RESTORATION ECOLOGY (NREM 682)

PROFESSOR: Dr. Creighton M. Litton
CONTACT INFO: Sherman Laboratory 239/240; **mailbox**: Sherman Laboratory 101;
phone: 956-6004; **e-mai**l: litton@hawaii.edu
CLASS HOURS: TR 2:00 – 4:00 PM
OFFICE HOURS: T W 2:00 – 3:00 PM; appointments also welcome (and encouraged)

COURSE OVERVIEW

This is a graduate level seminar course that will explore the foundations of restoration ecology and the application of ecological theory to the practice of restoration. Practical application of restoration principles to Hawaiian and other ecosystems will be considered. Restoration ecology is the process of assisting the recovery of ecosystems that have been degraded, damaged, or destroyed. It requires *a priori* knowledge of ecological theory, and consists largely of the application of this theory to "design" or modify ecosystems to overcome degradation. In as much, restoration ecology has been referred to as an "acid test for ecological theory".

PREREQUISITES

Advanced undergraduate ecology course and graduate standing, or consent of instructor. It is recommended, but not required, that students have successfully completed NREM 680 (Ecosystem Ecology) or an equivalent course.

READINGS

Required Textbook: Falk, D.A., Palmer, M.A. and Zedler, J.B., eds. 2006. Foundations of Restoration Ecology. Island Press, Washington, DC, USA.

Supplemental Reading: (1) *SER International Primer on Ecological Restoration*, and *Guidelines for Developing and Managing Ecological Restoration Projects* (both available from the Society for Ecological Restoration at http://www.ser.org/reading_resources.asp) and, (2) individual journal articles available as course handouts and/or PDFs on the course website (http://www.ctahr.hawaii.edu/littonc/).

STUDENT OBJECTIVES

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER, 2004). Restoration Ecology, in turn, includes the theoretical principles underpinning the field and the application of these principles to the restoration of ecosystems.

Through completion of NREM 682 students will understand how ecological principles are applied to restore ecosystems and will demonstrate comprehension, skill, and competency in the following:

1. The historical development and empirical foundations of ecological restoration, including the difference between restoration ecology and conservation biology
2. Use of reference ecosystems as endpoints for ecological restoration

3. How a subset of ecological principles in soil science, ecosystem ecology, population biology, etc. are used to restore ecosystems
4. Interrelation of ecological factors and processes governing ecosystem structure and function in disturbed and degraded ecosystems
5. Relationship between "restoration ecology" and "ecological restoration (or restoration practice)", including the role and value of science in restoration
6. Current research efforts and future research needs in restoration ecology

STUDENT EVALUATION

Grading will be assessed by giving equal weight to each of 3 categories: (1) discussion leader, (2) discussion participation, and (3) final comprehensive examination. Class attendance is mandatory. All students are expected to read required materials prior to class (see Course Schedule, below), and come prepared to critically analyze and **discuss** the topics/literature/case studies for that day. The final examination will be comprehensive and will include material covered during both lectures and discussions; it will consist of essay and short answer questions, and definitions.

A typical class will include 20-30 minutes of lecture presented by the instructor based on the textbook readings and supplemented with additional information from the primary and secondary literature, primarily to provide a basis of understanding in the foundations and principles of restoration ecology. Each day, this mini-lecture will followed by a student-led discussion of an assigned reading from the primary literature. Specifics will be provided in more detailed in class, but the role of discussion leader will primarily entail: (1) a brief (~10-15 minute) introduction of the article, (2) discussion of important background information, including that present in other primary and secondary sources, (3) a handout outlining the justification, methodology and important points in the article, (4) preparation of a list of questions to stimulate group discussion, and (5) an abbreviated bibliography (10-20 citations) pertinent to the discussion topic. Discussion leaders are expected to read additional literature, background articles, etc. to further facilitate discussion by developing "expertise" on the assigned topic.

