includes the copying of the language, structure, ideas and/or thoughts of another and passing off same as one's own, original work, or attempts thereof.

3. Falsification -- Falsification includes the statement of any untruth, either verbally or in writing, with respect to any circumstances relevant to one's academic work, or attempts thereof.

Therefore, the student body at Virginia Tech will not tolerate any violation of the Honor Code. All students, upon admission to this University, have pledged to abide by the Honor Code. Any student found by the appropriate forum within the Honor System to have violated the Honor Code shall be deemed guilty as charged."

I encourage students to work together when studying for class and in reviewing drafts of assignments. The work that you hand in for a grade should be your own. I will report any suspected honor code violations to the Honor System Office. If you have any questions about what is or is not appropriate behavior, please contact me immediately. Cheating, plagiarism, and falsification are completely at odds with the educational process.

DISABILITIES:

Any student that is in need of special accommodations due to a disability, as recognized by the Americans with disabilities Act, should contact the Services for Students with Disabilities (SSD; http://www.ssd.vt.edu). In addition, if you need adaptions or accommodations because of a disability (e.g., learning disability, attention deficit disorder, psychological, physical), if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible.