NREM 494
Environmental Problem Solving

SPRING 2005
Class MWF 11:30am-12:20pm Sherman Lab 103
Instructor Carol Ferguson, NREM Assoc. Professor
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Office hours T 3:00-3:45 and R 11:30-12:15

DESCRIPTION
Senior-level capstone for NREM and related majors. Ecosystem management within problem-solving context. Applications of research and analytical methods, management tools to case studies. Focus on student teamwork and oral communications.

OBJECTIVES
1. Integrate knowledge and skills from undergraduate studies in environmental sciences.
2. Utilize information and tools to solve real-world problems and manage resource systems.
3. Develop career-related skills including team organization and collaboration, time and information management, communications.

COURSE STRUCTURE
Course content is organized around six steps in the problem-solving process (see outline on pages 4-5). Each section includes general instruction on related concepts, methods and tools, plus a case study application(s). Class sessions will include lectures, case discussions and practicum labs, student presentations (see page 3 schedule). Spring 2005 case studies involve
• invasion of apple snails in Hawaii
• sustainable management of NW Atlantic harp seal population in Canada
• water quality of the St. Croix River (Minnesota-Wisconsin border).
Student teams will be formed to conduct the case studies, lead class discussions, assist with practicum labs, report research and practicum results.

ASSIGNMENTS AND GRADING
The attached outline lists general reading assignments from various print and online sources. Additional readings will be assigned for the case studies. Photocopies of print materials will be available in a reserved readings section in Sherman 201. The reading list gives URLs where students can access online materials.

Over the semester, each student will serve on four case study teams, including at least one Hawaii case team. Case team assisgnments are described in a separate handout (see Spring 2005 on pages 8-13). In addition, students will serve on an oral or written team for final reporting on Hawaii case study results.
Various assignments will account for the following portion of the final course grade:

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Participation in 4 case teams (15% each)</td>
<td>60%</td>
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<tr>
<td>Other class participation</td>
<td>25%</td>
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<tr>
<td>Final reporting on snail case</td>
<td>15%</td>
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<tr>
<td>oral presentation OR</td>
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<tr>
<td>written report and critique of oral presentation</td>
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The class will develop criteria to evaluate student teams, team outputs, and oral communications skills. Evaluations will include self- and peer assessments.
CLASS SCHEDULE - Spring 2005

Class: **L**=lecture, **D**=discussion, **P**=practicum lab. Case study teams by **T#**=team number.

