ENH 160 Restoration Ecology
Spring 2012

Location:	Environmental Horticulture Room 146
Time:	Tuesdays, Thursdays 9:00-10:20
Web:	https://smartsite.ucdavis.edu

Instructor:	Dr. Valerie Eviner	TA:	Ben Waitman
Office:	1312 PES		
Office Hours:	Tues 11-12 and by appointment	Office Hours:	by appointment
Email:	veviner@ucdavis.edu	Email:	bawaitman@ucdavis.edu
Phone:	752-8538	Phone:	754-8729

Course Description: Effective restoration requires an interdisciplinary, big-picture approach. In this class, we will study the basic principles of a number of different fields as they apply to ecological restoration. These fields include: physiology, population, community, ecosystem and landscape ecology. We will explore how the combination of these fields can improve the design and implementation of restoration projects. We will also explore how restoration projects can advance ecological science by addressing big-picture ecological questions.

Goal: The primary goal of this course is to develop critical thinking skills in the application of ecological principles to restoration.

Objectives:
Through this course, students will:

- describe the role of key ecological concepts in restoration
- use a big-picture approach to link ecological concepts with the:
  - selection of restoration goals
  - development of restoration plans
  - monitoring and evaluation of restoration projects
- identify goals and make decisions based upon:
  - tradeoffs
  - feedbacks
  - interactions
  - constraints/feasibility
- adapt goals and plans to new information or changing conditions
- identify uncertainties and risks in decision making, and use them to suggest key ecological questions that should be addressed to improve restoration
- use existing restoration projects and design new projects to research big-picture questions in basic and applied ecology

Readings: Readings for each lecture are available as PDFs on Smartsite https://smartsite.ucdavis.edu.

Policies:

- You are expected to be familiar with the UCD Code of Academic Conduct (http://sja.ucdavis.edu/files/CAC.PDF), this code will be enforced in this class.
- Office hours, as listed above, are for dropping in. You are welcome to contact the professor or TA via e-mail to make an appointment outside of office hours, or to ask a question. Please use your UC Davis e-mail account. Mail from other accounts may be disregarded as spam. Please use the memo line as an alert to the professor as to the content of your message. We will answer emails as soon as possible, but do not expect immediate answers, particularly at night or on weekends- plan accordingly if you have questions on assignments.
- Prerequisite: a general ecology class such as PB/EVE 117, EVE 121, PB 147, or equivalent. Because the focus of this class is on applying ecological principles to restoration, it requires that you have a strong ecological background. If you do not have the prerequisites, you should delay taking the course until you have the background.

Submitting assignments

- Assignments should be submitted in Smartsite, through the assignments folder. All assignments should be submitted in a format compatible with word processing software (e.g. Word), so that the professor and TA can make edits and comments electronically. PDFs should be avoided. If you have trouble submitting to Smartsite, email to veviner@ucdavis.edu BEFORE the deadline.
- All assignments are due *at the start of class* on the date designated in the syllabus. Late work will not be accepted unless you have made arrangements with the professor ***prior*** to the due date (exceptions in emergencies will be granted on a case-by-case basis).

Class Format: This course is designed to maximize your understanding and application of the topics covered throughout the class, and to prepare you for applying science to management scenarios. This is especially important in restoration, since effective restoration requires an integration of many topics, and constantly shifting management in response to new information. Thus, instead of cramming for a mid-term, or writing a last-minute term paper, these efforts will be spread out throughout the course—using a problem-set approach (e.g. single exam question at a time, which we'll discuss in class), and splitting your term-paper into multiple sections so that you can carefully think through each step of the assignment, and modify your paper in response to review. This reflects the actual planning and review process that occurs in restoration projects.

Grading: will be based on a point system

General class participation	20 points (4% of final grade)
Project - total project is 60% of your grade, breakdown as follows:	
Initial submissions	
- Literature list	15 points (3% of final grade)
- Part I-	65 points (15% of final grade)
- Part II-	65 points (15% of final grade)
Group presentation & Written group synthesis	30 points (7% of final grade)
Final version	100 points (22% of final grade)
Final exam	150 points (34% of final grade)

Problem sets:
Problem sets will be similar in nature to exam questions (they are previous exam questions). They will be assigned after each topic. You should work on each problem set and have it prepared for the next lecture, when we will discuss it in class (some will be done as in-class exercises). While these will not be graded, they are an essential part of your training, and will greatly help you develop your critical thinking skills that will be required for the final exam. Not doing the problem sets and just "listening in" to the class discussion will not be adequate preparation for the final exam. Discussion of problem sets will be an important component of your class participation grade.

