Course Title: Invasive Plants and Weeds: Ecosystems to Molecules

I. General Information

Course Number: BSPM 528
Number of credits: 3 credits
Meetings:
Prerequisites: General Biology
Instructor: Cynthia S. Brown, Professor
Text: Reading assignments from ecological, weed science and other relevant literature will be made each week. Papers will be provided via Canvas.

Course Summary

This course explores the invasion biology and addresses the question, "Are invaders different?". The course will take a systematic approach (i.e. organized hierarchically) to studying the contributions of the disciplines of invasion ecology and weed science to our understanding of the biology, ecology and control of "problem plants." We will discuss the history and review the terminology used. We will explore some of the current research on invasive plants and weeds, including: (1) biological invasion theory, (2) landscape scale patterns, (3) effects of climate change, (4) effects on ecosystems, (5) interactions with other species in communities, (6) population processes, (7) ecophysiology of individual species and, at the molecular level, (8) genetic and biochemical characteristics. The first section of the course will include reading of primary literature and lectures and discussions with local guest speakers who specialize in each of the topic areas. During the final part of the semester, students will select and present papers from the most recent literature that synthesize ideas, integrate across organizational, taxonomic or spatial scales or demonstrate significant progress in the field of invasive plant and weed biology and ecology.

Class meeting format

During the majority of the semester, Tuesday class meetings will include an introductory lecture and discussion on the topic of the week provided by the course instructor or an invited guest speaker who is a specialist in the field. A review or other paper on that subject will be assigned the previous week and should be read before class. Each Thursday, we will discuss one or two scientific papers on the subject of the week. For the final few weeks of the semester, each class will be led by a student and will include discussion of papers he or she has selected.

II. Objectives

A. The student will be able to explain verbally and in writing the history of the study of invasive plants and weeds.

B. The students will be able to explain verbally and in writing the leading theories of plant invasion biology.

C. The student will know which publications to explore for information on plant invasions in weed science and ecology

D. Students will be able to evaluate critically, through writing and discussion, the scientific merit, significance and potential impact of published scientific papers.

III. Performance Evaluation

A. Class Participation. Students will receive up to 2 points for each class meeting in which they actively participate for a total of 60 points possible during the semester. Absence results in 0 points.

B. Class Preparation-Reading/Discussion Questions. A set of questions to guide students' reading will be provided along with the paper or papers to read. Answers to these questions must be turned in before each class meeting. They are worth up to 3 points for each of the 24 class meetings and 3 points for each of the 11 student-led discussions (105 points total).

C. Research Paper. Students will turn in a 15 page literature review and analysis of a **topic** of the student's choosing and approved by the instructor. The topic must be related to invasive plants and/or weeds, and address the question, "Are invasive plants and weeds different?" or explore complex interactions among biotic and abiotic components of ecosystems. **Topic selection** will occur in the first few weeks of the semester. The **literature review** portion of the research paper will be due **before Spring Recess**. Details of the research paper format will be provided separately. The **complete research paper** must be turned in **within one week** after the student-led discussion (described below).

C. Leading Class Discussion. Each student will lead a class discussion during the final weeks of the course. He or she will be responsible for selecting an article from recent peer-reviewed weed science or ecological literature on the topic of the student's research paper. The student will provide the class with reading/discussion questions (see below) and lead the class discussion.

D. Preparation of Reading/Discussion Questions. Each student will write a set of questions based on the article(s) he or she selected to direct reading and discussion. The paper(s) will be made available and the questions will be distributed at least one week before the discussion is scheduled.

Grading Scale.

A- = 90 – 92.9%, A = 93 – 96.9%, A+ = 97 – 100%
B- = 80 – 82.9%, B = 83 – 86.9%, B+ = 87 – 89.9%,
C- = 70 – 72.9%, C = 73 – 76.9%, C+ = 77 – 79.9%
D- = 60 – 62.9%, D = 63 – 67.9%, D = 67 – 69.9%
F = <60%

Point Breakdown.

Participation in class discussion	60
Reading questions	90
Selection of topic for research paper & paper for Student-led class discussion	50
Research paper literature review	100

Reading/discussion questions for leading class discussion	50
Leading class discussion	50
Research Paper	100
Total possible points	500

The following is an example of the topics covered and literature covered, but this may change to reflect the most recent literature and issues in plant invasion ecology.

