

**Course Number:** MAR 580  
**Course Title:** Advanced Population Modeling  
**Instructors:** Gavin Fay, Assistant Professor  
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**Class Location:** SMAST East Room 247 (temporarily SMASTE 132)  
**Class Time:** Tuesday/Thursday 9:30-10:45 (Tuesday lecture, Thursday lab)  
Recitation Tuesday/Thursday 11:00-12:00  
**Office Hours:** By appointment

**Course Description:** Instruction, demonstration and exercises in advanced population modeling, as applied to fisheries. 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 and Template 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 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 536) and population dynamics (e.g. MAR 544), or seek permission from the instructors.

**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>)
3. Template Model Builder (an R package, can be installed from CRAN via the usual ‘install.packages()’ function).

**Evaluation procedures:**

1. Four homework assignments (90%) on advanced population models will be evaluated based on analytical approach, correct solution, and appropriate interpretation. Analytical components of assignments should include submission of complete analytical results (e.g., model scripts and input and output files). Assignments should be accompanied by a written report (e.g. Word doc) that provides answers to the assignment questions. Assignments are due before class on the due date by email, and two printed copies of the report to be submitted in class.
2. Participation (10%), including engagement in discussions during lecture and labs. Attendance at the weekly lectures and labs is the best way to understand topics and assignments. Absence from class and labs can be requested in advance.
3. Late submissions will be penalized 10 points (out of a 100) for each day that an assignment is late – assignments submitted later than three days after the deadline will not be graded.
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>).

**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.
- Cadrin, S.X. 2014 Do Not Believe Your Model Results. In *Future of Fisheries: Perspectives for the Next Generation of Professionals*, A. Lynch, N. Leonard & W. Taylor, eds. American Fisheries Society Press.
- Cooch E & G White, eds. 2009. Program MARK: a gentle introduction. 7th edition.
- Deroba J.J. and 30 co-authors. 2015. Simulation testing the robustness of stock assessment models to error: some results from the ICES Strategic Initiative on Stock Assessment Methods. *ICES JMS* 72: 19-30.
- 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.
- Edwards, CTT & DJ Dankel, eds. *Management Science in Fisheries: an introduction to Simulation-Based Methods*. Taylor & Francis pp 319-347.
- 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.
- Goethel D, TJ Quinn II & SX Cadrin. 2011. Incorporating Spatial Structure in Stock Assessment: Movement Modeling in Marine Fish Population Dynamics. *Reviews in Fisheries Science* 19:119–136.
- Haddon, M. 2001. *Modelling and Quantitative Methods in Fisheries*. CRC Press.

- Hilborn, R. 1990. Estimating the parameters of full age structured models from catch and abundance data. *Int. North Pac. Fish. Comm. Bull.* 50:207-213.
- 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.
- Mace, P.M. 1994. Relationships between Common Biological Reference Points Used as Thresholds and Targets of Fisheries Management Strategies. *Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51: 110-122, <https://doi.org/10.1139/f94-013>.
- Maunder MN & AE Punt. 2013. A review of integrated analysis in fisheries stock assessment. *Fisheries Research* 142: 61-74.
- Myung, I.J. 2003. Tutorial on maximum likelihood estimation. *Journal of Mathematical Psychology* 47: 90–100.
- 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.
- Punt, A.E. 2003. Extending production models to include process error in the population dynamics. *Canadian Journal of Fisheries and Aquatic Sciences* 60: 1217-1228. <https://doi.org/10.1139/f03-105>
- 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.
- Restrepo, V.R. & Legault, C.M. 1998. A Stochastic Implementation of an Age-Structured Production Model. In *Fishery Stock Assessment Models Alaska Sea Grant College Program AK-SG-98-01*, 1998.
- 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 (subject to change):**