Final Exam:
The final exam will be a mixture of short answer and essay questions that will test your understanding of the course objectives (see above). You will be expected to synthesize across lectures, discussions, case studies, and readings. Questions will be similar in style to the problem sets and class discussions. The final exam will cover all material presented in the class.

Plagiarism
Plagiarism is a serious academic offense and will not be tolerated. The ideas and text in your project are expected to be your own, as are the words and phrasing. For specifics on how to avoid plagiarism, see: http://sja.ucdavis.edu/files/plagiarism.pdf

Plagiarism is any time you present someone else's work as your own- whether it's a published source or not. Any time you are presenting someone else's ideas, be sure to cite them as a source. Word-for-word quotes are discouraged, but if are being used, must be an exact copy of the original, in quotes, and cited appropriately. Merely shuffling the order of a few words, or changing a few words of text can still be regarded as plagiarism (see examples from web-link above, also attached to this syllabus).

It is expected that all of the work you turn in is your own, in your own words. Plagiarism will be reported to student judicial affairs.

Syllabus

For readings associated with each lecture, see smartsite or list below

	Date	**Topic**	**Assignments due**
1	4/3	Course logistics, Introduction to restoration ecology	
2	4/5	Class project overview	Select project preference
3	4/10	Elements of ecological restoration	
4	4/12	Principles of restoration ecology	
5	4/17	Ecosystem states, State transitions, Resilience	Literature list due
6	4/19	Restoration of abiotic conditions Organismal ecology I	
7	4/24	Organismal ecology II Population ecology I	Project- Part I due
8	4/26	Population ecology II	
9	5/1	Community ecology I	
10	5/3	Community ecology II Ecosystem ecology I	
11	5/8	Ecosystem ecology II	
12	5/10	Landscape ecology	
13	5/15	Socioeconomic considerations	
14	5/17	Lab presentation Group project preparation	Project- Part II due
15	5/22	Group project preparation	
16	5/24	Group presentations, Class integration	
17	5/29	Group presentations, Class integration	
18	5/31	Class project integration	Written group syntheses due
19	6/5	Restoration in a changing environment	
20	6/7	Synthesis, Future challenges, Global-scale restoration	Project-Final version
	6/11	**1-3pm Final Exam**	

Readings- All readings listed here are mandatory readings for the class. These readings, as well as supplementary material, are available on Smartsite.

