# REM 612: Simulation Modelling in Natural Resource Management
# Spring 2016


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| ***Classes:*** | Thursdays | 10:30 - 2:20 PM AQ 5020 |
| ***Computer Labs:*** | | |


## Course overview

Contemporary environmental challenges involve complex interactions and feedback effects linking our social and economic choices to natural system processes. Simulation modelling helps us to understand, assess, and optimize these choices to better reflect resource management goals in the presence of uncertainties.

## Educational Goals for Students

REM 612 provides an introduction to simulation modelling methods and techniques used in contemporary natural resource management systems. The course provides hands-on experience where students develop research and problem-solving skills in scientific computing, model building, and analysis applied to a variety of resource management issues. After completing REM 612, students will be able to:

1. Apply modelling and R programming skills to resource management problems. Skills include conceptual models, scientific programming, R functions and packages, flow diagramming, pseudocode, data IO, graphics, and parallel processing;
2. Develop quantitative deterministic and stochastic simulation models ranging from population dynamics to simple management systems;
3. Implement Monte Carlo simulation procedures to evaluate performance of monitoring and research designs, estimate parameters for non-linear Bayesian models, and to simulate performance of decision-making procedures used in resource management;
4. Develop fast and efficient computer programs using parallel processing and interpolation methods;
5. Design and implement single and multi-variable numerical optimization procedures involving simulation models;
6. Critically evaluate study designs and environmental management policies by conducting sensitivity analyses to modelling assumptions;

7. Communicate the rationale, approach, results, and implications of simulation analyses to resource managers and stakeholders.

**Computer requirements:**
REM 612 is an applied, hands-on modelling course. Therefore, students must bring a laptop computer to every class.

**Required Software:**
 statistical computing software. Download the most recent Windows or Mac version at the **R**-project website. (http://www.r-project.org/).

**Optional software for systems analysis:**
STELLA® Systems Thinking Software. Students enrolled in REM 612 are eligible to obtain the student educational version from *isee Systems*. To preview the software, see their website: (http://www.iseesystems.com/softwares/Education/StellaSoftware.aspx).

Vensim PLE (Personal Learning Edition). Free system dynamics modelling software with interface and capability similar to STELLA.

**Optional software for non-linear parameter estimation:**
AD Model Builder (ADMB):
Students already familiar with R and who also wish to pursue advanced topics in non-linear optimization may find this optimization package useful. (http://admb-project.org).

**Format and Grades**
REM 612 involves class discussion, lectures, and hands-on computer programming exercises. Student grading is based on performance against the objectives listed above (1-7) in the following assignments:

1. **30% - Simulation Assignments** – short modelling and programming assignments approximately weekly;
2. **10% - Class Participation** – simulation modeling and programming are creative activities that benefit from a flow of ideas and alternative approaches. Students are expected to engage in class discussions, provide constructive feedback on peer presentations, and comment on modelling challenges where applicable;
3. **60% - Simulation Research Term Project** – each student will identify and implement a narrowly defined simulation research project in four parts:
    a. Project concept and scoping (*10%*) – a 15-minute presentation and discussion of project concept (due mid/late-January);
    b. Preliminary project presentation (*10%*) – present concept and leading in-class discussion of direction and alternatives (late-January);
    c. Final project presentation (*20%*) – 20-minute presentation of final project (April);
    d. Research paper (*20%*) – Journal manuscript format paper describing the background, research question, objectives, methods, results, and discussion/interpretation (due at final class).

**Schedule of Topics**

The following schedule of topics is intended as a guide to the structure and general order for REM 612. Students will gain modelling, programming, study design, and presentation skills and techniques in each of the following topics:

1. **Course overview (Alon 2009);**
2. **Approaches to model building;**
3. **Introduction to R (Maindonald 2001, Burns 2009, Chambers 2008);**
4. **Scientific Programming**
5. **Population dynamics simulation (Turchin 2003)**
6. **Simulation-Estimation of population growth models for British Columbia marine mammals**
7. **Probability distributions and Monte Carlo simulation (Limpert et al. 2001)**
8. **Power analysis: Simulation approach to monitoring program design (Gibbs et al. 1998)**
9. **Optimization approaches to non-linear parameter estimation (Walters and Hilborn 1978)**
10. **Simulating resource management feedback systems**
11. **Markov Chain Monte Carlo simulation for Bayesian estimation (Ellison 1998, Clark and Gelfand 2006)**

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