

SYLLABUS FOR INVASIVE SPECIES BIOLOGY AND MANAGEMENT

Instructor:	Helen Poulos Email: hpoulos@wesleyan.edu Phone: 860-426-0266
Course Description:	Invasive species account for 39% of the known species extinctions on Earth, and they are responsible for environmental damages totaling greater than \$138 billion per year. However, the general population has little knowledge of what invasive species are or what threats they pose to society. In this course, we will explore the biological, economic, political and social impacts of invasive species. We will begin by exploring defining an invasive species and looking at the life history characteristics which make them likely to become pest. Then, we will consider the effects of invasive species expansion on the conservation of biodiversity and ecosystem function, as well as their global environmental and political impacts. Finally, we will explore the potential future changes in invasive species distributions under a changing climate.
Student Learning Goals:	Learning requires you to take an active role in the course. Students in this course are expected to participate in all of the course components including lecture, discussions and field trips. Your acquisition of the course material depends on your own personal interpretation of the concepts we cover in class. As an instructor, it is my job to facilitate your learning in an active manner, but ultimately it is up to you to process the information I present to you in this course. Although facts and vocabulary are important to any discipline, I ask you to go beyond simple memorization of details and to interconnect those facts to concepts, applications and problems; to ask meaningful questions; to test well developed hypotheses; to develop a range of intellectual abilities, including critical thinking, logical argument, appropriate uses of evidence and interpretation of varied kinds of information; and communication of your understanding in writing and orally.
Achieving Learning Goals:	Active class participation and attendance is a must for your success in this course. You will be expected to participate in cooperative group discussions, complete assigned projects and read assigned articles in advance of class meetings to critically analyze the themes presented in the course material.
Meetings:	1 Evening a week, 3 hours
Field Trips:	1 Full day and 1 half-day fieldtrips (one urban-centered; one to Southbury, CT). Field trips are not optional; they are an essential part of the learning experience.
Readings:	There is no single text. Scientific papers, chapters from several books and other supplemental readings will be assigned. These will be provided as PDF files. Readings will be discussed in class, following a short lecture or other exercise on the topic. Students must read the material prior to class since a major portion of the grade will be class preparation and participation.

Requirements: **Exams:** There will be one exam – a take home midterm and a comprehensive final exam – that will test students' understanding of key concepts and familiarity with the literature.
Project: Students will choose a topic of interest within the framework of the course and participate in a conservation, management, or field based activity in which students will apply the topics covered in class to a real-world setting.
Paper: Students will also be required to write a synthesis paper on related to their project, using a review of the scientific literature as a basis. Students will be expected to critically evaluate the literature with respect to the project they have carried out, particularly with respect to implications for management or policy.
Presentation: Each student will do a short class presentation that summarizes their project – as if they were presenting to policy makers.
Class Participation: class participation is essential as this is a seminar format.

Topics: The course focus is on the biology, ecology, and management of invasive species as well as the economic and political issues surrounding them.

Grades: Grades are calculated as follows:

Midterm	20%
Final	20%
Synthesis Paper	20%
Project Presentation	10%
Class and Fieldtrip Participation	30%

Tentative Schedule:

Invasive Species Biology and Management Helen Poulos

Schedule of Classes

Week 1	Course Introduction and Stakeholders Exercise
	Reading Scientific Publications for Content
Week 2	The Nature of the Invasive Species Problem
Week 3	A History of Biological Invasions
Week 4	Biology and Ecology of Invasive Species
Week 5	Impacts of Invasive Species on Ecosystem Function
Week 6	Invasive Species and Biodiversity
	Video: Cane Toads – A Case Study of IAS Issues and discussion
Week 7	Biological Control Issues

Spring Break

Week 8	Human Health Impacts of Invasive Microbes and Parasites Project Proposals Due Writing A Synthesis Paper MIDTERM Exam Handed out – due 1 week later
Week 9	Biological Invasions and the Globalization of Commerce Economic Consequences of Biological Invasions Project Literature Search Due
Week 10	Biological Invasions and Social Justice: Who Benefits/Who Pays? ½ day field trip to Audobon Society in Southbury, CT
Week 11	The Policy Arena: Local to National Spheres of Interest The Policy Arena: International Spheres of Interest
Week 12	Effects of Climatic Change on IAS ½ Day Field Trip: Urban Alien Invasives
TBD	Student Project Presentations During Final Exam Time

Final Papers Due at the End of Finals Week

POTENTIAL READINGS

Week1 Course Introduction / Stakeholders

1. Simberloff, D. 2003: Confronting introduced species: a form of xenophobia? *Biological Invasions* 5: 179-192.
2. Lodge, D.M. and Shrader-Frechette, K. 2003. Nonindigenous species: ecological explanation, environmental ethics, and public policy. *Conservation Biology* 17(1): 31-37.
3. Helmrich, S. 2005. How scientists think; about 'natives', for example. A problem of taxonomy among biologists of alien species in Hawaii. *Journal of the Royal Anthropological Institute (N.S.)* 11: 107-128.
4. Sagoff, M. 2005. Do non-native species threaten the natural environment? *Journal of Agriculture and Environmental Ethics* 18:215-236.