<table>
<thead>
<tr>
<th>week</th>
<th>Mon</th>
<th>Wed</th>
<th>Fri</th>
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</thead>
<tbody>
<tr>
<td>#1 Jan 10-14</td>
<td>L class introduction</td>
<td>L case assignments and methods</td>
<td>L problem definition, stakeholders</td>
</tr>
<tr>
<td>#2 Jan 17-21</td>
<td>holiday</td>
<td>D apple snail problem <strong>T#1</strong></td>
<td>D harp seal problem <strong>T#2</strong></td>
</tr>
<tr>
<td>#3 Jan 24-28</td>
<td>P seal lab 1 <strong>T#2</strong></td>
<td>L ecosystem management</td>
<td>P seal lab 2 <strong>T#2</strong></td>
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<tr>
<td>#4 Jan 31-Feb 4</td>
<td>open</td>
<td>D St. Croix resources <strong>T#3a,b</strong></td>
<td>P St. Croix lab 1 <strong>T#3a</strong></td>
</tr>
<tr>
<td>#5 Feb 7-11</td>
<td>L flow diagrams</td>
<td>P St. Croix lab 2 <strong>T#3b</strong></td>
<td>D St. Croix lab results <strong>T#3b</strong></td>
</tr>
<tr>
<td>#6 Feb 14-18</td>
<td>L managem’t options, snail interviews <strong>T#1</strong></td>
<td>D snail social analysis, implications <strong>T#1</strong></td>
<td>reserved for field trip <strong>T#4</strong></td>
</tr>
<tr>
<td>#7 Feb 21-25</td>
<td>holiday</td>
<td>L feasibility, evaluation process</td>
<td>reserved for field trip <strong>T#4</strong></td>
</tr>
<tr>
<td>#8 Feb 28-Mar 4</td>
<td>D field trip results <strong>T#4</strong></td>
<td>D snail control feasibility <strong>T#4</strong></td>
<td>L prediction, modeling</td>
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<tr>
<td>#9 Mar 7-11</td>
<td>L intro to modeling</td>
<td>D harp seal system &amp; gov’t model <strong>T#5a</strong></td>
<td>open</td>
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<tr>
<td>#10 Mar 14-18</td>
<td>D seal data trends <strong>T#5b</strong></td>
<td>L seal spreadsheet modeling</td>
<td>P seal model lab 1 <strong>T#5a</strong></td>
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<td>spring break</td>
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<tr>
<td>#11 Mar 28-Apr 1</td>
<td>P seal model lab 2 <strong>T#5a,b</strong></td>
<td>P seal model lab 3 <strong>T#5b</strong></td>
<td>L evaluation methods, impact assessment</td>
</tr>
<tr>
<td>#12 Apr 4-8</td>
<td>D snail spread &amp; modeling <strong>T#6a</strong></td>
<td>D snail impacts, evaluation <strong>T#6b</strong></td>
<td>P snail lab 1 <strong>T#6b</strong></td>
</tr>
<tr>
<td>#13 Apr 11-15</td>
<td>P snail lab 2 <strong>T#6a</strong></td>
<td>open</td>
<td>L monitoring, env. indicators</td>
</tr>
<tr>
<td>#14 Apr 18-22</td>
<td>D St. Croix monitoring <strong>T#7a</strong></td>
<td>L final case reporting - content, organization</td>
<td>P St. Croix lab 3 <strong>T#7a</strong></td>
</tr>
<tr>
<td>#15 Apr 25-29</td>
<td>L project management</td>
<td>D St. Croix nutrient program <strong>T#7b</strong></td>
<td>P St. Croix lab 4 <strong>T#7b</strong></td>
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<tr>
<td>#16 May 2-4</td>
<td>final report teams</td>
<td>oral report (9:45am)</td>
<td>oral dress rehearsal (tba)</td>
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<td>FINALS May 9</td>
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COURSE OUTLINE AND GENERAL READINGS

Syllabus sections are listed below by problem-solving step, including required readings and case studies by student team number (T#). Optional readings are listed for reference. Complete bibliographic information is given on pages 6-7.

STEP 1 Define Problem (Jan. 10-21)
topics problem solving framework, problem identification and boundaries stakeholders, participatory methods, interviewing techniques
cases T#1 - apple snails in Hawaii T#2 - harp seal issues and stakeholder interests
optional EPA Community-Based Env. Protection ... §2.1 Getting Everyone Involved (pp. 2-1 to 2-5) and §2.3 Geographic Boundaries (pp. 2-15 to 2-16) NRCS(b) Strengthening Public Involvement publication PPC030

STEP 2 Understand Relationships (Jan. 24, Feb. 1-11)
topics ecosystem management, systems approach conceptual modeling, system diagrams
case T#3a - St. Croix River resources & landscape ecology T#3b - St. Croix water quality problems/threats
readings Christensen Implementing Ecosystem Management ... (pp. 325-341) GPM(a) Chapter 3: Conceptual Model Formulation (pp. 31-43)
optional Slocombe Implementing Ecosystem-based Management

STEP 3 Identify Potential Solutions (Feb. 14-Mar. 2)
topics management options, developing solutions evaluation process, feasibility constraints
case T#1 - taro culture & apple snail control options T#4 - apple snail field trip, feasibility of controls
readings EPA op. cit., §5.1 Initial Considerations (in Chapter 5: Evaluating and Choosing Strategies ..., pp. 5-1 to 5-4) McAllister Chapter 1: Introduction (pp. 3-11)
optional Casley and Kumar Chapter 2: Qualitative Interviewing
STEP 4  Predict Outcomes from Prospective Solutions (Mar. 4-30)

topics  prediction methods, quantitative models

case  T#5a - harp seal system vs. gov’t population model
T#5b - harp seal data trends and uncertainties

readings  GPM(a) Chapter 1: The Systems Approach to Problem Solving, §1.1 Introduction and §1.3 A Brief Example ...
GPM(b) Ecological Modeling: Systems Analysis and Simulation (pp. 103-109)

optional  Hufshmidt et al. sections on Approaches to Estimating Effects (pp. 128-135) and Examples of Estimating Effects on Natural Systems (pp. 136-154)
Carpenter and Maragos §II.F on prediction methods and models (pp. 43-50)

