NRE 523 - 001
(2 credit hours)

Ecological Risk Assessment
School of Nature Resources & Environment, University of Michigan

Class Schedule
Lectures: Winter 2017; Wednesday 5:10 - 6:50 pm

Professor
G. Allen Burton, burtonal@umich.edu
Dana 1068; Office hours: By appointment or walk-in

Course Objectives and Outcomes
This course introduces ecological risk assessment (ERA), describing the basics of how ERAs are most often conducted by governments and environmental consultants. In the U.S. the process often follows that of the U.S. Environmental Protection Agency (EPA), but Canada and Europe use somewhat different approaches. A wide range of assessments exist dealing with chemical-specific criteria development to the remediation of small to mega-sites exceeding $1billion in costs. Common shortfalls often made when conducting ERAs, such as failing to adequately link stressor exposures to biological effects will be discussed. Case study examples will demonstrate the state-of-the-practice and new approaches that decrease uncertainty associated with the ERA process. The important linkage of ERA issues to decision-making in the risk management process will be emphasized, with real-world, high visibility case studies discussed by national experts.

In addition, this year we will utilize a new component to the class – premiering the Michigan Sustainability Class project, in partnership with the U-M School of Public Health. Our case example will focus on the Gelman industry contamination of the Ann Arbor aquifer. Students will "enter" the immersive case environment as an assignment (readings, watching videos, listening to interviews) for a couple of days. The in-class case discussion offers a chance to digest and debate elements of the case, after which there will be an engaged learning exercise. We will consider the environmental, human health, and political complexities within which specific quantitative, spatial or other skills are nested in many sustainability situations.

The primary objectives of the course are to build competency in assessing stressors in ecosystems and thereby become more effective in dealing with real-world issues commonly encountered. This bridges process, science and practice throughout the ERA process. This should result in the ability to recognize quality ERAs and identify ways to strengthen the linkage between an accurate ERA and management options. We will describe the state-of-the-practice including its limitations, realities and ways to improve ERAs along with remediation efforts in freshwaters and marine near-coastal areas. We will also discuss the realities of challenging management options, past management actions and how the assessment process links to management decisions.

Course Description
ERAs are common in many environmental professions crossing the job sectors of government, industry and business, consulting, academia, and not-for-profit organizations. An ERA is a non-scientific, interdisciplinary process that uses science to help make management decisions. The course reviews the ERA and hazard assessment processes used in developed countries to determine 1) whether contaminated sites should be cleaned-up, 2) safe levels for
chemicals in the environment, 3) if other non-chemical stressors are a concern, and, 4) thereby, provide for sound environmental management applications.

Most ERAs are filled with scientific uncertainty, often leading to contentious disagreements resulting in litigation. Students in this course will learn how to both recognize an ERA that is strong and scientifically-grounded vs. one that is laden with scientific uncertainties that confound settlements and decision making.

The most common process of conducting an ERA is similar to that used for human health risk assessments and is a four-step process: 1) Problem formulation, 2) Exposure characterization, 3) Effects characterization, and 4) Risk characterization. Once the risk characterization is completed then findings are shared and discussed with a Risk Manager to make decisions on how the ERA will be implemented. Complex multi-stakeholder issues surrounding decision-making will be identified and a focus of guest speakers and the Gelman case study.

The majority of ERAs being conducted revolve around the determination of whether contaminated sites need to be cleaned-up. Most of these sites have groundwater, soil and sediment contamination, which in turn is a hazard and risk to aquatic organisms, wildlife and humans. Thousands of sites in the U.S. and the European Union have had ERAs; however many have been crude with high associated uncertainties. Another major aspect of ERAs is their integration into the environmental quality criteria/guidelines/standards development process that is currently a focus in the European Union and other developed countries. Both of these aspects will be covered in the course, with a greater emphasis on assessing the ecological risk at sites.

During the first stage of an ERA (problem formulation), stakeholder concerns are identified along with the likely stressors at the site and species that may be at risk. A conceptual model is then developed, linking likely stressors and receptors (terrestrial and aquatic species, populations, communities). An analysis plan is developed on how to best assess this model.

The second and third parts of the ERA (exposure and effects characterization) consist of literature and database reviews, and laboratory and field sampling and analyses. This critical phase is where most ERA’s fall short because the exposures to various stressors are not well characterized (over space and time) and exposures not well linked to biological responses (such as adverse effects – mortality, reproduction, growth, endocrine disruption). The typical approaches used, and the ideal approaches to reduce uncertainties will be reviewed.