	Date	Reading
1	4/3	Galatowitsch 2012. Ecological Restoration, Chapter 1. Sinauer Associates, Sunderland, MA.
2	4/5	Vaghti, M.G. and S.E. Greco. 2007. Riparian Vegetation of the Great Valley. *In:* Barbour, M, T Keeler-Wolf, and AA Schoenherr (editors). Terrestrial Vegetation of California, 3rd Edition. University of California Press, Berkeley, CA.
3	4/10	Galatowitsch 2012. Ecological Restoration, Chapter 2. Sinauer Associates, Sunderland, MA. Howell et al. 2012. Introduction to Restoration Ecology. Island Press, Washington. pp. 16-22.
4	4/12	DeFries, Foley and Asner. 2004. Land-use choices: balancing human needs and ecosystem function. Frontiers in Ecology and Environment. 2: 249-257.
5	4/17	Resilience Alliance 2007. Excerpt from "Assessing and managing resilience in social-ecological systems: Volume 2 Supplementary notes to the practitioners workbook. Folke et al. 2004. Regime shifts, resilience and biodiversity in ecosystem management. Annual Review of Ecology, Evolution and Systematics 35: 557-581.
6	4/19	Whisenant SG. 2002. Terrestrial systems. *In:* Perrow, MR & AJ Davy (eds.). Handbook of ecological restoration. Volume 1: Principles of restoration. Cambridge: Cambridge University Press. pp. 83-105.
7	4/24	Whisenant, SG. 1999. Repairing damaged wildlands: a process-oriented, landscape-scale approach. Cambridge: Cambridge University Press. pp. 118-149.
9	5/1	MacDonald, DW, TP Moorhouse & JW Enck. 2002. The ecological context: a species population perspective. *In:* Perrow, MR & AJ Davy (eds.). Handbook of ecological restoration. Volume 1: Principles of restoration. Cambridge: Cambridge University Press. pp. 47-65. Gray, AJ. 2002. The evolutionary perspective. *In:* Perrow, MR & AJ Davy (eds.). Handbook of ecological restoration. Volume 1: Principles of restoration. Cambridge: Cambridge University Press. pp. 68-80
10	5/3	del Moral, R, LR Walker & JP Bakker. 2007. Insights gained from succession for the restoration of landscape structure and function. *In:* Walker, LR, J Walker & RJ Hobbs (eds). Linking restoration and ecological succession. New York: Springer Science. pp. 19-44.
11	5/8	Krueger-Mangold, JM, RL Sheley and TJ Svejcar. 2006. Toward ecologically-based invasive plant management on rangeland. Weed Science. 54: 597-605.
12	5/10	Galatowitsch 2012. Ecological Restoration, Chapters 6 & 7. Sinauer Associates, Sunderland, MA.
13	5/15	Hobbs, RJ. 2002. The ecological context: a landscape perspective. *In:* Perrow, MR & AJ Davy (eds.). Handbook of ecological restoration. Volume 1: Principles of restoration. Cambridge: Cambridge University Press. pp. 24-45.
19	6/5	Howell et al. 2012. Introduction to Restoration Ecology. Chapter 13. Island Press, Washington.
20	6/7	Hobbs et al. 2009. Novel ecosystems: implications for conservation and restoration. Trends in Ecology and Evolution 24: 599-605. Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: synthesis. pp. 71-102, 123-131.

Spring 2012- Project for ENH 160

Project Scope- The focal experience of this class will be to develop a restoration handbook for Putah Creek Riparian Reserve. This reserve balances a number of goals, including decreasing invasives and increasing natives in riparian, upland, and creek habitats, as well as accommodating recreational and educational activities. In order to manage for multiple goals, it is critical to bring together the latest information on each goal, and to use this information to develop management plans that can achieve multiple goals. This is where you come in. Each student will rate their preferred topics from the list (separate handout), and based on these rankings, will be assigned a given topic. You will research this topic, summarize your key findings, and make a management plan based on that information (see details below). Students working on similar goals will then work together to:

1. Develop management plans that can balance multiple goals (each goal represented in the group). This is not always possible by one approach, but is often possible by varying management goals and practices over space and time. When some goals conflict, it may be necessary to provide multiple management plans, each with different goals (and then the Preserve will have to choose to prioritize one set of goals over others).
2. The group will present a short summary of their topics and management plan to the class.
3. The group will provide a brief written summary of their topics and management plan.

After the group presentations, as a class, we will discuss management options that encompass as many of these goals as possible. All individual projects, group projects, as well as a class synthesis, will be compiled and sent to the Putah Creek Riparian Reserve, and be made available on the web for other managers.

General approach- The project will be divided into different stages, which will allow you to develop the project step-by-step, and get feedback before the final compilation is due. You will essentially be graded twice for each written section you turn in. The project has been designed this way to reflect actual restoration planning- where each step of the planning process is improved based on feedback from various stakeholders. Thus, the first version you turn in for each section should reflect a serious attempt to "get it right", and will be graded for overall quality. A high quality first draft will not only affect your grade, but will also minimize the work you will need to put into a final version. At the end of the quarter, you will submit a final version of all sections, where you have incorporated feedback. The grade of the final version will be based on overall quality and how well you address suggestions you received on your draft versions of each section. Details on each step are below.

Writing style- The project is intended to be a brief overview of the key issues involved in your selected restoration topic. As such, it is entirely appropriate to touch on key points through the use of bullets and numbered lists, *as long as you are conveying enough information for the reader to follow along with your logic and story.* Remember, this is a professional document that will be used to inform managers—be sure your writing is clear, concise, and professional. Be sure to cite all reference sources, including websites, newspaper articles, journal articles, books, etc. Provide complete information for each reference at the end of each section (for most sources that includes author, date of publication, article/chapter title, journal/book title, publisher, city of publication, page numbers). (See attachments to the syllabus for handouts on avoiding plagiarism and details on proper citations).