STEP 5  Evaluate Predicted Outcomes for Management Decision (Apr. 1-11)

topics  evaluation methodology, impact assessment processes and methods

case  T#6a - apple snail spread and evaluating controls
T#6b - apple snail impacts and indicators

readings  McAllister Chapter 5: Introduction to Evaluation Methods (pp. 67-81)
EPA op. cit., §3.1 Using Indicators (pp. 3-1 to 3-5)

optional  Smith on impact evaluation methods (pp. 18-26)
Herweg and Steiner op. cit., Step 4: Selection of Impact Indicators
USFS Monitoring and Evaluation §II. Setting Objectives

STEP 6  Implement Decision and Monitor Results (Apr. 15-29)

topics  monitoring process, environmental management indicators
project planning and management

case  T#7a - St. Croix River water quality monitoring plan
T#7b - St. Croix River nutrient monitoring program

readings  Smith, Parker & Peine Env. Monitoring (pp. 167-173 only)
EPA op. cit., §3.2 Assessing Conditions and Trends in Local Ecosystems (pp. 3-6 to 3-9)
MacDonald Developing a monitoring project

optional  NRCS(c) Using Cost Estimates in Conservation publication PPC037
USFS op. cit., §III. Monitoring Approaches
Greer 20 Key Project Manager Actions and Results at www.michaelgreer.com/20-actns.htm


*Environmental Protection Agency (EPA), *Community-Based Environmental Protection: A Resource Book for Protecting Ecosystems and Communities*, Washington, DC, 1997, zipped files online <www.epa.gov/ecocommunity/book.zip> or unzipped files on CD in reserved readings.


Greer, Michael, 20 Key Project Manager Actions and Results, from *The Project Manager’s Partner*, online <www.michaelgreer.com/20-actns.htm>.


Apple snails (Pomacea and Pila sp.), also known as golden snails, were introduced to Hawaii as an alternative economic crop about 1989. They have rapidly invaded wetland taro systems and streams throughout the state. This case study will be used to illustrate three steps in the environmental problem-solving process. All students must serve on at least one of the four student teams (#1, #4, #6a, #6b) that will conduct the case study.

**STEP 1 Define Problem**

**Classes**
1/19 panel discussion with snail researchers

**Team #1 assignments**
- compile list of questions for panel discussion
- lead panel discussion
- write summary of discussion results

**Readings**
handout including:
- Apple Snail Fact Sheet
- T-STAR snail research proposal (pp. 2-4)
- Cowie, Apple Snail Spread in Hawaii (2 pp.)

*Taro production hits record low*, Honolulu Advertiser (3/16/04) online at http://the.honoluluadvertiser.com/article/2004/Mar/16/ln/ln07a.html

**STEP 3 Identify Potential Solutions**

**Classes**
2/14 Team #1 oral report on snail expert interview methods & results
2/16 J. Taylor presentation on snail social research, discussion on implications for snail control

**Team #1 assignments**
- search for assigned reading(s) on Hawaii taro culture, distribute to class
- interview “experts” on snail control options, report results
- arrange Taylor presentation, lead implications discussion
- write summary of interview & discussion results

**Classes**
TBA field trip to snail area(s)
2/28 discussion on field trip results
3/2 Team #4 oral report on snail controls, discussion on feasibility

**Team #4 assignments**
- organize & lead field trip to snail area(s)
- research 2ndary sources on feasibility of snail control, report results
- lead discussions on field trip and control feasibility
- write summaries of research & discussion results

**Readings**
CTAHR, *Apple Snails in Wetland Taro Production*, online at http://agrss.sherman.hawaii.edu/onfarm/pest/pest0008.html
taro reading(s) selected by Team #1
**STEP 5**  
*Evaluate Predicted Outcomes for Management Decision*

**Classes**
- 4/4 Team #6a oral report on snail spread, K. Burnett presentation on modeling
- 4/6 Team #6b discussion on snail impacts & evaluation
- 4/8 snail lab 1 to develop snail impact indicators (Team #6b)
- 4/11 snail lab 2 to evaluate snail control options (Team #6a)