Week 2 Reading Scientific Publications for Content

The Nature of the Invasive Species Problem I

5. McNeely, J.A. 1999. The great reshuffling: how alien species help feed the global economy. pp. 11-31 In: Sandlund, O.T., P.J. Schei and A. Viken, eds. *Invasive Species and Biodiversity Management*. Kluwer Academic Publishers: Dordrecht.
6. Simberloff, D. 2000. Foreword in Elton, C.S. *The Ecology of Invasions by Animals and Plants*. 1958 (2000 edition). University of Chicago Press: Chicago.
7. Leahy, M., M. Tyrrell and A. Camp eds. 2005. *Invasive Species and the Public Good: A summary of a forum and speaker series exploring the human and political dimensions of invasive species*. Issue Introduction (pp. 6-8) and Discussion with Dan Simberloff (pp. 41-46).
8. *Now, They're Invading Your Business*. 2003. Connecticut Nursery & Landscape Magazine Issue 1:2003. Connecticut Nursery & Landscape Association.
9. *Frontiers in Ecology and the Environment Forum*: Sarah Reichard; Don C. Schmitz and Dan Simberloff; Darrel Morrison; Polly P. Lehtonen; Phyllis N. Windle and Gabriela Chavarría; and R. Wayne Mezitt. 2005. The Tragedy of the Commons Revisited. *Frontiers in Ecology and the Environment* 2(3) pp. 109-115.
10. Brown, J. M. and D. E. Sax. 2004. An essay on some topics concerning invasive species. *Austral Ecology* 29:530-536. Abstract.
11. Cassey, Phillip, T. M. Blackburn, R.P. Duncan and S.L. Chown. 2005. Concerning invasive species: reply to Brown and Sax. *Austral Ecology* 30:475-480. Abstract.
12. Brown, J. M. and D. E. Sax. 2005. Biological invasions and scientific objectivity: reply to Cassey et al. *Austral Ecology* 30:481-483. Abstract.

Week 3 A History of Biological Invasions

13. Di Castri, F. 1989. Chapter 1 *History of biological invasions with special emphasis on the old world*. In: *Biological Invasions: A Global Perspective*. Drake, J.A. et. al. (eds.) SCOPE. Wiley and Sons, Ltd. pp. 1-30.
14. Denevan, W.M. 2003. The pristine myth: the landscape of the Americas in 1492. *Annals of the Association of American Geographers* 23(3): 369-385.
15. Jeschke, J. M., and D. L. Strayer. 2005. Invasion success of vertebrates in Europe and North America. *Proceedings of the National Academy of Sciences of the United States of America* 102:7198-7202.

Week 4 Biology and Ecology of Invasive Species

Plants:

16. Ludsin, S.A. and Wolfe, A.D. 2001. Biological invasion theory: Darwin's contribution from *The Origin of Species*. 2001. *BioScience* 51(9): 780-789.
17. Davis, M.A., Grime, J.P., and Thompson, K. 2000. Fluctuating resources in plant communities: a general theory of invasibility. *Journal of Ecology* 88: 528-534.
18. Parker, I.M., Simberloff, D., Lonsdale, W.M. and others. 1999. Impact: toward a framework for understanding the ecological effects of invaders. *Biological Invasions* 1:3-19.

Aquatic and Marine Invaders:

19. Carlton, J.T. 1996. Pattern, process, and prediction in marine invasion ecology. *Biological Conservation* 78: 97-106.
20. Simon, K.S. and Townsend, C.R. 2003. Impacts of freshwater invaders at different levels of ecological organization, with emphasis on salmonids and ecosystem consequences. *Freshwater Biology* 48: 982-994.
21. Nyberg, C.D. and Wallentinus, I. 2005. Can species traits be used to predict marine macroalgal introductions? *Biological Invasions* 7: 265-279.