Specific requirements:
Below you will find *guidelines* for addressing your target restoration goal in each section of the project. Different goals will require some different information, or have different information available. If after a thorough search, you cannot find some of this information, make it clear that this is a current hole in our knowledge about the subject. The guidelines below will fit most projects, but feel free to expand on certain topics, add certain components that are critical for your goal, or briefly describe why a given topic is not relevant to your goal. You're encouraged to look at examples from previous years (available in the resources folder on smartsite) as examples of what is expected. The sections of their papers were not identical to this year's assignment, but most of the key information/approaches are still valid to your assignment. Strong examples include: From 2010 report- manna grass, milk vetch, spearscale, conservancy fairy shrimp (see Smartsite for these examples)

Literature list Due 4/17
Because many of the topics have not been thoroughly reviewed before, the project requires a thorough literature review of primary literature (e.g., scientific journals), agency reports, books, and other documents. Starting your review before you write part I is due is important to ensure that you have time to consult with us if you're having trouble finding the required information. See attached handout for instructions on using databases such as web of science.

The assignment can be 1-4 pages, and requires you to:

1. Tell us where you searched (Web of Science, library databases (e.g. government publications), Google scholar) and search terms used.
2. List SELECT references (the ones that will be useful).
    a. Provide a full citation.
    b. Provide a brief 1-2 line description of the information available in the document. This should be **YOUR** summary, do not paste in the abstract, etc. (see plagiarism guidelines).
3. List the topics you've earnestly tried to track down information for, but need assistance with.

This will be graded while we grade part I of your project, which will be the best way for us to assess how thorough you've been. If you're having difficulty finding some good references for your topic, we expect you to come to office hours or email us to follow-up, so that you're prepared to write part I. Be sure that you've earnestly tried to find the information before asking us—if we can find the information easily, that will be reflected in your grade.

Part I: Literature review: Project background and justification Due 4/24
Part I should focus on YOUR specific goal- providing the conceptual background that will be needed to make a management plan. Do not cover the background of riparian systems that is provided in class—rather, the background on your specific goal. In this part, you should NOT yet focus on our project site.

A. Background & Justification: 1 paragraph

- Why do we care about this goal? (e.g. this invader decreases native diversity and lowers the depth of the water table).
- Why is this restoration goal important and interesting? For example, what is your target goal's conservation value, its impact on agriculture and/or the environment?

- What is the current state of your target goal? (Not necessarily at our project site, but overall). For example, to what extent are populations in decline?
- What is the history of degradation of your goal? (e.g. This was a widespread native plant in riparian systems, but since the 1930's, it has been eliminated from most of its range. It is only still present in perennial streams of the Central Valley, where average population sizes have been reduced by 90%).

B. Literature review- this should be presented as a 2-4 page fact sheet, not including references (e.g. see examples from 2010 report on Smartsite—e.g. Solano grass/Crampton's tuctoria or Alkali milk vetch). This fact sheet must be clearly organized into key topics (which may vary project by project). Formatting can range from bulleted phrases to short paragraphs summarizing each key point, but must clearly convey the main message to unfamiliar readers. Unlike examples from 2010, each key fact requires citations immediately following it, and a full reference list must be included at the end of the document. Key topics that should be covered:

- What are the main factors affecting your goal? (Biotic, abiotic, human land use, etc.). Consider all topics covered in class- at the levels of physical site conditions, organism, population, community, ecosystem, landscape, socio-economic, global change, etc.) Some specific examples include:
    - specific characteristics of your species- germination controls, seed bank dynamics, environmental tolerances and preferences, key mutualists and competitors, pathogens, etc.
    - specific to riparian areas- what are your species requirements in terms of: inundation depth or duration or frequency, location (in relation to creek vs. upland, depth from water table, etc.), phenology (timing of activity, particularly in relation to timing of water flow)
    - How does your goal respond to: climate change, grazing, fire, nearby plowing, herbicides/pesticides? other potential management actions?