Grading Summary

1. Discussion leader = 50 points
2. Discussion participation = 50 points
3. Final Examination = 50 points.

   Total Points = 150 points

Grading Scale (based on a total of 150 points during the semester)

1. A = 150-135	(100-90%)	2. B = 134-120	(89-80%)
3. C = 119-105	(79-70%)	4. D = 104-90	(69-60%)

Cheating & Plagiarism: A student who cheats or plagiarizes on any assignment or examination will be given an "F" for the assignment or examination and may receive an "F" for the course. Plagiarism is repeating someone else's sentences, in whole or in part, ideas from other sources, turns of phrase, or arguments as your own, even if you paraphrase them, without acknowledgement. You can avoid plagiarism by acknowledging (providing the complete citation) for the source of the ideas, arguments, or sentences you are borrowing.

Role in the Graduate Program: The course is a graduate elective course in the Department of Natural Resources and Environmental Management, College of Tropical Agriculture and Human Resources. The Student Learning Outcomes (SLOs) for a graduate degree in NREM are: (a) Students are expected to acquire quantitative reasoning, critical thinking and other advanced skills, and (b) students are expected to utilize these skills to solve resource use problems and assist in developing sound resource policies. The proposed course will provide exposure to and experience for students in both SLOs, while covering a topic of considerable importance to the management of natural resources (i.e., restoring damaged, degraded or destroyed ecosystems).
Other graduate students not associated with NREM are also welcome and encouraged to take the course. Pending approval, this course may satisfy the ecology course requirement of the Ecology, Evolution, and Conservation Biology certification program at the University of Hawaii at Manoa.

COURSE SCHEDULE

Week	Topic
1	**Introduction** (introduction to course content and format; discussion of expectations; assignment of discussion leaders)
2	**Foundations of restoration ecology** (definitions; historical context; what is "natural"?; what are we trying to restore?; "reference ecosystems" as endpoints) Text *Ch. 1: Ecological theory and restoration ecology*, & *SER International Primer on Ecological Restoration* (http://www.ser.org/reading_resources.asp) Discussion (Role of Science in Restoration) (*i*) Cabin 2007. Science-driven restoration: A square grid on a round earth? Rest Eco 15:1-7; (*ii*) Giardina *et al*. 2007. Science driven restoration: A candle in a demon-haunted world - Response to Cabin (2007). Rest Eco 15:171-176; (*iii*) Cabin 2007. Science and restoration under a big, demon haunted tent: Reply to Giardina *et al*. (2007). Rest Eco 15:377-381.
3	**Recruitment dynamics and population ecology in a restoration context** (populations and metapopulations; minimum viable population size; seed banks) Text *Ch. 4: Implications of population dynamic and metapopulation theory for restoration* Discussion Griscom *et al*. 2005. Seedling survival and growth of native tree species in pastures: Implications for dry tropical forest rehabilitation in central Panama. Forest Ecology and Management 218:306-318
4	**Genetic and evolutionary considerations for restoration** (genetic variation, plasticity, and adaptation; seed source; natural selection and evolution) Text *Ch. 2: Population and ecological genetics in restoration ecology* & *Ch. 6: Evolutionary restoration ecology* Discussion McKay et al. 2005. "How local is local?" – A review of practical and conceptual issues in the genetics of restoration. Restoration Ecology 14: 432-440
5	**Succession and restoration** (primary and secondary succession; multiple states and restoration trajectories; natural disturbance regimes)

Text *Ch. 9: The dynamic nature of ecological systems: Multiple states and restoration trajectories*
Discussion Daehler & Goergen. 2005. Experimental restoration of an indigenous Hawaiian grassland after invasion by buffel grass (*Cenchrus ciliaris*). Restoration Ecology 13:380-389

6 **Soils and belowground ecology from a restoration perspective** (topography; soil microbiology; soil structure and chemistry; nutrients and water)
Text *Ch. 7: Topographic heterogeneity theory and ecological restoration*
Discussion Baer et al. 2005. Soil heterogeneity effects on tallgrass prairie community heterogeneity: An application of ecological theory to restoration ecology. Restoration Ecology 13: 413-424

7 **Community ecology and competition in a restoration context** (environmental filters; competition and biotic interactions; diversity effects)
Text *Ch. 5: Ecological communities: from theory to practice*
Discussion Cabin *et al*. 2002. Effects of light, alien grass, and native species additions on Hawaiian dry forest restoration. Ecological Applications 12:1595-1610.