Week 5 Impacts of Invasive Species on Ecosystem Function I

22. Crooks, J.A. 2002. Characterizing ecosystem-level consequences of biological invasions: the role of ecosystem engineers. *Oikos* 97: 153-166.
23. Ehrenfeld, J.G. 2003. Effects of exotic plant invasions on soil nutrient cycling processes. *Ecosystems* 6(6): 503-523.
24. Sutherst, R.W. 2000. Climate change and invasive species: a conceptual framework. Chapter 10 in: *Invasive Species in a Changing World*. Island Press. Washington, D.C. pp. 211-240.
25. Hobbs, R.J. and Huenneke, L.F. 1992. Disturbance, diversity, and invasion: implications for conservation. *Conservation Biology* 6(3): 324-337.
26. Brooks, M.L., D'Antonio, C.M., Richardson, K.D.M. and others. 2004. Effects of invasive alien plants on fire regimes. *BioScience* 54(7): 677-688.
27. Stachowicz, J.J., Fried, H., Osman, R.W. and Whitlatch, R. B. 2002. Biodiversity, invasion resistance, and marine ecosystem function: reconciling pattern and process. *Ecology*, 83(9): 2575-2590.
28. Zavaleta, E.S., Hobbs, R.J., and Mooney, H.A. 2001. Viewing invasive species removal in a whole-ecosystem context. *Trends in Ecology and Evolution* 16(8): 454-459.

29. Parker, I.M., Simberloff, D., Lonsdale, W.M., Goodell, K., Wonham, M., Kareiva, P.M., Williamson, M.H., Von Holle, B., Moyle, P.B., Byers, J.E., Goldwasser, L. 1999. Impact: toward a framework for understanding the ecological effects of invaders. *Biological Invasions* 1(1): 3-19.

Week 6 Invasive Species and Biodiversity

30. Clavero, M., and E. Garcia-Berthou. 2005. Invasive species are a leading cause of animal extinctions. *Trends in Ecology & Evolution* 20:110-110.
31. Houlahan, J. E., and C. S. Findlay. 2004. Effect of Invasive Plant Species on Temperate Wetland Plant Diversity. *Conservation Biology* 18:1132-1138.
32. Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. *BioScience* 48(8): 607-615.

Cane Toads- A Case Study of IAS Issues and Discussion

33. Phillips, B.L. and R. Shine. 2004. Adapting to an invasive species: Toxic cane toads induce morphological change in Australian snakes. *Proceedings of the National Academy of Sciences* 101(49): 17150-17155.
34. Phillips, B.L., G.P. Brown, J.K. Webb, and R. Shine. 2006. Invasion and the evolution of speed in toads. *Nature*. 439: 803.
35. Urban, M.C, B.L. Phillips, D.K. Skelly, and R. Shine. 2007. The cane toad's (*Chaunus [Bufo] marinus*) increasing ability to invade Australia is revealed by a dynamically updated range model. *Proceedings of the Royal Society B* 274: 1413-1419.
36. Hagman, M. and R. Shine. 2007. Effects of cane toads on Australian mosquitoes: Does the dark cloud have a silver lining? *Biological Invasions* 9:445-452.

Week 7 Biological Control Issues

37. Hoddle, M. 2004. Restoring balance: using exotic species to control invasive exotic species. *Conservation Biology*. 18(1): 38-49.
38. Proffitt, Jr., W.T. 2003. Legitimacy and adoption of a scientific biological control program: an institutional analysis of Hoddle. *Conservation biology* 18(1): 58-60
39. Hoddle – rebuttal to above
40. Simberloff, D. and P. Stiling. 1996. Risks of species introduced for biological control. *Biological Conservation*. 78: 185-192.

41. Secord, D. 2003. Biological control of marine invasive species: cautionary tales and land-based lessons. *Biological Invasions*. 5: 117-131.

Spring Break

Week 8 Human Health Impacts of Invasive Microbes and Parasites

42. McMichael, A.J. and Bouma, M.J. Chapter 9 in: *Invasive Species in a Changing World*. Island Press. Washington, D.C. pp191-210.
43. Lanciotti, R.S., Roehrig, J.T., Deubel, V. and others. 1999. Origin of the West Nile virus responsible for an outbreak of encephalitis in the northeastern United States. *Science* 286: 2233-2237.
44. Jones, C.G., Ostfeld, R.S., Richard, M.P. and others. 1998. Chain reactions linking acorns to gypsy moth outbreaks and lyme disease risk. *Science* 279: 1023-1026.
45. Andreadis, T.G., Anderson, J.F., Munstermann, L.E. and others. 2001. Discovery, distribution, and abundance of the newly introduced mosquito *Ochlerotatus japonicus* (Diptera: Culicidae) in Connecticut, USA. *Journal of Medical Entomology* 38(6): 774-779.
46. Urbansky, E.T., Magnuson, M.L., Kelty, C.A., and Brown, S.K. 2000. Perchlorate uptake by salt cedar (*Tamarix ramosissima*) in the Las Vegas Wash riparian ecosystem. *The Science of the Total Environment* 256: 227-232.