The fourth stage of the ERA is risk characterization, where stressor exposures are linked to adverse effects. By knowing threshold levels for biological effects and the tendency for populations to be exposed, a risk determination can be made. At this stage, the findings are compared to the conceptual model developed in step one, to determine if it is correct.

The last stage is Risk Management, where the ERA findings are discussed with a risk manager and the stakeholders to determine the best path forward. This is perhaps the most complex and difficult aspect of the process because viewpoints on what is best are so diverse.

The course will also discuss the challenges of determining stressor causality in human dominated watersheds. This uncertainty directly impacts effective decision making regarding remediation of contamination and restoration of degraded and impaired waterways. The
current practice of installing Best Management Practices, implementing habitat restoration and dredging contaminated sediments will be reviewed in terms of effectiveness.

**Course Meetings**
The course is 2 credit hours and will meet once per week. There will be some guest lectures by recognized experts. There will be a focus project (Gelman case) as described above.

**Readings and Online Resources**
Reading assignments are listed below in the class-by-class schedule below. Additional readings may be provided. All powerpoints used in lecture will be uploaded for students. This will be the primary means of distributing announcements, so it should be checked weekly.

**Required Reading**
Selected portions of:
Other readings will be uploaded as assigned.

**Prerequisite requirements**
Ecology and freshman chemistry courses are recommended - but not required.

**Requirements and Evaluation**
The final grade will be based on two 100-point exams, the Gelman case study (100 points), stressor ranking exercise (25 points due class 2), and class participation (25 points) for a total of 350 points.

The exams will be short answer, fill-in the blank and multiple-choice questions covering lectures and assigned reading materials.

Loss of one letter grade for late make-up exams; however, exams may be taken up to 2 days prior to the scheduled exam date if it is impossible to attend (see dates below).

Opportunities for bonus points will be provided on each exam and by attending relevant (approved) seminars and summarizing the message in ~ ½ page (5 points each), and the option for writing a literature review for up to 25 points. The literature review must be on an approved topic following format requirements shown during Lecture 1.
# Class-by-Class Outline

<table>
<thead>
<tr>
<th>Lecture Topic*</th>
<th>Date</th>
<th>Reading**</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Syllabus; Risk and stressors overview; Emerging issues; Ecotoxicology overview</td>
<td>Jan 4</td>
<td></td>
</tr>
<tr>
<td>- The ERA process. Problem formulation; Exposure characterization. <strong>Stressor ranking assignment due</strong></td>
<td>Jan 11,18</td>
<td>Eco-Update on Ecological Assess. Superf. Sites; App B &amp; C, Chps 1-3</td>
</tr>
<tr>
<td>- Exposure characterization cont’d. Team assignments. The local MichCon and Gelman sites.</td>
<td>Jan 25</td>
<td>Chp 4 (exposure)</td>
</tr>
<tr>
<td>- Effects characterization</td>
<td>Feb 1</td>
<td>Eco-Update on Field Studies...</td>
</tr>
<tr>
<td>- Karl Gustavson case examples and perspectives</td>
<td>Feb 8</td>
<td></td>
</tr>
<tr>
<td>- Effects characterization cont’d</td>
<td>Feb 15</td>
<td>Chp 4 (effects)</td>
</tr>
<tr>
<td>- <strong>Exam 1</strong></td>
<td>Feb 22</td>
<td></td>
</tr>
<tr>
<td>- <strong>WINTER BREAK</strong></td>
<td>Mar 1</td>
<td></td>
</tr>
<tr>
<td>- <em>In situ</em> approaches; Risk characterizations</td>
<td>Mar 8</td>
<td>Chp 5 and Passaic Fact Sheet, Atrazine ERA</td>
</tr>
<tr>
<td>- Gelman project</td>
<td>Mar 15</td>
<td></td>
</tr>
<tr>
<td>- Steve Brown case examples and perspectives</td>
<td>Mar 22</td>
<td></td>
</tr>
<tr>
<td>- Marc Greenburg case examples and perspectives</td>
<td>Mar 29</td>
<td></td>
</tr>
<tr>
<td>- Gelman project</td>
<td>Apr 5</td>
<td></td>
</tr>
<tr>
<td>- <strong>Exam 2</strong></td>
<td>Apr 12</td>
<td></td>
</tr>
</tbody>
</table>

* The schedule for lecture topics and speakers may change.

** Readings from EPA ERA Guidelines (1998) unless otherwise noted