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, and interactions between social, economic and ecological systems. 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:
  o selection of restoration goals
  o development of restoration plans
  o monitoring and evaluation of restoration projects
- identify and make decisions based upon:
  o tradeoffs
  o feedbacks
  o interactions
  o non-linearities
  o 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. In particular,
become familiar with what plagiarism is and how to avoid it—the ideas and text in your project are expected to be your own (see http://sja.ucdavis.edu/files/plagiarism.pdf).

**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 plans and 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), 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 both professor and peer-review. This reflects the actual planning and review process that occurs in restoration.

**Grading:** will be based on a point system

- **Class participation** 30 points (6% of final grade)
- **Problem sets- total value of all** 70 points (14% of final grade) (each will be worth 7-20 points)
- **Project - total project is 50% of your grade, breakdown as follows:**
  - **Initial submissions** (all parts together are 20% of your final grade)
    - **Part I-** 50 points
    - **Part II-** 50 points
  - **Talk** 30 points (5% of your final grade)
  - **Peer assessment** 30 points (5% of your final grade)
  - **Final version (all 3 parts)** 100 points (20% of final grade)
- **Final exam** 150 points (30% of final grade)

**Problem sets:**
Problem sets will be similar in nature to exam questions. They are designed to develop your skills in applying the information learned in class to actual decision-making scenarios. They will be handed out in lecture and will be due the following class period. These should not take you more than 10-15 minutes per set.

**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.
# Syllabus

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Assignments due</th>
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<tbody>
<tr>
<td>1 3/31</td>
<td>Course logistics, goals, introduction to restoration ecology</td>
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<tr>
<td>2 4/2</td>
<td>Elements of restoration - goals, design principles, monitoring and adaptive management</td>
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<tr>
<td>3 4/7</td>
<td>Principles of restoration and ecosystem management- multiple goals, constraints, tradeoffs, interactions, feedbacks, thresholds, context-dependence, spatial and temporal perspectives, uncertainty</td>
<td>Select project preference</td>
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<tr>
<td>4 4/9</td>
<td>Restoration of basic conditions: soils for revegetation- guest lecture, Dr. Vic Claassen, UCD</td>
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<tr>
<td>5 4/14</td>
<td>Ecosystem states, state transitions, resilience</td>
<td>Problem Set I due</td>
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<tr>
<td>6 4/16</td>
<td>Restoration of basic conditions: hydrology and geomorphology of rivers- guest lecture, Dr. Greg Pasternack, UCD</td>
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<tr>
<td>7 4/21</td>
<td>Restoration of basic conditions: hydrology in wetlands</td>
<td>Problem Set II due</td>
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<td>Organismal Ecology- how physiology and behavior determine suitability and constraints</td>
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<tr>
<td>8 4/23</td>
<td>Population ecology- age structure, life stage vulnerability, vulnerability of small populations, meta-populations, population genetics</td>
<td>Project- Part I due</td>
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<tr>
<td>9 4/28</td>
<td>Community Ecology-interactions, community assembly, succession, invasions</td>
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<tr>
<td>10 4/30</td>
<td>Ecosystem Ecology- ecosystem processes and services</td>
<td>Problem Set III due</td>
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<tr>
<td>11 5/5</td>
<td>Student presentations</td>
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<td>12 5/7</td>
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<td>15 5/19</td>
<td>Student presentations</td>
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<td>Lab reports to class</td>
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<tr>
<td>16 5/21</td>
<td>Group synthesis- multifunctional restoration plan based on student presentations</td>
<td>Project- Part II due ( &amp; 3 copies of parts I&amp;II for peer review)</td>
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<tr>
<td>17 5/26</td>
<td>Landscape Ecology- fragmentation, heterogeneity, configuration, scale, landscape context</td>
<td>Problem Set IV due</td>
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<tr>
<td>18 5/28</td>
<td>Peer review</td>
<td>Peer assessments</td>
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<tr>
<td>19 6/2</td>
<td>Interactions between socio-economic and ecological systems- cultural constraints, costs, policy, valuation, subsidies</td>
<td>Problem Set V due</td>
</tr>
<tr>
<td>20 6/4</td>
<td>Synthesis, Future challenges, Global-scale restoration</td>
<td>Project Final versions I-III</td>
</tr>
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6/8 10:30am Final Exam
Readings- Readings are designated in 3 categories:

1. (B) “Background”- similar to textbook readings- meant to reinforce what’s covered in lecture. If you are very comfortable with the material, you don’t need to read these. All of these are currently available on Smartsite.

