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Meeting times: Thursday 10:30 – 2:20 Fisheries Computer Lab

Office hours TBA

Objectives of the course
After completing the course, students will:
1. possess fundamental skills in population dynamics modeling, parameter estimation and statistics, and harvest policy analysis in support of fisheries management decisions;
2. be able to develop simulation analyses to assess bias and precision of stock assessment methods and harvest recommendations;
3. apply critical evaluation skills to advice derived from fisheries stock assessments;
4. characterise and communicate risks and the consequences of uncertainty in fish stock assessments;
5. communicate practical advice to non-technical audiences.

Style of the course
The course covers the range of topics commonly encountered in modern stock assessments for marine and freshwater fisheries (although these topics are readily extended to assessment of terrestrial and marine wildlife as well). Non-linear parameter estimation and the performance of population dynamics and statistical models are the core themes that span these topics. Classroom discussion and hands-on computer lab sessions develop the biological, mathematical, and statistical background required for fisheries modelling and management as well as simulation approaches for performing and evaluating stock assessments. Course material and assignments are based on issues and approaches relevant to the management of marine and freshwater fisheries.

Main topics covered in REM 614

Quantitative Methods
1. Linear and non-linear parameter estimation methods for population dynamics models
2. Analytical and numerical maximum likelihood methods
3. Bayesian estimation
4. Open- and closed-form multivariable optimization
5. Modelling and estimation in MS Excel, R, and AD Model Builder software
6. Estimator performance testing using parametric and non-parametric bootstrapping

Stock assessment models and techniques
1. Stock-recruitment analysis
2. Closed and open population depletion estimators
3. Deterministic and stochastic population dynamics models
4. Mixed-error stock assessment models
5. Closed-loop harvest strategy evaluation
6. Area-under-the-curve escapement estimation
7. Statistical catch-at-age and Stock Synthesis methods
8. Retrospective analysis
9. Fisheries risk assessment
10. Passive and active adaptive management

Recommended Texts:
The following represent the most useful texts for quantitative modeling and assessment of fisheries and wildlife resources.


Williams, B.K., Nichols, J.D., and Conroy, M.J. 2002. *Analysis and management of animal populations*. Academic Press, San Diego, CA. Note: this book contains both basic and advanced sections on topics ranging from parameter estimation and survey design to optimal control and adaptive management. It is the most comprehensive book available on population assessment.


Student evaluation and grading
Evaluation will be based on five assignments involving the development and application of stock assessment techniques to either fake or real data. Most assignments will involve data analysis, population dynamics and statistical model formulation, computer implementation, and report writing. Grading is based on technical competence, critical evaluation, and communication.

Prerequisite courses
Students in this course should have basic knowledge of Fisheries Science and Management, Applied Ecology, and Statistics. Courses such as REM 613 (Fisheries Stock Assessment), REM 611 (Applied Population and Community Ecology), and REM 612 (Simulation Modelling in Natural Resource Management) provide most of the necessary background. Although not required, students who are not familiar with basic probability, likelihood, and Bayesian methods are also encouraged to take at least one upper level or graduate course in either Basic Probability, Risk Assessment (e.g., REM 625) or Experimental Design (e.g., STAT 650). We currently use R statistical software and MS Excel for quantitative work, although others such as Mathcad, Maple, AD Model Builder or Visual Basic could be used. Beginning in Fall 2012, there will be tutorials for using AD Model Builder.

**Example Literature**

The following are examples of advanced topics in stock assessment that should become accessible (i.e., readable, understandable, workable) to students during and after completion of REM 614. Papers marked with "**" will be used to guide class discussion and assignments. Additional literature will be provided as needed.

*Schnute, J. and Richards, L. 1995. Influence of error on population estimates from catch-age models. CJFAS 52:2063-2077

Readings by topic. Journal articles shown in **bold** are required reading. Normal font and text references are optional. Readings on topics outside this list may be assigned as needed.

1. Depletion models
   Hilborn and Walters 1992: Ch 12

2. Stock-recruitment analysis (A2)
   Hilborn and Walters 1992: Ch 12
   **Schnute and Kronlund 1996. A management oriented approach to stock recruitment analysis. CJFAS 53: 1281-1293**
   **Myers et al. 1999. Maximum reproductive rate of fish at low population sizes. CJFAS 56: 2404-2419.**

3. Omniscient manager simulation/Open form optimization

4. Area-under-the-curve escapement estimation

5. Risk assessment in fisheries

Page 4 of 5
revised 2 September 2010

6. Mixed-error production models
   Punt 2003. Extending production models to include process error in the population dynamics. CJFAS 60: 1217-1228.

7. Statistical catch-age and Stock Synthesis

8. Closed loop feedback simulation

9. Adaptive management

10. Multi-species assessment
   Walters et al. 1997. Structuring dynamics models of exploited ecosystems from trophic mass-balance assessments. Rev in Fish Biol Fisheries 7: 139-172. (original Ecosim paper!)