Week	Date	Topic & Reading
Week 1	Class #1	**Introduction**
	Class #2	**Weed science/invasive plant overview discussion-Historical perspective** Primary: Mack et al. 2000. Ecological Applications 10: 689-710. Secondary: Appleby, A.P. 2005. A history of weed control in the United States and Canada – a sequel. Weed Science 53:762-768.
Week 2	Class #3	**Terminology of invasion** Primary: Pyšek, P., D.M. Richardson, M. Rejmánek, G.L. Webster, M. Williamson, and J. Kirschner. 2004. Alien plants in checklists and floras: towards better communication between taxonomixts and ecologists. Taxon 53:131-143. Secondary: Beck, K.G, K. Zimmerman, J.D. Schardt, J. Stone, R.R. Lukens, S. Reichard, J. Randall, A.A. Cangelosi, D. Copper, and J.P. Thompson. 2008. Invasive species defined in a policy context: recommendations from the Federal Invasive Species Advisory Committee. Invasive Plant Science and Management 1:414-421.
	Class #4	**Do invasions cause extinctions?** Primary: Sax, D.F. and S.D. Gaines. 2008. Species invasions and extinction: the future of native biodiversity on islands. Proceedings of the National Academy of Sciences 105:11490-11497. Secondary: Zimmer, C. Friendly invaders. New York Times, September 9, 2008.
Week 3	Class #5	**Landscape level patterns – Species distribution models** Elith, J. and J. Leathwick 2009. Species distribution models: ecological explanation and prediction across space and time. Annual Review of Ecology, Evolution and Systematics 40:677-697.
	Class #6	**Landscape level patterns – Species distribution models** Primary: Elith, J., M. Kearney, and S. Phillips. 2010. The art of modelling range-shifting species. Methods in Ecology & Evolution 1: 330-342. Secondary: Bromberg, J.E., S. Kumar, C.S. Brown, T.J. Stohlgren. 2011. Distributional changes and range predictions of downy brome in Rocky Mountain National Park. Invasive Plant Science and Management 4:173-182.
Week 4	Class #7	**Global change and invasive plant species** Primary: Bradley, B., D. M. Blumenthal, D. S. Wilcove, and L. H. Ziska. 2010. Predicting plant invasions in an era of global change. Trends in Ecology and Evolution 25: 310-318. Secondary: Dukes, J. S. 2011. Responses of invasive species to a changing climate and atmosphere. *In* D. M. Richardson, ed, Fifty Years of Invasion Ecology: The Legacy of Charles Elton, 1st edition, Blackwell Publishing Ltd., Oxford, UK, pp