2. (S) “Supplemental”- optional readings if you want to pursue a subject/case study in more depth. Some of these are currently on Smartsite and more will be posted throughout the quarter.

3. (M) “Mandatory”- key background or synthesis readings, or readings to cover restoration goals in the class project. All of these are currently available on Smartsite.

The letter in parentheses, preceding each reading in the list below, will designate the type of reading.

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Project Scope
The focal experience of this class will be to develop a restoration handbook for the campus’ restoration program (part of Putah Creek Reserve). The campus restoration program is charged with multiple goals: some are related to mitigation (and the campus is legally bound to achieve these), others are key management issues (e.g., fire control near buildings), and other goals are not required, but highly desirable (e.g., diversity, ecosystem services, recreational opportunities, etc.). In order to manage for multiple goals, it is critical to bring together the latest information on various components, 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). Each student will make a short presentation to the whole class, so that everyone is familiar with the broad scope of the overall project. As a class, we will then discuss management options that encompass as many of these goals as possible, and you will amend your management plan to encompass a broader array of goals. All individual projects, as well as a class synthesis (taken on by the students in the lab), will be compiled and sent to the campus restoration team, 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 from your teachers and peers 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 based on the effort you’ve demonstrated in addressing the key issues outlined for that part. At the end of the quarter, you will submit a final version of all sections, where you have incorporated feedback from your teachers and peers. 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 project. 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 part (for most sources, that includes author, date of publication, article/chapter title, journal/book title, publisher, city of publication, page numbers). (See the handout attached to the syllabus on avoiding plagiarism for more 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. 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.

**Part I: Project background and justification, literature review  Due 4/23**

A. Background & Justification: View this as a brief proposal for funding of the restoration target.
- State your broad goal (detailed goals will be addressed in part II)
- 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 on campus, but overall). For example, to what extent are populations in decline?
- What is the history of degradation of your goal?
- What are the local to national laws/policies that constrain or provide opportunities for your target goal?
- What are some potential sources of funding for restoration of this goal?

B. Literature review

A 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.

- What are the main factors affecting your goal (both ecologically and major challenges to restoration)? (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.)
- In particular, 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

Part I should be approximately 6 double-spaced pages, and key information can be summarized in a bulleted form, if desired.

**Part II: Goals and management plans- focused on your target  Due 5/21**

(At this time, turn in one copy of Part II for grading, and THREE copies of Parts I & II for peer review—part I should be revised based on earlier comments!)

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 broad, 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), justify the measurements you have selected as indicators (For example, with complete failure of reestablishment of a population…….. versus establishment at only small, sporadic locations).
- 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 double-spaced pages.

**Extra credit opportunity** (up to 10 points)
Do a restoration budget for your goals, including factors such as: site preparation, labor hours, materials, monitoring costs, etc. (** Note: this can be handed in up to the last day of class).

**Class presentation**
You will be assigned a date to present- see class schedule
Briefly present the key facets of your project to the class. Presentations should be 6-8 minutes in duration (no longer!! To fit everyone in, I will need to cut you off if you go over), and 1-2 minutes will be allowed for questions. The point of this is for all classmates to be aware of the importance, constraints, and opportunities of your project, so that we can fit all of these goals together in a comprehensive management plan. Be sure to keep that in mind during your presentations. Remember, we’re all part of the same broad restoration team, so we’d all like to see all of these things happen. We’ll address tradeoffs and hard decisions in the group discussion following the talks.