It is critical to be as specific as possible about the factors that can increase or decrease your goal, and your goal's dependence on site conditions and timing of management/key life stages. For example: ground nesting bird X requires brush-covered habitat that is not subjected to flooding, grazing, or feral cats from February through May.

- For all of the above information, focus on potential: constraints, non-linearities/ thresholds, interactions, feedbacks
- What scale (spatial and temporal) do these controls operate over?
- What restoration/management options have been effective or ineffective? Do these change site-to-site or project-to-project?
- What are key gaps in our knowledge that limit effective restoration planning?
- Other relevant information

While the presentation of this section will be brief**, it needs to highlight the most important aspects of your topic, derived from your comprehensive review of our existing knowledge on your topic—this requires considering multiple sources of information**. This is particularly critical because it is common to draw very different conclusions about restoration effectiveness at different sites. It is critical that you base this review on trusted sources (e.g. peer reviewed literature and government reports) and emphasize specific facts—avoid citing opinions or propaganda that you may find on the web, and avoid speculation or vague comments. For example, rather than making a vague comment about an invader decreasing ecosystem health,

describe how its increased evapotranspiration dries up vernal pools faster, thus not providing the period of inundation needed for a specific native species of interest.

Part II: Goals and management plans- focused on your target **Due 5/17**

Part 2 again should focus on YOUR goal (not the overall class goal). Your goal(s), restoration plan, and monitoring plan should be specific, clear, and actionable. For example, rather than saying seed will be collected and spread on the site—you need to be specific about where it will be collected, and what seeding rate you will use. Similarly, if you suggest using grazing or fire as a management tool, you need to be specific about the timing of the fire, the frequency (every year?), and how much flexibility there might be in this plan (refer to specific examples given in lecture #3).

A. Goals: Outline the key goal(s) relevant for the restoration of your focal target (a list or table is fine, as long as you have descriptive phrases about each goal). Be sure to be explicit about the spatial and temporal scale of these goals (and in many cases, it may be appropriate to have different goals focusing on short- vs. long-term, small- vs. large-scale). Discuss the potential for restoring these goals, giving careful consideration of tradeoffs, feedbacks, interactions, and thresholds.

B. Restoration plan: Describe your restoration plan(s), be sure to justify your choices. If possible, discuss a few different restoration options (which will really help fit your project into the class' multiple goal plan), and the relative effectiveness of each. Points to include:

- specifics on methodologies (e.g. genetic sources of seeds, seeding in vs. transplanting, density and configuration of introductions, frequency and intensity of manipulated disturbance regimes)
- the temporal and spatial scale of your plan
- monitoring techniques (pre- and post-restoration) and "thresholds of action", justify the measurements and thresholds you have selected as indicators (For example, with complete failure of reestablishment of a population you plan to…….. versus with species establishment at only small, sporadic locations, you plan to ……). Be sure to be specific about when you will monitor, for how long monitoring must occur (and will it be of equal intensity the whole time, or change over the years?). Again, be sure there is enough detail to be actionable.
- potential problems you might encounter, and how you might adjust the plan along the way if you encounter those problems
- a description of the risks and uncertainties associated with your plan
- highlight research questions that need to be answered in order to improve the plan
- what research questions could be answered by this restoration project (or by comparing a suite of similar restoration projects?) How does your restoration design allow for those to be tested? (e.g. the presence of control plots, replicate treatments, etc.)

This section should be approximately 4-7 double-spaced pages (not including references), and must be written up in paragraph form (will not be in fact-sheet form). The plans must be based on the literature review you did in part I. Be sure to refer to specific information about the ecology of your goal to justify your plans. Cite references as appropriate.

Extra credit opportunity (up to 10 points) This can be handed in up to the last day of class.
Do a restoration budget for your goals, including factors such as: site preparation, labor hours, materials, monitoring costs, etc. This must be detailed and specific, based on actual data and a thoughtful plan. This should not be generic or "pulled out of thin air".

Group presentation 5/24-5/29 Group write-up Due 5/31
You will be assigned a group and a date to present after we grade Part I.

