BIOL 898 Sec 17: Ecotoxicology Theory and Practice

Instructor	Dr. Christy Morrissey Office: Rm 243, Biology Ph: 966- 4433 Email: christy.morrissey@usask.ca Website: http://christymorrissey.wix.com/morrisseylab
Course delivery	Graduate Lectures/Tutorials: 2 hours per week Wed 1:30-3:30 Undergrad Lectures (if required; see prerequisites):3 hours per week MWF 11:30-12:20
Location	TBD
Office hours	By appointment (email)
Prerequisites	At least 1 undergraduate or graduate course in Ecotoxicology or permission from instructor – attendance of BIOL 475 undergraduate lectures may satisfy this prerequisite.
Enrollment Limit	12

Course Description

This course examines how principles and theories in ecology can better inform ecotoxicology problems at multiple levels of biological organization (individuals to ecosystems). Much of the science of this relatively young discipline has traditionally lacked a conceptual basis and major recent advances are being drawn from ecological theories, models and approaches to strengthen the field. Students will examine current advanced topics and contemporary approaches that add ecological relevance and predictive strength to both field and laboratory ecotoxicology studies.

Learning Outcomes

Upon completion of this course, students will be able to:

1. Understand the theories of how life history traits affect contaminant exposure and explain how contaminants act at multiple levels of biological organization (individuals, populations, communities and ecosystems)
2. Critique and apply the various approaches, tools and ecological theories relevant to advanced topics in ecotoxicology
3. Apply newly learned theory and approaches to their own ecotoxicology research
4. Demonstrate advanced level critical thinking, judgement, analytical, oral and written communication skills through independent writing, discussion and collaborative work

Class Schedule and Format

Each week, the 875 class will meet for ~2 hours to examine and critique novel and current approaches and theories of ecotoxicology in addition to specific skill development required for designing, reviewing and conducting advanced ecotoxicological research. Typically, one week will involve group discussion of a set of assigned readings that review the topic and critique specific case studies where authors have or have not incorporated the application of ecological theory. The second week of the topic will take the form of structured in class activities and computer exercises. It is expected that students come prepared for all sessions having completed the readings ahead of time and bring laptops to complete the exercises.

The BIOL 875 course is structured to run in parallel with the lecture portion only of BIOL 475: Ecological Toxicology. The undergraduate lectures (3 hrs/wk) provide a foundation in the important principles and hierarchy of Ecotoxicology with topics on contaminant fate and transport, influence of life history traits and contaminant effects on multiple levels of biological organization. The undergraduate lecture material is required only for discipline-specific students without a background in Ecotoxicology as it will establish the basis for advanced interdisciplinary topics covered throughout the graduate course. Students who have taken BIOL 475 or equivalent course in Ecotoxicology at the undergraduate or graduate level will have met the pre-requisite and are not required to attend undergraduate lectures. No course credit will be given for BIOL 475 and you do not need to register for that course.

Course schedule (beginning second week of Jan- see table page 5)

Week 2: Being a grad student in 2 worlds: need for integrating ecology and environmental toxicology.

Readings:

Clements, WH and Rohr, JR 2009. Community responses to contaminants: using basic ecological principles to predict ecotoxicological effects. Environ Toxicol Chemistry 28: 789-1800

Schmitt-Jansen et al. 2008. An ecological perspective in aquatic ecotoxicology: approaches and challenges. Basic and Applied Ecology 9: 337–345

In class Activity: Defining individual strengths. Identifying common themes between disciplines (see table 1 Clements and Rohr 2009).

Week 3 and 4: Coping with natural variability: dynamics of individual life histories and the detection of environmental impacts during the whole annual cycle.

Readings:

Tjalling, J. 2013. All individuals are not created equal; accounting for interindividual variation in fitting life-history responses to toxicants. ES&T 47: 1664-69.

Cairns, J Jr. 1986 The myth of the most sensitive species. Bioscience 36: 670-672

Homework: Caddis – compiling and interpreting data to create species sensitivity distribution (SSD) curves for group of species and toxicant of interest (see http://www.epa.gov/caddis/da_software_ssdmacro.html)

***Assignment 1:** Knowing your study species or community- Research the relevant life history traits of your chosen study spp or the community dynamics of multiple spp. Plot a SSD curve for the group of species and contaminant of choice and interpret your findings.