**Team #6a assignments**
- research primary/secondary sources on snail spread factors & current spread in Hawaii, report results
- arrange Burnett presentation, lead spread discussion
- write summary of spread research & discussion results
- lead lab 2 work groups, write summary of results

**Team #6b assignments**
- research on snail evaluation framework, data to evaluate control options
- lead discussion on snail impacts & evaluation
- lead lab 1 work groups, write summary of results

**Readings**
HARP SEAL CASE STUDY

This case study is taken from Isobel Heathcote’s *Environmental Problem Solving* text. Assigned readings include selected pages from that book. The harp seal (*Phoca groenlandica*) is one of Atlantic Canada’s most common seal species. The Canadian Government manages the size of the NW Atlantic population with a hunting quota. Some critics argue that current hunting levels are not sustainable. This case study will be conducted by three student teams (#2, #5a, #5b) over two problem-solving steps.

**STEP 1 Define Problem**

<table>
<thead>
<tr>
<th>Classes</th>
<th>1/21</th>
<th>Team #2 oral report on gov’t policies, discussion to identify stakeholders &amp; issues for seal management</th>
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<tbody>
<tr>
<td>1/24</td>
<td>seal lab 1 to identify stakeholder interests, information needs &amp; data collection assignments</td>
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<tr>
<td>1/28</td>
<td>seal lab 2 to review data collected, report results</td>
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**Team #2 assignments**

- research current Canadian Government seal management policies, report results
- lead stakeholder discussion and lab work groups, oral summary of results

**Readings handout including:**

- Heathcote case (pp. 92-95)

**STEP 4 Predict Outcomes from Prospective Solutions**

<table>
<thead>
<tr>
<th>Classes</th>
<th>3/9</th>
<th>Team #5a oral report on gov’t seal model, discussion to diagram seal system</th>
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</thead>
<tbody>
<tr>
<td>3/14</td>
<td>Team #5b discussion on seal data trends &amp; uncertainties</td>
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<tr>
<td>3/18</td>
<td>seal model lab 1: simulation design &amp; math specification (Team #5a)</td>
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<tr>
<td>3/28</td>
<td>seal model lab 2: spreadsheet simulation (Teams #5a,b)</td>
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<tr>
<td>3/30</td>
<td>seal model lab 3: evaluate simulation results, oral reports (Team #5b)</td>
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**Team #5a assignments**

- review & critique government seal model
- lead seal system discussion, report on government seal model
- lead lab 1 work groups, write summary of lab results
- assist with lab 2 work groups

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1 Additional resources from National Geographic online at http://magma.nationalgeographic.com/ngm/0403/feature3/

2 Shelton et al., *Model estimates of harp seal numbers at age for the Northwest Atlantic*, DFO Atlantic Fisheries Research Document 95/21, Dept. of Fisheries and Oceans, Canadian Government, 1995. A photocopy will be provided to Team #5a.
Team #5b assignments
• collect data on seal system & population, distribute to class
• lead seal data discussion, write summary of results
• assist with lab 2 work groups
• lead lab 3 work groups, oral report on results

Readings handout including:
• Heathcoate case (pp. 95-101)
• abstract from gov’t research paper²
Lavigne, Harp seals and Atlantic Cod: Notes for a presentation to the Standing Committee on Fisheries and Oceans, House of Commons, Ottawa, 1999, online at www.imma.org/fishcomm/
The case *Endangered? The Scenic St. Croix River: A Case Study in Water Stewardship* is from an online database of the National Center for Case Study Teaching in Science. Assigned readings are taken from this source but the assignments will be different. The St. Croix River flows 154 mi. from St. Croix Lake near Solon Springs, Wisconsin, until it joins the Mississippi River at Prescott. Approximately 80% of the river runs along a boundary between Minnesota and Wisconsin. The watershed covers about 7,760 mi.², with 46% of the area located in Minnesota. Due to its location and federal designation as a Wild and Scenic River, multiple agencies manage the St. Croix. Degradation of water quality is a concern. This case addresses four specific issues: replacement of a historic bridge, invasion by zebra mussels, nutrient pollution, maintaining large woody debris piles. The study will be conducted by four student teams (#3a, #3b, #7a, #7b) over two problem-solving steps.