Writing a Synthesis Paper

Week 9 Biological Invasions and the Globalization of Commerce

47. Carlton, J.T. 1999. The scale and ecological consequences of biological invasions in the World's oceans. pp. 195-212 In: Sandlund, O.T., P.J. Schei and A. Viken, eds. *Invasive Species and Biodiversity Management*. Kluwer Academic Publishers: Dordrecht.
48. Shine, C., N. Williams, and F. Burhenne-Guilmin. 2005. Legal and institutional framework for invasive alien species. pp. 233-284 In: Mooney, H.A., Mack, R.N., McNeely, J.A., Neville, L.E., Schei, P.J., and Waage, J.K. (eds.) *Invasive Alien Species: A New Synthesis*. Island Press.
49. Normile, D. 2004. Invasive species - Expanding trade with China creates ecological backlash. *Science* 306:968-969.

Economic Consequences of Biological Invasions

50. Naylor, R. 2000. The economics of Alien Species Invasions. Chapter 11 in: Mooney, H.A. and R.J. Hobbs. *Invasive Species in a Changing World*. Island Press. pp: 241-259.
51. Pimental, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics*. 52:273-288.
52. Connelly, N.A., C.R. O'Neill, Jr., B.A. Knuth, and T.L. Brown. 2007. Economic impacts of zebra mussels on drinking water treatment and electric power generation facilities. *Environmental Management* 40:105-112.

Week 10 Biological Invasions and Social Justice: Who Benefits / Who Pays?

53. McNeely J.A. 2005. Human dimensions of invasive alien species. Chapter 11 in Mooney, H.A., Mack, R.N., McNeely, J.A., and others (eds.) *Invasive Alien Species: A New Synthesis*. Island Press, Washington, D.C., pp. 285-309.
54. Drake, J.M. and R. P. Keller. 2004. Environmental justice alert: do developing nations bear the burden of risk for invasive species? *BioScience*. 54(8): 718-719.
55. Wallner, W.E. 1996. Invasive pests ('biological pollutants') and US forests: whose problem, who pays? *Bulletin OEPP/EPPO Bulletin* 26: 167-180.
56. Perrings, C., M. Williamson, E.B. Barbier, D. Delfino, S. Dalmazzone, J. Shogren, P. Simmons, and A. Watkinson. 2002. Biological invasion risks and the public good: an economic perspective. *Conservation Ecology*. 6(1): 1.

Week 11 The Policy Arena: Local to National Spheres of Interest

57. Schmitz, D.C. and D. Simberloff. 2001. Needed: A national center for biological invasions. *Issues in Science and Technology* 17 (4): 57-62.
58. Pimentel, D., Zuniga, R., Morrison, D. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52(3): 273-288.
59. Lodge DM, Williams, S., MacIsaac, H.J., Hayes, K.R., Leung, B., Reichard, S., Mack, R.N., Moyle, P.B., Smith, M., Andow, D.A., Carlton, J.T., McMichael, A. 2006. Biological invasions: Recommendations for US policy and management. *Ecological Applications* 16(6): 2035-2054.

The Policy Arena: International Spheres of Interest

60. Firestone, J., and J. J. Corbett. 2005. Coastal and port environments: International legal and policy responses to reduce ballast water introductions of potentially invasive species. *Ocean Development and International Law* 36(3): 291- 316.
61. Westphal, M. I., Browne, M., MacKinnon, K. and I. Noble. 2008. The link between international trade and the global distribution of invasive alien species. *Biological Invasions* 10(4): 391-398.
62. Work, T. T., D. G. McCullough, J. F. Cavey, and R. Komosa. 2005. Arrival rate of nonindigenous insect species into the United States through foreign trade. *Biological Invasions* 7(2): 323-332.

Project Literature Search Due

Week 12 Effects of Climatic Change on IAS

63. Dukes, J.S., and Mooney, H.A. 1999. Does global change increase the success of biological invaders? *Trends in Ecology and Evolution* 14(4): 135-139.
64. McCarty, J.P. 2002. Ecological consequences of recent climatic change. *Conservation Biology* 15(2): 320-331.
65. Simberloff, D. 2000. Global climate change and introduced species in United States forests. *The Science of the Total Environment* 3(15): 253-261.
66. Stachowicz, J.J., Terwin, J.R., Whitlach, R.B., Osman, R.W. 2002. Linking climate change and biological invasions: Ocean warming facilitates nonindigenous species invasions. *Proceedings of the National Academy of Sciences* 99(24): 15497-15500.