This talk should not be a reiteration of everything you’ve written & researched. Instead, briefly hit on the highlights (think about the brevity and clarity you’d like from your classmates’ presentations). Be sure to cover:
- justification for your target goal
- key constraints/opportunities (Be sure to think about this broadly—e.g. if you’re working on frogs, will your project be decimated by snakes, grazing, a certain % change in water availability, etc.)
- “proven” restoration techniques vs. uncertainties
- your restoration plan(s) and alternative options- paying particular attention to what management needs to occur, and over what spatial and temporal scales

**Peer assessment**
You will get the assignments on 5/26, and your reviews are due on 5/28
You will be divided into groups of 3-4 students. On 5/26 you will receive the full draft (parts I&II) of each member of your group. Read and give both written and oral feedback on each project in your group. The goal of this is to provide constructive criticism, helpful hints, and to point out potential tools or problems that the writer may have missed. Your comments should be
written- you will need 2 copies; you will turn in the first to the professor (these will be graded), and give the other copy to the project author. On 5/28, your group will spend the class discussing each other’s projects and exploring ways to overcome any remaining hurdles in the projects.

Detailed guidelines on peer review are provided in an attached handout. Peer reviews should be 1 page per project, and should include:
- what the author did well
- general suggestions for what the author might have missed
- constructive criticism

For discussion (15 minutes per project):
- discuss suggestions you made as a reviewer
- as an author, bring up questions you’d like the groups help on
- 15 minute summary- comparison of projects’ challenges, unknowns, tools, what you’ve learned from each other’s projects

**Part III- Revised plan and goals**  Due 6/4, along with final versions of Parts I & II

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? Compare at least 2 different scenarios using a tradeoff diagram (example on the left)—for example, contrast your original plan’s impact on a number of different goals, to your revised plan. What is your rationale for your final choice of goals and management plans (in terms of this new multiple-goal perspective)?

In addition, for each of the broad multiple goal scenarios decided upon in the group discussion, write a 2-3 sentence summary of the positive and negative impacts of that scenario on your target restoration goal. Of the group scenarios, which is the best-case scenario for your target goal and why? Which is the worst-case scenario and why?

Part III should be 1-2 double-spaced pages

**Final version**  - BOTH A PAPER COPY AND AN ELECTRONIC COPY IS DUE (electronic copy can be emailed to Dr. Eviner) Due 6/4

The final version should include Parts I-III, merged as one document, and all citations should be grouped together at the end (both in paper and electronic form). Sections I&II should incorporate the comments you received from the teachers and your peers. 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 do not have to address every point. However, if there is a substantial conflict between some feedback and your project, you should note that in the final version and justify your reasons for not adjusting the project in response to reviewer comments.
Peer review guidelines ENH 160

(Adapted from CA Delta restoration program)

Peer review is a critical step to ensure high quality science and management plans. Scientists and managers, when submitting proposals or project reports, typically ask colleagues to review their work informally to increase the quality of the work. Once these proposals or reports are submitted, they typically go through a very thorough review process that can consist of peer reviews, public comments, etc. These reviews make or break the funding, implementation, or publication of a project.

As a peer reviewer, your charge is to be fair, thorough, and balanced. Present both the strengths and weaknesses of the project, and provide helpful suggestions for its improvement. Start out with a big-picture approach. What was most exciting/impressive? What left you wondering or disagreeing? What did you learn from reading this project?

Some aspects you may want to comment on: (These are just suggestions- you don’t necessarily need to hit on all of these, and you will likely want to address points not mentioned here).

1. For each section of the project, does the write-up meet the assignment’s requirements?
2. Does the author make a clear case of site history and why it warrants restoration?
3. Does the author provide a clear presentation of multiple potential goals and their potential tradeoffs? Are there important aspects of the system that were not considered?
4. Does the author convincingly make a case for the choice of goals?
5. Are statements grounded in ecological and social science? Do authors point out where the data gaps are and do they make a convincing case for restoration goals/plans in spite of these data gaps?
6. What are the key assumptions the author makes, and are these warranted?
7. What needs to be discussed in more detail? Less detail? (is there a need for more focus in some sections?)
8. Is the project well-designed, accurate, complete, and easily understandable?
9. Does the project describe the key system constraints, tools and questions that are important for restoration?
10. What do you think about the proposed restoration plan? Is it feasible? Did the author consider both short-term and long-term success? Are there key elements of the system they didn’t account for? Are there trade-offs, feedbacks, thresholds that need to be addressed in more depth?