Week 5 and 6: Extrapolation from individuals to populations. Using demographic theory to inform population models in ecotoxicology.

Readings:

Kramer, V.J. et al. 2011. Adverse outcome pathways and ecological risk assessment: bridging to population level effects. Environmental Toxicology and Chemistry 30: 64-76.

Forbes, V. et al. 2008. The extrapolation problem and how population modeling can help. Environmental Toxicology and Chemistry 27: 1987-1994

Willson, JD et al. 2012. Making leaps in amphibian ecotoxicology: translating individual-level effects of contaminants to population viability. Ecological Applications 22:1791–1802

In class Activity: Independent population modeling exercise using dataset provided: Download PopTools software

Week 7 and 8: The influence of multiple stressors and trait based approaches in understanding effects on populations and communities.

Readings:

Verberk, W.C.E.P. 2013. Delivering on a promise: integrating species traits to transform descriptive community ecology into a predictive science. Freshwater Science 32: 531-547

Brittain, C. and Potts, S. 2011. The potential impacts of insecticides on the life-history traits of bees and the consequences for pollination. Basic and Applied Ecology Volume 12, Issue 4 Pages 321-331.

Bryden, J., Gill, R. J., Mitton, R. A. A., Raine, N. E., Jansen, V. A. A. (2013), Chronic sublethal stress causes bee colony failure. Ecology Letters. doi: 10.1111/ele.12188

Williams, N., Crone, E., Roulston, T., Minckley, R., Packer, L., Potts, S. 2010. Ecological and life-history traits predict bee species responses to environmental disturbances. Biol Conserv. 143: 2280-2291.

In class Activity: Understanding trait based approaches, SPEAR website. Case study on pollinator declines and pesticides.

***Assignment 2:** Research the origin and application of Trait based approaches in addressing community level changes (based on the Ecology and/or Ecotoxicology literature). Write an essay to describe how trait based approaches could be applied to your own research system pesticides on pollinators among other stressors in a complex system. Review the ecotoxicology literature on the topic to position your arguments.

Week 9: Indirect effects and trophic relationships: concepts, approaches and applications to ecotoxicology problems

Readings:

Relyea, R. and Hoverman, J. 2006. Assessing the ecology in ecotoxicology: a review and synthesis in freshwater systems. Ecology Letters 9:1157-1171

Relyea, R. Amphibians are not ready for Roundup®. In Wildlife Ecotoxicology: Forensic Approaches. Ch.9. pp. 267-300

In class Activity: Amphibians and pesticides case study- can indirect effects be used in regulatory world

Week 10 and 11: Incorporating time and space: exploring the importance of macroecology and ecosystem approaches to ecotoxicology.

Readings:

Kerr, J.T., Kharouba, H.M., Currie, D.J., 2007. The macroecological contribution to global change solutions. Science 316, 1581-1584.

Beketov, MA.; Liess, M. 2012. Ecotoxicology and macroecology – Time for integration. Environmental Pollution 162: 247-254

Burton, G. A., et al. (2012), Making ecosystem reality checks the status quo. Environmental Toxicology and Chemistry, 31: 459–468.

Willson, JD. and WA Hopkins. 2013. Evaluating the Effects of Anthropogenic Stressors on Source-Sink Dynamics in Pond-Breeding Amphibians. *Conservation Biology* **27**:3, 595-604

In class Activity: Discussion and in class debate on the topics. Students may bring own paper for class discussion.

***Assignment 3:** Make an ecosystem reality checklist for your own research program. Justify what elements in your lab and field study that needs to be considered to ensure your design and conclusions are "ecologically relevant".

Week 12: Evolution in ecotoxicology- what would Darwin have to say about persistence and resistance?

Readings:

Monosson, E. 2012. Evolution of the toxic response: How might ecotoxicology benefit by considering evolution? Integrated Environmental Assessment and Management 8 : 379-380

Whitehead, A. et al. 2012. Common mechanism underlies repeated evolution of extreme pollution tolerance. Proc Royal Soc B: 279: 427-433

Jansen, M. et al. Evolutionary ecotoxicology of pesticide resistence: a case study in Daphnia. Ecotoxicology. 2011 May; 20(3):543-51

Oziolor, E.M. et al. 2014. Evolved resistance to PCB- and PAH-induced cardiac teratogenesis, and reduced CYP1A activity in Gulf killifish (*Fundulus grandis*) populations from the Houston Ship Channel, Texas, Aquatic Toxicology 150: 210-219.

