Simon Fraser University
School of Resource and Environmental Management

Advanced Methods in Fisheries Assessment

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Lectures: Wednesday 3:30pm – 5:20pm (WMC 2533)

Lab Tutorials: Fridays 9:00am – 11:00am (Fisheries Computer Lab)

Office hours TBA

Objectives of the course

After completing the course, students will:

1. develop fundamental skills in population dynamics modeling, parameter estimation and statistics, and policy analysis in support of fisheries management decisions;
2. 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 the consequences of uncertainty in fish stock assessments;
5. communicate practical advice to non-technical audiences.

Style of the course

The course will cover the fundamentals of model parameter estimation and the performance of population dynamics and statistical models. The central theme of the course considers fisheries as systems that include controls, dynamics, measurements, and performance measures. Classroom and discussion sessions include the biological, mathematical, and statistical background required for fisheries modelling and management. Computer lab sessions develop tools such as quantitative models, estimation, and 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. Parameter estimation methods for linear and non-linear models
2. Analytical and numerical maximum likelihood methods
3. Empirical variance estimation methods

4. Bayesian estimation methods
5. Model selection criteria and evaluation (information theoretic and retrospective approaches)
6. Estimator performance testing using computer simulation
7. Hierarchical models

Stock Assessment
1. Trend analysis
2. Random, Stratified, and Systematic survey designs
3. Stock-recruitment models
4. Formulating and testing stochastic production models
5. Introduction to management strategy evaluation
6. Removal estimators of abundance
7. Area-under-the-curve abundance estimation
8. Spatial assessments

Recommended Texts:
Gelman, Andrew, and Hill, Jennifer, 2007. Data analysis using regression and multilevel/hierarchical models. Cambridge University Press, New York. (I highly recommend getting a copy of this book).

Hilborn, R. and Walters, C.J. 1992. *Quantitative Fisheries Stock Assessment: choice, dynamics, and uncertainty*. Kluwer Academic Publishers, Norwell, MA. (This is the basic reference text on fisheries stock assessment. It is written in a very accessible way)

Williams, B.K., Nichols, J.D., and Conroy, M.J. 2002. Analysis and management of animal populations. Academic Press, San Diego, CA. (1 will be on 4-hour reserve in the library). (this book contains both basic and advanced sections on topics ranging from parameter estimation to optimal control. It is an excellent resource book).

Student evaluation and grading
Evaluation will be a combination of in-class examination(s) and out-of-class assignments, one for each unit in the course (20% each). Most assignments will involve data analysis, population dynamics and statistical model formulation, computer implementation, and reporting. 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 WinBUGS for quantitative work, although others such as Mathcad, Maple, Microsoft Excel or Visual Basic could be used.

Example Literature

The following are examples of the types of literature that should become accessible (i.e., readable, understable, workable) to students during and after completion of REM 614. Some papers will be used to guide class discussion and assignments.

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

Walters, C.J. and Punt,A. 1994. Placing odds on sustainable catch using virtual population analysis and survey data. CJFAS 51: 946-958.

Botsford, L.W. and Wickham, D.E. 1978. Behaviour of age-specific, density-dependent models and the Northern California Dungeness Crab fishery. J. Fish. Res. Board Can. 35: 833-843.

Schnute, J.T. and Richards, L.J. 2001. The use and abuse of fishery models. CJFAS 58: 10-17.

Parma, A.M. and Deriso, R.B. 1990. Experimental harvesting of cyclic stocks in the face of alternative recruitment hypotheses. CJFAS 47: 595-610.

Meinhold, R.J. and Singpurwalla, N.D. 1983. Understanding the Kalman Filter. The American Statistician 37(2): 123-127.

Walters, C. 1998. Evaluation of quota management policies for developing fisheries. 55: 2691-2705.

Parma, A.M. 2002. Bayesian approaches to the analysis of uncertainty in the stock assessment of Pacific halibut. AFS Symposium 27: 113-136.

Walters, C.J. 1987. Non-stationarity of production relationships in exploited populations. CJFAS 44:156 – 165

Cooke, J.G. 1999. Improvement of fishery-management advice through simulation testing of harvest algorithms. ICES J. of Mar. Sci. 56: 797-810 (see other references in this ICES issue).

Walters, C.J. 1989. Value of short-term forecasts of recruitment variation for harvest management. CJFAS 46: 1969-1976.

Link, M.R. and Peterman, R.M. 1998. Estimating the value of in-season estimates of abundance of sockeye salmon (Oncorhynchus nerka). CJFAS 55: 1408-1418.

Walters, C.J. and Bonfil, R. 1999. Multispecies spatial assessment models for the British Columbia groundfish trawl fishery. CJFAS 56: 601-628.

Martell, S.J.D. and Walters, C.J. 2001. Implementing harvest rate strategies by directly monitoring exploitation rates and estimating catchability changes. Bull. Mar. Sci. 70: 695–713.

Walters, C.J. 2004. Simple representation of the dynamics of biomass error propagation for stock assessment models. CJFAS 61: 1061–1065.

McAllister, M. and Kirkwood. 1998. Using Bayesian decision analysis to help achieve a precautionary approach for managing developing fisheries. CJFAS 55: 2642–2661

Schnute, J.T. and Kronlund, A.R. 2002. Estimating salmon stock-recruitment relationships from catch and escapement data. CJFAS 59: 433-449.

Myer, R. and Millar, R.B. 1999. Bayesian stock assessment using a state-space implementation of the delay-difference model. CJFAS 56: 37-52.