Methods in Fisheries Assessment

Lectures:

Mon., 10:30-12:20 RCB 7102 (Robert C. Brown Hall)
Wed., 2:30-4:20 RCB 7102

If we're having a computer lab: Fisheries Computer Lab, TASC I, Room 8410

OBJECTIVES OF THE COURSE

At the completion of the course the student will be able to:

- Identify the basic biological and ecological characteristics of marine exploited populations and how these are affected by fishing
- Estimate yields using simple deterministic population models
- Examine effects of variability and stochasticity in population dynamics
- Apply linear and non-linear regression methods to the estimation of biological and population parameters
- Develop an assessment of an exploited fish stock using standard methods
- Criticise the assessment in terms of possible departures from the underlying assumptions

PREREQUISITES

Students will require permission from the instructor at least one week before the course begins.

COURSE THEORY / LAYOUT

The course has been organized such that lectures and discussion will reinforce the readings; the labs will put the lectures, discussions, and reading material into practice; and the assignments will give you a chance to build upon what you have already seen, heard, and done. Computer labs will take place sporadically throughout the course and will be held in the Fisheries Computer Lab during the regularly-scheduled class periods. Each lab will last between one and two hours depending on the topic.

GRADES

Students in this course are graded on a mix of individual, group and class achievements. A good grade in this course depends on developing the ability to work in teams and to contribute to class discussions. Students will be graded a total of 5 assignments, each worth 18%. Participation in class discussions will contribute10%.

Each student is to do their own work. These will not be group projects, per se. You should feel free to help one another overcome obstacles and discuss your final results with your peers; however, it is important to remember that such things as debugging is an important part of the learning process when it comes to modelling and programming. The skills you'll be gaining here are transferable to many other areas beyond fisheries assessment, and you will be selling yourself short if you do not put forth a concerted effort on your own prior to consulting with your peers.

To be fair to all students University policy requires that deferred grades are given only under extreme and exceptional circumstances, such as illness or death in the family. A heavy

workload is not a sufficient justification for a deferred grade. There are no exceptions to this policy.

Students should schedule their assignment work as evenly as possible throughout the semester. Start each assignment early.

TEXT

Hilborn, R. and C.J. Walters. 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty. Chapman and Hall. ISBN: 0-412-02271-0. Available as a zipped PDF

Cooper, A.B. 2006. A Guide to Fisheries Stock Assessment: From data to recommendations. New Hampshire Sea Grant, Durham, NH. 44 pgs. Available for download at http://www.seagrant.unh.edu/newsstock.html

Other relevant readings will be assigned throughout.

COMPUTATIONAL TOOLS

The primary tool for this course will be MS Excel; however, some analysis may require R, because they can not be performed in MS Excel.

INSTRUCTOR'S OFFICE HOURS

I will hold regular office hours (times to be decided during first class). I will be in my office during those hours to discuss any questions or concerns you may have. Occasionally, my office hours may clash with some other commitment, but to the extent possible I will advise the class of alternative times at the latest by the preceding class. Unless there is a major crisis I would like to keep the remaining time relatively uninterrupted to concentrate on preparing new course material, grading assignments, doing research and so on. I will very much appreciate your cooperation. Thank you.

TOPICAL COURSE OUTLINE

THE SCOPE OF FISHERIES AND FISHERIES MANAGEMENT

THE BIOLOGY AND ECOLOGY OF HARVESTED MARINE ORGANISMS

- Life history strategies
- Ecological processes that effect harvested marine populations
  - Biotic processes
    - Competition
    - Predation
  - Physical processes
    - Environment
      - Variability at various spatial and temporal scales
      - Global change spatial and temporal scales
- Ecological aspects of fishing
  - Community effects - including intra and inter-specific competition
  - By-catch
  - Fishing down
  - collateral effects
  - selection pressure

THE THEORY OF HARVESTING
(Particular attention will be on explicit and implicit assumptions)

- Harvesting is a particular case of perturbation
- Concept of stock
  - Density dependence and MSY
  - Recruitment
    - Stock recruitment relations as density dependent processes
    - Yield per recruit
  - Mortality
  - Growth
  - Basin models - density dependent habitat selection
  - Interspecific interactions
- Concept of dynamic equilibrium
  - Transients, time constants and equilbria
- Theory of fishing
  - Baranov's equation and discrete time equivalents
  - Age structured models
  - Overfishing
    - Growth
    - Recruitment

Identification of the key variables for the application of the theory and their estimation; what are the difficulties in applying the theory, what are the sources and effects of variability on the estimates?