		345-357.
	Class #8	**Global change and invasive plant species** Dukes, J. S., N. R. Chiariello, S. R. Loarie, and C. B. Field. 2011. Strong response of an invasive plant species (*Centaurea solstitialis* L.) to global environmental changes. Ecological Applications 21: 1887–1894.
Week 5	Class #9	**Global patterns of invasion** W.M. Lonsdale. 1999. Global patterns of plant invasions and the concept of invisibility. Ecology 80: 1522-1536.
	Class #10	**Landscape level patterns** Firn, J., J. L. Moore, et al. Abundance of introduced species at home predicts abundance away in herbaceous communities. Ecology Letters 14: 274-281.
Week 6	Class #11	**Ecosystem processes – Review of invader effects on ecosystem processes** Vilà, M, J.L. Espinar, M. Hejda, P.E. Hulme, V. Jarošék, J.L. Maron, et al. 2011. Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities and ecosystems. Ecology Letters 14:702-708.
	Class #12	**Ecosystem processes – Case study of ecosystem effects of an invader** Chambers, J. C., B. A. Roundy, R. R. Blank, S. E. Meyer,and A. Whittaker. What makes Great Basin sagebrush ecosystems invasible by *Bromus tectorum*. Ecological Monographs 77:117-145.
Week 7	Class #13	**Plant community – Diversity-invasibility overview** Fridley, J.D., J. Stachowicz, S. Naeem, D.F. Sax, E.W. Seabloom, M.D. Smith, T.J. Stohlgren, D. Tilman, B. von Holle. 2007. The invasion paradox: Reconciling pattern and process in species invasions. Ecology 88:3-17.
	Class #14	**Plant community – Diversity-invasibility examples** Various papers assigned to teams to evaluate consistency with Fridley et al. 2007
Week 8	Class #15	**Plant community – Mechanisms of invasion-Enemy Release Hypothesis** ***Guest: Marianna Szucs*** Primary: Cappuccino, N. and J.T. Arnoson. 2009. Novel Chemistry of Invasive Exotic Plants. Ecology Letters 2: 189-193. Secondary: Zangerl, A.R. and M.R. Berenbaum. 2005. Increase in toxicity of an invasive weed after reassociation with its coevolved herbivore. Proceedings of the Natonal Academies of Science 102: 15529-15532
	Class #16	**Plant community – Mechanisms of invasion-Theories building on ERH** Primary: Bossdorf, O., Auge, H., Lafuma, L., Rogers, W.E., Siemann, E., and Prati, D. 2005. Phenotypic and genetic differentiation between native and introduced plant populations. Oecologia 144:1-11. Secondary: Blumenthal, D. 2005. Interrelated causes of plant invasion. Science 310: 243.
Week 9		**SPRING RECESS**
Week 10	Class #17	**Physiological traits – Review article** van Kleunen, M., E. Weber, and M. Fischer. A meta-analysis of trait differences between invasive and non-invasive plant species. Ecology Letters 13: 235-245.
	Class #18	**Physiological traits – Case studies** Primary: Mozdzer, T.J. J.P. Megonigal. 2012. Jack-and-master trait responses to

		elevated CO_2 and N: a comparison of native and introduced *Phragmites australis*. PLoS ONE 7: e42794. Secondary: Smith, M.D. and A.K. Knapp. 2001. Physiological and morphological traits of exotic, invasive exotic, and native plant species in tallgrass prairie. International Journal of Plant Science 162:785-792.
Week 11	Class #19	Population processes – Demography-Review paper Sakai, A.K. F.W. Allendorf, J.S. Holt, D.M. Lodge, et al. 2001. The population biology of invasive species. Annual Review of Ecology and Systematics 32:305-332.
	Class #20	**Population processes – Demography-Case study** E.A. Pardini, J.M. Drake, J.M. Chase & T.M. Knight. 2008. Complex population dynamics and control of the invasive biennial *Alliaria petiolata* (garlic mustard). Ecological Applications 19:387–397.
Week 12	Class #21	**Ecological genetics – Genetic structure of agronomic weed and invasive plant populations: are they the same?** Ward et al. 2008. Ecological genetics of plant invasion: What do we know? Invasive Plant Science and Management 1:98-109.
	Class #22	**Ecological genetics – Can we use genetic analysis to reconstruct weedy and invasive plant spread?** (i) Gladieux et al. 2011. Distinct invasion sources of common ragweed (*Ambrosia artemisiifolia*) in Eastern and Western Europe. Biol. Invasions 13:933-944. (ii) Fuentes et al. 2011. Alien plants in Chile: inferring invasion periods from herbarium records. Biol. Invasions 10:649-657.
Week 13	Class #23	**Ecological genetics – Adaptation vs plasticity: what makes a successful weed or invasive plant species?** Davidson et al. 2011. Do invasive species show higher phenotypic plasticity than native species and, if so, is it adaptive? A meta-analysis. Ecology Letters 14:419-431.
	Class #24	**Ecological genetics – Interspecific hybridization in weedy and invasive plant populations.** (i) Schierenbeck and Ellstrand. 2009. Hybridization and the evolution of invasiveness in plants and other organisms. Biological Invasions 11:1093-1105. (ii) LaRue et al. 2012. Hybrid watermilfoil lineages are more invasive and less sensitive to a commonly used herbicide than their exotic parent (Eurasian watermilfoil). Evolutionary Applications 6:462-471.
Week 14	Class #25	**Student-led discussion**
	Class #26	**Student-led discussion**
Week 15	Class #27	**Student-led discussion**
	Class #28	**Student-led discussion**
Week 16	Class #29	**Student-led discussion**
	Class #30	**Student-led discussion**