Course Number: **MAR 580**
Course Title: **Advanced Population Modeling**
Instructors:

Gavin Fay, Assistant Professor
School for Marine Science & Technology
SMAST II 325; (508) 910-6363; gfay@umassd.edu

Steve Cadrin, Associate Professor
School for Marine Science & Technology
SMAST II 315; (508) 910-6358; scadrin@umassd.edu

Class Location: SMAST II Room TBD
Class Time: Tuesday 9:30-12:00
Office Hours: Tuesday afternoon or by appointment

Course Description: This course provides instruction, demonstration and exercises in advanced population modeling, as applied to fishery resources. A wide range of stock assessment methods will be developed through statistical programming to fit increasingly complex models to fishery data through estimation of parameters and their variance. Programming software, including Automatic Differentiation (AD) Model Builder, will be used for class assignments. The course is designed to train students to "have the ability to conduct high-quality scientific research in stock assessment, fishery population dynamics and related fields" (U.S. Dept. Commerce and U.S. Dept. Education 2008 NOAA Tech. Mem. NMFS-F/SPO-91).

Course Objectives:
1. Familiarity with advanced stock assessment models
2. Experience in basic model building and parameter estimation
3. Understanding of quantitative theories, model diagnostics and results

Prerequisites:
Students should have taken coursework in applied statistics (e.g. MAR 535) and population dynamics (e.g. MAR 544), or seek permission from the instructors.

Evaluation procedures:
1. Semi-weekly assignments on advanced population models will be evaluated based on analytical approach, correct solution, and appropriate interpretation (80%). Submissions of all analytical assignments should include:
    a. A brief report with text, tables and figures (e.g., Word file and hard copy) stating the problem, modeling approach, parameter estimates, evaluation of goodness-of-fit, and interpretation of model results,
    b. Documentation of complete analytical results (e.g., ADMB input and output files).
2. Final project that expands on one of the model types covered in lecture and assignments (20%).
    a. A more detailed term paper (~10 pages of text) plus tables and figures (e.g., Word file and hard copy) stating the problem, modeling approach, parameter estimates, evaluation of goodness-of-fit, and interpretation of model results,
    b. Documentation of complete analytical results (e.g., R scripts, ADMB files).

3. Attendance at all lectures is the best way to understand topics and assignments, but is not required for evaluation.
4. Failure to complete any of these requirements for evaluation will result in a score of zero for missing components. A final grade of 'incomplete' may be recorded at the request of the student and the discretion of the professor.
5. University policy on academic dishonesty, including plagiarism, applies (see: http://www.umassd.edu/studenthandbook/academicregs/ethicalstandards.cfm).

Required Hardware: laptop computer

Required Software:
1. R (free download at http://r-project.org, students may also wish to install Rstudio, an integrated development environment for R, free download at http://www.rstudio.com)
2. AD Model Builder (free download at http://admb-project.org)

Reading (pdfs distributed by professors):

Bolker, B. M. 2008. Ecological models and data in R. Princeton University Press.

Bunnefeld, N., Hoshino, E., & Milner-Gulland, E. J. 2011. Management strategy evaluation: a powerful tool for conservation?. Trends in Ecology & Evolution, 26: 441-447.

Cooch E & G White, eds. 2009. Program MARK: a gentle introduction. 7th edition.

Dorn M. 2002. Advice on west coast rockfish harvest rates from Bayesian meta-analysis of stock- recruit relationships. North American Journal of Fisheries Management, 22: 280–300.

Fournier DA. 2008. An Introduction to AD Model Builder Version 9.0.0 For Use in Nonlinear Modeling and Statistics. http://admb-project.org.

Fournier DA, HJ Skaug, J Ancheta, J Ianelli, A Magnusson, MN Maunder, A Nielsen & J Sibert. 2011. AD Model Builder: using automatic differentiation for statistical inference of highly parameterized complex nonlinear models. Optimization Methods and Software 2011: 1-17.

Haddon, M. 2001. Modelling and Quantitative Methods in Fisheries. CRC Press.

Hilborn, R. and C.J. Walters. 1992. Quantitative Fisheries Stock Assessment: Choice, Dynamics, and Uncertainty. Chapman and Hall.

Legault, C.M. and V.R. Restrepo. 1998. A flexible forward age-structured assessment program. ICCAT Working Doc. SCRS/98/58.

Maunder MN & AE Punt. 2013. A review of integrated analysis in fisheries stock assessment. Fisheries Research 142: 61-74.

Newman, K. B., Buckland, S. T., Morgan, B. J., King, R., Borchers, D. L., Cole, D. J., Besbeas, P., Gimenez, O., & Thomas, L. (2014). Modelling Population Dynamics. Model formulation, fitting and assessment using state-space methods. Springer.

Polachek T, R Hilborn & AE Punt. 1993. Fitting surplus production models: comparing methods and measuring uncertainty. Can. J. Fish. Aquat. Sci. 50: 2597–2607.

Punt, A. E., & Hilborn, R. 1997. Fisheries stock assessment and decision analysis: the Bayesian approach. Reviews in Fish Biology and Fisheries, 7(1), 35-63.

Punt, A. E., Butterworth, D. S., Moor, C. L., De Oliveira, J. A., & Haddon, M. (2014). Management strategy evaluation: best practices. Fish and Fisheries.

Thorson, J. T., & Minto, C. 2014. Mixed effects: a unifying framework for statistical modelling in fisheries biology. ICES Journal of Marine Science. doi: 10.1093/icesjms/fsu213

Course topics outline:

Date	Topic	Assignment	Reading
9/1	Introduction to Programming	Linear Models in ADMB	Fournier et al. 2011
9/8	Maximum Likelihood	Mark-Recapture Experiment	Cooch & White 2009 (Ch1)
9/15	Mixed-Effects Models	Stock-Recruitment Meta-Analysis	Thorson & Minto 2014, Dorn 2002
9/22	guest lecture		
9/29	Simple Population Models	Biomass Dynamics	Polachek 1993
10/6	State-Space Models	Univariate Linear State Space Model	Newman et al 2014 (Ch3-4)
10/13	no class (Monday schedule)		
10/20		Review assignments & discuss term papers	
10/27	Model Building & Model Selection	Time-Varying Parameters	Cooch & White 2009 (Ch4-5)
11/3	Simulation testing	Reference point estimation	Bolker 2008 (Ch5)
11/10	Multi-State Models	Survival & Movement	Cooch & White 2009 (Ch8)
11/17	Bayesian Methods	Rebuilding analysis	Punt & Hilborn 1997
11/24	Age-Structured Models	Statistical Catch-at-Age	Maunder & Punt 2013
12/1	Management Strategy Evaluation	Performance of empirical harvest control rules	Bunnefeld et al 2011
12/8	Review	Discuss term papers	

Schedule and readings subject to change.