INTRODUCTION TO THE THEORY OF ESTIMATION

- Fitting models to data
  - Basic concepts and terminology
    - Explanatory models and parameters
    - Dependent and independent variables
    - Statistical models
      - Bias and precision
    - Prediction and calibration
    - Data Exploration
  - Regression methods
    - Linear
    - Non-linear
    - The origins and nature of variability in the data
      - Process error versus sampling error
  - Fitting criteria - least squares, weighted least squares and maximum likelihood
    - Bayesian estimation
  - Evaluating goodness of fit – model criticism
  - Traps for the unwary
    - Weakness of 'natural experiments'
    - Confounding
    - Spurious correlation and indirect causation
    - One way trips
    - Transformations that mix dependent and independent variables
      - $f(E[x]) \neq E[f(x)]$
  - Measures of uncertainty
    - Likelihood profiles and other asymptotic measures
      - Joint, conditional and marginal likelihoods
    - Re-sampling methods

ESTIMATING BIOLOGICAL PARAMETERS
(Each topic will discuss assumptions, data, methods and difficulties)

- Stock Identity
  - Mixing
  - Migration
  - Age
- Length
- Age-length keys
- Spawning stock and recruitment relationships
- Growth
  - Growth curve by length and weight
  - Mass at length relationships
- Mortality and predation

ESTIMATION OF SUSTAINABLE YIELD

- Shaefer method
- Yield per recruit and $F_{0.1}$
- Optimal escapement
- Projection methods

ESTIMATION OF ABUNDANCE AND TRENDS IN ABUNDANCE

- Surveys
  - Trawl
  - Acoustic and other line transect
  - Eggs and Larvae
  - CPUE
- Mark - recapture
- VPA

ESTIMATION OF FISHING MORTALITY

- Age data
- Mark - recapture
- Virtual Population Analysis
  - Tuning
  - Separable VPA

DEVELOPMENT AND CRITICISM OF AN ASSESSMENT

- Sensitivity analyses
- Uncertainty
- Management advice
- Future research requirements

ROUGH TEMPORAL COURSE OUTLINE

Wednesday, Sept 5	Introduction, course outline, Stock assessment in context
Monday, Sept 10	Stock Assessment in Context
Wednesday, Sept 12	Whirlwind tour - hang on to your hats!
Monday, Sept 17	Dynamics of Exploited populations: Age-aggregated model
Wednesday Sept 19	**LAB 1**: Intro to Excel and Age-aggregated models **(Assignment 1)**
Monday, Sept 24	Dynamics of Exploited populations: Age-Structured models
Wednesday, Sept 26	Age-structured models, growth curves, maturity ogives, and selectivity
Monday, Oct. 1	**LAB 2**: Harvesting stochastic, structured populations **(Assignment 2)**
Wednesday, Oct 3	The grand tour of fisheries data, Part 1
Monday, Oct 8	**THANKSGIVING HOLIDAY**
Wednesday, Oct 10	The grand tour of fisheries data, Part 2
Monday, Oct 15	Parameter Estimation: The basics
Wednesday, Oct 17	Linear Models, CPUE Standardization, and Stock-recruitment
Monday, Oct 22	Guest Lecture
Wednesday, Oct 24	Guest Lecture
Monday, Oct 29	Guest Lecture
Wednesday, Oct 31	**LAB 3**: Fitting models to data **(Assignment 3)**
Monday, Nov 5	Fitting biomass dynamic models
Wednesday, Nov 7	**LAB 4**: Fitting biomass dynamic models to data **(Assignment 4)**
Monday, Nov 12	REMEMBRANCE DAY HOLIDAY
Wednesday, Nov 14	Fitting age-structured models: catch curves and VPA
Monday, Nov 19	Fitting Age-structured models: Statistical catch-at-age
Wednesday, Nov 21	**LAB 5**: Fitting stastistical catch-at-age models
Monday, Nov 26	Targets, Thresholds, and harvest strategies
Wednesday, Nov 28	**LAB 6**: Estimating targets and thresholds **(Assignment 5)**
Monday, Dec 3	Ecosystem models