### STEP 2 Understand Relationships

**Classes**
- 2/2 Team #3a discussion on resource systems & uses, location & nature of water quality problems/threats; Team #3b oral report on problems
- 2/4 St. Croix lab 1 to identify ecosystem relationships affecting water quality (Team #3a)
- 2/9 St. Croix lab 2 to flow diagram water quality subsystems (Team #3b)
- 2/11 Discussion on lab results with Team #3b oral report

**Team #3a assignments**
- research St. Croix ecoregions, resource uses, map(s) related to water quality problems
- lead resources-problems discussion
- lead lab 1 work groups, write summary of results

**Team #3b assignments**
- search for assigned reading on nutrient water quality problems, distribute to class
- research St. Croix water quality problems³ and report results
- lead lab 2 work groups and report results

**Readings**
- Online case study sections including *Introduction, Section One-The History of the St. Croix and Section Two-Water Quality Issues*, linked webpages beginning at [http://ublib.buffalo.edu/libraries/projects/cases/river.html](http://ublib.buffalo.edu/libraries/projects/cases/river.html)

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³ Online references include *St. Croix River Crossing Project* at [www.dot.state.mn.us/metro/projects/stcroix/](http://www.dot.state.mn.us/metro/projects/stcroix/)

*Zebra mussels & boating on the St. Croix River* at [www.dnr.state.mn.us/boating/zebramussels_stcroix.html](http://www.dnr.state.mn.us/boating/zebramussels_stcroix.html)

*Minnesota’s Wild & Scenic Rivers* at [www.dnr.state.mn.us/waters/watermgmt_section/wild_scenic/wsrivers/rivers.html](http://www.dnr.state.mn.us/waters/watermgmt_section/wild_scenic/wsrivers/rivers.html)

and *St. Croix River Basin*, which includes nutrient management, at [www.pca.state.mn.us/water/basins/stcroix/](http://www.pca.state.mn.us/water/basins/stcroix/)
Maps of St. Croix River Basin, online at
www.pca.state.mn.us/water/basins/stcroix/#basinmap
handout from St. Croix Basin Water Resources Planning Status Report 2003
nutrient reading(s) selected by Team #3b

**STEP 6 Implement Decision and Monitor Results**

Classes

<table>
<thead>
<tr>
<th>Date</th>
<th>Assignment</th>
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<tbody>
<tr>
<td>4/18</td>
<td>Team #7a discussion to specify monitoring indicators for St. Croix water quality problems</td>
</tr>
<tr>
<td>4/22</td>
<td>St. Croix lab 3 to develop monitoring plan: data collection procedures &amp; sites (Team #7a)</td>
</tr>
<tr>
<td>4/27</td>
<td>Team #7b oral report on current nutrient program, discussion on program successes &amp; challenges</td>
</tr>
<tr>
<td>4/29</td>
<td>St. Croix lab 4 to develop recommendations to improve nutrient monitoring program (Team #7b)</td>
</tr>
</tbody>
</table>

Team #7a assignments

- search for assigned reading(s) on water quality indicators, measurement techniques, site sampling\(^4\) and distribute to class
- lead indicators discussion, write summary report
- lead lab 3 work groups, oral report on results

Team #7b assignments

- research current nutrient monitoring program\(^5\) for St. Croix, report results
- lead discussion on current program
- lead lab 4 work groups, oral report on results

Readings

Online case study sections including *Section Three-Environmental Decision Making* and *Section Four-Biomonitoring*, linked webpages beginning at http://ublib.buffalo.edu/libraries/projects/cases/river3.html

water quality indicators reading selected by Team #7b

Handout with *Data Quality Level Matrix* by Oregon DEQ

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\(^4\) Online references include the NRCS *National Handbook of Water Quality Monitoring* at ftp://wwc.nrcs.usda.gov/downloads/wqam/wqm1.pdf

CSREES *Volunteer Water Quality Monitoring* project at www.usawaterquality.org/volunteer/
and *Guidance & Technical Documents* from the Oregon Dept. of Environmental Quality (DEQ) Laboratory at www.deq.state.or.us/lab/qa/techdocs.htm

which updates the assigned DEQ reading.

\(^5\) See last reference in footnote 3.