In class Activity: Discussion on how common is contaminant induced resistance? What factors are necessary to drive resistance?

Week 13: Student oral lectures to undergraduates: Teaching one principle, theory, or technique learned from the course that is applied to a current ecotoxicological problem to undergraduate class

BIOL 898 schedule and lecture schedule. [1]Undergraduate lecture topics are shown for reference. Attendance is *not required if exemption granted by instructor*.

Week	898 Theme	Readings 898	BIO 475 Lecture topics [1]
Week 1		see syllabus for detailed list	Intro and history of Ecotox; Role of Ecology in Ecotoxicology; Review of major principles in toxicology; Contaminant sources
Week 2	Integrating Ecology and Toxicology		Contaminant transport and fate in Ecosystems; Exposure and uptake;
Week 3	Individual Variation and Life History traits		Bioaccumulation/Bioavailability; Trophic transfer and Biomagnification; Food webs
Week 4	Continued		Scale and the Individual organism; Lethal and Sublethal Effects; Stress, Growth and Energy allocation; Behaviour;
Week 5	Population demographic models and theory		Intro to Population ecotoxicology; Epidemiology, Effects on population size and dynamics;
Week 6	Continued		Population models; Population demographics;
			MIDTERM BREAK - NO CLASSES
Week 7	Multiple stressors, trait based approaches to community ecotox		Spatial distributions of contamination; Consequences for Metapopulations;
Week 8	Continued		Intro to Community Ecotoxicology, Abiotic/Biotic factors regulating communities; Measuring community effects,
Week 9	Indirect effect case studies		Indirect effects; Disturbance and recovery from pollution; Intro ecosystem ecotoxicology
Week 10	Macroecology and ecosystem approaches		Contaminant effects on ecosystems; Landscape ecotoxicology
Week 11	Continued		Current issues in Ecotoxicology: Chemical mixtures, Multiple stressors; Climate change and contaminants
Week 12	Contaminant induced evolutionary change		Ecotoxicology in the Regulatory context;
Week 13	**Grad Student teaching lectures**		**Grad Student teaching lectures**
Date TBC	**FINAL TAKE HOME EXAM**		

Required Resources

Textbooks

No textbook required. Readings from primary literature provided in syllabus. Supplementary reading can be drawn from Newman: Ecotoxicology: A Comprehensive Treatment (recommended) or Fundamentals of Ecotoxicology (undergraduate required). A list of suggested chapter readings can be provided upon request.

Textbooks are available from the Natural Science library on reserve or the University of Saskatchewan Bookstore: www.usask.ca/consumer_services/bookstore/textbooks

Other Required Materials

Laptop computer is required to download reading material and to complete certain assignments. They should be brought to class on dates indicated by the instructor. Downloading of free software packages will be required in advance of the class. A separate journal (notebook) is recommended to keep a "Learning Log" notes on the course. This can also be in electronic form (e.g. OneNote, Evernote).

Electronic Resources

Caddis (USEPA) http://www.epa.gov/caddis/index.html
ECOTOX (USEPA) http://cfpub.epa.gov/ecotox/
ISI Web of Science http://library.usask.ca/find/node.php?nid=137352

Downloads

PopTools http://www.poptools.org/
R http://www.r-project.org/ (optional)
Cadstat (package for R) (optional)

Grading Scheme

Assignments (3 - weighted equally)	45 %
Oral teaching seminar to undergraduates on current topic	20 %
Final take home exam	35 %
Total	100%

Assessments

A detailed rubric with expectations for each assignment will be developed and shared with students at the time of assigning.

Assignments 1-3

Value: 45% of final grade (approx. 15% each)
Due Date: See Course Schedule

Type: The assignments are designed to complement and extend the in class activities through research and computer exercises.

Description: Students must complete analysis of data provided, present and interpret the findings and submit a concise written report. No formal format for each report is required but direction will be offered for each assignment. The due dates are provided.