8 **Plant physiological ecology and restoration** (resource capture and use; adaptations to stress)
Text *Ch. 3: Ecophysiological constraints on plant responses in a restoration setting*
Discussion Pywell *et al*. 2003. Plant traits as predictors of performance in ecological restoration. Journal of Applied Ecology 40:65-77

9 **Restoring ecosystem processes** (nutrient cycling; productivity; ecosystem services)
Text *Ch. 10: Biodiversity and ecosystem functioning in restored ecosystems: extracting principles for a synthetic perspective* & *Ch. 8: Food-web approaches in restoration ecology*
Discussion Ruiz-Jaén & Aide. 2005. Vegetation structure, species diversity, and ecosystem processes as measures of restoration success. Forest Ecology and Management 218:159-173

10 **Restoration and invasive species I** (integration of a variety of issues in the context of nonnative invasion)
Text *Ch. 12: Using ecological theory to manage or restore ecosystems affected by invasive plant species*
Discussion (*i*) Cabin *et al*. 2000. Effects of long-term ungulate exclusion and recent alien species control on the preservation and restoration of a Hawaiian tropical dry forest. Conservation Biology 14:439-453; (*ii*) Litton *et al*. 2006. Effects of non-native grass invasion on aboveground carbon pools and tree population structure in a tropical dry forest of Hawaii. Forest Ecology and Management 231:105-113.

11 **Restoration and invasive species II** (use of nonnative species to restore ecosystem function)

Text *Ch. 12: Using ecological theory to manage or restore ecosystems affected by invasive plant species*

Discussion Ewel & Putz. 2004. A place for alien species in ecosystem restoration. Frontiers in Ecology and the Environment 2:354-360

12 **Restoration in the context of global change biology** (integration of a variety of issues in the context of global climate change, nitrogen deposition, increased CO_2)

Text *Ch. 15: Climate change and paleoecology: New contexts for restoration ecology*

Discussion (*i*) Wright. 2005. Tropical forests in a changing environment. Trends in Ecology and Evolution 20:553-560; (*ii*) Palmer *et al*. Ecology for a crowded planet. Science 304:1251-1252.

13 **Restoration from a landscape perspective** (integration of a variety of issues at landscape and regional scales)

Text *Ch. 14: Ecological restoration from a macroscopic perspective*

Discussion Lamb *et al*. 2005. Restoration of degraded tropical forest landscapes. Science 310:1628-1632.

14 **Restoration of wetland and aquatic ecosystems** (concerns and issues specific to aquatic and wetland ecosystems)

Text *TBA*

Discussion Bruland & Richardson. 2006. Comparison of soil organic matter in created, restored and paired natural wetlands in North Carolina. Wetlands Ecology and Management 14: 245-251 **and/or** Bruland & Richardson. 2005. Hydraulic, edaphic and vegetation responses to microtopographic reestablishment in a restored wetland. Restoration Ecology 13:515-523.

15 **Synthesis** (synthesis of theoretical aspects of restoration ecology and application to restoration projects)

Text *Ch. 16: Integrating restoration ecology and ecological theory: A synthesis* & *SER Guidelines for Developing and Managing Ecological Restoration Projects* (http://www.ser.org/reading_resources.asp)

Discussion (*i*) Young *et al*. 2005. The ecology of restoration: historical links, emerging issues and unexplored realms. Ecology Letters 8:662-673; (*ii*) Hilderbrand & Randle, A.M. 2005. The myths of restoration ecology. Ecology and Society 10:19; (*iii*) Davis & Slobodkin, L.B. 2004. The science and values of restoration ecology. Restoration Ecology 12:1-3.

16 **Final Comprehensive Examination**