<b>Date</b>	<b>Type</b>	<b>Topic</b>	<b>Reading</b>	<b>Assignment</b>	<b>Instructor</b>
<b>7-Sep</b>	Lecture	Introduction & Likelihood Review	Myung 2003, Cooch & White		Steve
<b>12-Sep</b>	Lecture	Numerical methods review	Bolker et al. 2008		Gavin
<b>14-Sep</b>	Lab	Intro to programming: linear models	Fournier 2008		Gavin
<b>19-Sep</b>		ICES MEETING			
<b>21-Sep</b>		ICES MEETING			
<b>26-Sep</b>	Lecture	Biomass dynamics	Hilborn & Walters Ch.8, Punt 2003		Steve
<b>28-Sep</b>	Lab	Surplus production modeling	Fournier 2008, Polacheck et al. 1993	HW1 assigned	Gavin
<b>3-Oct</b>	Lecture	Age structured models	Hilborn 1990		Steve
<b>5-Oct</b>	Lab	Age-Structure Production Model	Restrepo & Legault 1998		Steve
<b>10-Oct</b>	Lecture	Statistical Catch at Age	Legault & Restrepo 1998		Steve
<b>12-Oct</b>	Lab	SCAA	Fournier 2008	HW1 due, HW2 assigned	Steve
<b>17-Oct</b>	Lecture	Numerical Methods & Mixed effects	Thorson & Minto 2014		Gavin
<b>19-Oct</b>	Lab	Nonlinear mixed effects			Gavin
<b>24-Oct</b>	Lecture	State-space models	Newman et al. 2014		Gavin
<b>26-Oct</b>	Lab	State-space production models	Punt 2003	HW2 due, HW3 assigned	Gavin
<b>31-Oct</b>	Lecture	Integrated Models	Maunder & Punt 2013		Steve
<b>2-Nov</b>	Lab	Tag-Recovery	Cooch & White 2009, Goethel et al 2011		Steve
<b>7-Nov</b>	Lecture	Bayesian methods	Punt and Hilborn 1997		Gavin
<b>9-Nov</b>	Lab	Rebuilding analysis		HW3 due	Gavin
<b>16-Nov</b>	Lecture	Simulation testing	Deroba et al. 2015		Steve
<b>16-Nov</b>	Lab	Reference point estimation	Mace 1994		Steve
<b>21-Nov</b>	Lecture	State-space age structured models	Newman et al. 2014	HW 4 assigned	Gavin
<b>23-Nov</b>		<b>NO CLASS -THANKSGIVING</b>			
<b>28-Nov</b>	Lecture	Management Strategy Evaluation	Bunnefeld et al. 2011		Gavin
<b>30-Nov</b>	Lab	MSE	Edwards & Dankel Ch. 1-2.		Gavin
<b>5-Dec</b>	Lecture	Future directions and perspectives	Cadrin 2014		Steve
<b>7-Dec</b>	Lecture	Review – last day of class.		HW4 due	Steve

**Title IX statement:** The purpose of a university is to disseminate information, as well as to explore a universe of ideas, to encourage diverse perspectives and robust expression, and to foster the development of critical and analytical thinking skills. In many classes, including this one, students and faculty examine and analyze challenging and controversial topics.

If a topic covered in this class triggers post-traumatic stress or other emotional distress, please discuss the matter with the professor or seek out confidential resources available from the Counseling Center, <http://www.umassd.edu/counselling/>, 508-999-8648 or -8650, or the Victim Advocate in the Center for Women, Gender and Sexuality, <http://www.umassd.edu/sexualviolence/>, 508-910-4584. In an emergency contact the Department of Public Safety at 508-999-9191 24 hrs./day.

UMass Dartmouth, following national guidance from the Office of Civil Rights, requires that faculty follow UMass Dartmouth policy as a “mandated reporter” of any disclosure of sexual harassment, abuse, and/or violence shared with the faculty member in person and/or via email. These disclosures include but are not limited to reports of sexual assault, relational abuse, relational/domestic violence, and stalking. While faculty are often able to help students locate appropriate channels of assistance on campus, disclosure by the student to the faculty member requires that the faculty member inform the University’s Title IX Coordinator in the Office of Diversity, Equity and Inclusion at 508-999-8008 to help ensure that the student’s safety and welfare is being addressed, even if the student requests that the disclosure not be shared.

For confidential counseling support and assistance, please go to <http://www.umassd.edu/sexualviolence/>