Oral Teaching Seminar

Value: 20% of final grade
Date: Last week of class
Type: Oral powerpoint lecture style presentation delivered to undergraduate students.
Description: A presentation on a topic or research area of choice where you teach how one or more Ecotoxicology theories and approaches can improve the design and interpretation of ecotoxicology studies. The presentation must provide a clear research question or case, demonstrate knowledge and application of the theory or method, and the rationale for your approach/methods to address that question. The topic may be *related or extend* from your thesis work but not duplicate it. The objective is to have you integrate the information from the course to highlight and teach the approaches you would use to address an ecotoxicology problem or research question. Consult with instructor early to discuss topic. Length: 20-25 minute oral presentation delivered to undergraduate students.

Final Written Exam (take home)

Value: 35% of final grade
Date: TBD- during final exam period
Type: Written research essay on topic provided by instructor

Description: Students will write a take home exam that consists of an essay written over 7 days. The exam will be structured as a written critique of a published paper provided by the instructor based on the material learned in the course. The final exam paper will have a word limit of 2500 words plus references. This will test your ability to integrate material learned across the course, draw from relevant literature (assigned), and express your thoughts in a clear and concise format.

Required Materials

Textbooks

No textbook required. Readings from primary literature are provided in the syllabus.

Other Required Materials

Laptop computer is required to download reading material and to complete certain assignments. They should be brought to class on dates indicated by the instructor. Downloading of free software packages will be required in advance of the class. A separate journal (notebook) is required for keeping your “Learning Log” notes on the course. This can also be in electronic form (e.g. OneNote, Evernote).

Electronic Resources

Caddis (USEPA) http://www.epa.gov/caddis/index.html
ECOTOX (USEPA) http://cfpub.epa.gov/ecotox/
ISI Web of Science http://library.usask.ca/find/node.php?nid=137352

Downloads

PopTools http://www.poptools.org/
R http://www.r-project.org/ (optional)
Cadstat (package for R) (optional)

Key Dates

The following table summarizes key due dates for assignments.

Week	Module	Evaluation Due Date
3-4	Assignment 1	Jan.29
7-8	Assignment 2	Feb.26
10-11	Assignment 3	Mar.19
13	Oral teaching seminar	Apr.2
	Final written exam	TBD

Submitting Assignments

All assignments should be handed in via Blackboard in PAWS before midnight on the due date. No assignment will be accepted more than 3 days past the due date without prior arrangement. A 10% penalty per day applies.

Criteria That Must Be Met to Pass

Students must submit all the assignments and exams to pass the course.

Attendance and Participation Expectations

Attendance and participation are expected for the weekly grad course meetings. Attendance of undergraduate BIOL 475 lectures is required to meet the pre-requisite unless waived by the instructor. Participation is key to your learning and you are encouraged to keep a learning log. If you are unable to attend a class due to illness or emergency, you should notify me by email and make arrangements to make up the material.

Student Feedback

I welcome student feedback throughout the course. There will be formal opportunities at the start and end of the course to offer feedback and suggestions on course design, material and delivery and topics may be modified to fit the needs of the students.

Final Examination Scheduling

The final exam scheduling is to be determined. The final exam will be delivered at a mutually agreed date after all other coursework is complete. Students are encouraged to review all examination policies and procedures:

http://www.usask.ca/calendar/exams&grades/examregs/

Integrity Defined (from the Office of the University Secretary)

The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals section of the University Secretary Website and avoid any behavior that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students should read and be familiar with the Regulations on Academic Student Misconduct (http://www.usask.ca/university_secretary/honesty/StudentAcademicMisconduct.pdf) as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals (http://www.usask.ca/university_secretary/honesty/StudentNon-AcademicMisconduct2012.pdf)

For more information on what academic integrity means for students see the Student Conduct & Appeals section of the University Secretary Website at:
http://www.usask.ca/university_secretary/pdf/dishonesty_info_sheet.pdf

Examinations with Access and Equity Services for Students (AES)

Students who have disabilities (learning, medical, physical, or mental health) should register with Access and Equity Services for Students (AES) if they have not already done so. Students who suspect they may have disabilities should contact AES for advice and referrals. In order to access DSS programs and supports, students must follow AES policy and procedures. For more information, check http://www.students.usask.ca/health/centres/access-equity-services.php/, or contact AES at 966-7273 or aes@usask.ca.
Students registered with DSS may request alternative arrangements for mid-term and final examinations.
Students must arrange such accommodations through AES by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by AES.