1. On 5/17 and 5/22, groups will meet to develop management plans that can balance group member goals. Be ready to share a brief review of your project to your group, particularly focusing on habitat requirements, key timing (for management/ protection, etc.), key management practices that benefit your goal, and that your goal is vulnerable to. Remember, we're all part of the same broad restoration team, so we'd all like to see all of these goals happen. This is not always possible by one approach, but is often possible by varying management goals and practices over space and time. When some goals conflict, it may be necessary to provide multiple management plans, each with different goals (and then the Preserve will have to choose to prioritize one set of goals over others).
2. The group will present a short summary of their topics and management plan to the class. Specifics on the presentation (e.g. length) will be presented in class once groups have been assigned. **Email ONE group powerpoint file to veviner@ucdavis.edu BEFORE 7am on the day of your presentation.** Those students with Macs should be sure that their presentation will run properly in PC format (convert it to a pdf if necessary).
3. The group will provide a brief written summary of their topics and management plan (2-5 pages). This is to provide the class with the necessary information to pull together a broader management plan, and also will be used by managers.

Final version Due 6/7
The final version should include Parts I-II, merged as one document, and all citations should be grouped together at the end . Sections I&II should incorporate the comments you received from the professor. If you do not agree with some of the suggestions (we're not talking about grammar, but suggestions for shifts in management plans, etc.), you should note that in the final version and justify your reasons for not adjusting the project in response to reviewer comments.

In addition, include one short paragraph address the following:
Based on your classmates' presentations and the group discussion of options for managing for multiple goals, discuss how your goals and restoration practices fit in with other key goals. Are there key tradeoffs and/or win-win situations? What are the potential feedbacks and interactions in managing for these multiple goals? How will you revise your original goals and management plan to accommodate these multiple goals?

Web posting of compiled papers. The overall class report will be compiled and placed on the web for wide access to managers. By handing in your final paper, you are permitting us to post your paper as part of the compiled class report. If you do not want your paper posted, you must email Dr. Eviner within a week of the end of spring quarter 2012, and we will keep your project out of the full class report.

Citing references
Unless a statement is considered general knowledge (e.g. "the sky is blue"), any statement of fact needs to have a citation. This is particularly important when bringing up any specific data or ideas. Citations play two important roles: 1) giving credit for the work and ideas of others; and 2) allowing the reader to follow up on an idea by looking to its original source.
There are many different ways to cite references in your writing. Different fields of study have different general methods. Even in the scientific community, each scientific journal has its own style that you must use. I am not picky about the style you use, but be sure to be consistent.
Examples of scientific citations:

- Gerlach (2004) demonstrated that in California alone, the costs of lost water associated with yellow starthistle amount to $3 – 15 million dollars annually.
- In California alone, the costs of lost water associated with yellow starthistle amount to $3 – 15 million dollars annually (Gerlach 2004).

All cited sources must be listed at the end of the paper in a References or Literature Cited section. Each entry must include the author(s), year, title, and journal or book information.

Examples:

Duncan, C., and J.K. Clark, eds. 2005. Invasive plants of range and wildlands and their environmental, economic, and societal impacts. Lawrence, KS: Weed Science Society of America. 222 p.

Belnap, J., and S.L. Phillips. 2001. Soil biota in an ungrazed grassland: response to annual grass (*Bromus tectorum*) invasion. *Ecological Applications* 11: 1261-1275.

Literature sources
You are expected to delve into peer-reviewed literature and government reports for this project. See the class handout on "searching for references" for guidance. The UCD library's website also provides some good search engines for looking up government reports and books. Shields library has a great government documents section (searchable through Melvyl) which will be very useful for some topics.

Internet Sources
Be cautious about the use of internet sources—anyone can publish documents on the internet, there is no quality control. Carefully check the source of information before you take the material seriously (e.g. The USDA Forest Service's reports are peer-reviewed technical reports that are scientifically valid). Some advocacy groups and non-profit groups have carefully cited and researched statements on their websites—these can be a good start in your search for information, but must be followed up on by verifying the information not only with the original citation, but also with a broader look at the literature to verify a broader view of an issue. Some websites are extremely biased and opinion-based, and are not a credible source of information, and you will only detect this through proper follow up of the information presented in these. Sites like Wikipedia can be a good starting point when looking for information—but should only be used to point you to key references and ideas, and should not be relied upon as your final source.
When using a website for information, you must cite the website and the date it was accessed.