

## COMMUNITY COLLABORATIONS

# Collaborative Ecological Restoration

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Faculty and students at the University of Washington forge interdisciplinary partnerships with the regional community to restore damaged habitats.

The complexity of the interface between human communities and ecological sustainability demands that we supersede our traditional, balkanized disciplines (1). The field of ecological restoration showcases the necessity and merits of interdisciplinary approaches to real-world problems. Drawing on ecology, other life sciences, physical and social sciences, and the humanities, ecological restoration has a long history (2).

The dust bowl of the midwestern United States in the 1930s was rehabilitated with the benefit of diverse skills that were grounded in ecological science. Subsequent experience in treating degraded landscapes has developed the field of ecological restoration with a focus on returning biological potential and ecological integrity to damaged land (3, 4) [supporting online material (SOM) text]. Successful restoration requires interdisciplinary participation from land managers, policy-makers, scientists, and educators (5, 6).

In 1999, the University of Washington (UW) began linking components of restoration ecology studies across academic units among its three campuses (7). The UW Restoration Ecology Network (UW-REN) was created with one-time internal funds to catalyze faculty and student participation across the traditional boundaries of academic departments (8).

Students from natural and social sciences and humanities can earn an academic certificate (similar to a minor) in Restoration Ecology on any of the three UW campuses. Students learn how knowledge from their discipline applies to restoration. All students participate in a year-long ecological restoration

project. This capstone project engages students in interactive hands-on learning, revealing the complexity of real-world solutions and creating bonds between the university and the public (see photograph, below).

### UW-REN Capstone Projects

The restoration ecology capstone lasts for one academic year (fig. S1) and is directed by diverse faculty (9). Students, ideally representing a range of scientific and humanities fields, team up for aquatic and terrestrial restoration projects in neighboring communities. Participation is limited to senior students, who



**Retrieving degraded land.** UW-REN capstone students restoring streamside habitat.

have sufficient knowledge of their field to contribute to a multidisciplinary team.

Projects are selected by a panel of UW-REN faculty that meets prospective clients, who might represent local governments, schools, utilities, foundations, or community groups (table S1). Usually, projects are proposed by clients who would otherwise be working independently or with private-sector consultants but lack the financial or technical resources to do so. Some clients do have the resources but prefer to work with our students. Projects are selected on the basis of their regional ecological importance and potential for community and client involvement. These projects are also chosen for their educational value in representing a range of ecological and restoration challenges, and they must be feasible in size and scope for a student team to handle in an academic year. Project sites have generally been less than one acre, although larger project sites

have been restored by multiple student teams working in sequential years.

### The Capstone Experience

The first course, in the autumn quarter, introduces restoration tools through lectures, field visits, and demonstrations by restoration professionals. Topics range from scientific (site assessment, bioengineering, invasive species, and ecological theory application) to pragmatic (project management, grants, and community relations). Previous projects are studied to judge how well original goals were achieved and to understand the sustainability of outcomes. Teams of four to six students make their initial visit to the project site. This quarter builds shared foundations of scholarly and practical knowledge and promotes interdisciplinary communication in the teams.

The second course, in the winter quarter, begins with an ecological site analysis during which students collect the information necessary to design and implement their project. Student teams then draft a proposal for the client, responding to the client's stated needs by describing proposed actions and the ecological possibilities of the site. The proposal undergoes peer review by students in other capstone teams and UW-REN faculty before it is sent to the client. Next, by discussing and clarifying objectives and budget constraints with the client, the team negotiates a final proposal. A detailed work plan is then created that is rigorously tied to client needs, site conditions, prospects for long-term stewardship, and the underlying science. Students draw on their academic backgrounds to connect site-specific project implementation to previous knowledge represented in the literature (see table). That each restoration site is unique complicates this task but also proves the utility of providing a process to formulate unique responses.

In the spring quarter, teams finish site preparation, control invasive species, install habitat elements (including plants), describe the baseline conditions after installation, and develop long-term maintenance strategies. Teams craft stewardship plans, train their clients in the plan, and galvanize community support to ensure long-term project success. All project documents are accessible online. A poster session, attended by current and former clients, students,

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and neighbors of restored sites, ends the class. This event supports links among the university and surrounding communities and gives students an opportunity to communicate their work.

### Context of the Capstone

The capstone experience is intended for students with prior training in basic concepts of restoration ecology, which they may acquire through a junior-level prerequisite course that is open to students from any academic background. Beyond the academic knowledge of ecology, skills in project management, communication, collaboration, and negotiation are honed on the way to project success.

Through the course of a project, students encounter and learn to address a variety of pragmatic challenges that can be found in many restoration projects. A project may require canvassing neighbors, finding and managing volunteers, preparing education materials, posting signs, attending neighborhood meetings, applying for permits and small grants, soliciting materials, or installing public art.

Capstone students apply scholarly understanding developed in other classes to solve project problems. They must also take the critical step of conveying that knowledge and its application to team members and the public. They learn to communicate the scientific basis of their restoration concept to clients, peers in various disciplines, and the public.

### Our Experiences and Outcomes

Over the past 6 years, 155 students from all three UW campuses have participated in the UW-REN capstone. Of these, 95 have also pursued and been awarded the Restoration Ecology Certificate, which requires additional coursework. The interest in applying academic knowledge to restoring damaged ecosystems occurs across many university departments (6, 10), although the natural sciences dominate our student population (table S3). UW-REN began with courses and faculty from natural science departments. Students

from these programs quickly discover UW-REN offerings and are already inclined toward environmental themes. With the natural science foundation in place, we plan to engage a broader set of students and faculty and to add content and skills from fields such as ethics, anthropology, sociology, environmental history, and policy (11). Faculty will be recruited who can help students consider such social and humanistic dimensions.

UW-REN offers a model for collaborative education among science and nonscience students. We feel it has been effective in (i) fostering their ability to apply scientific understanding to practical problems in the field, (ii) tackling challenges in a multidisciplinary context and applying their knowledge in a framework with other disciplines, and (iii) developing their abilities to communicate broadly. Through this process, we have watched students come to understand that science is necessary but not sufficient for successful restoration (6) and that success depends on effective communication and cross-cutting alignment of values of the project team, clients, and the surrounding community (12). Lessons learned in working with community clients have improved our ability to prepare both students and clients for the capstone (13).

Our experience has not been without institutional challenges. Although we have had some success, we face repeated challenges in developing ongoing support in terms of funds, faculty time, and resources (14).

Students have appreciated how the capstone process reflects the stresses of team-based problem-solving for clients. As one student explained, "The varied perspectives and priorities of our team and clients challenged us to find common ground. As a result, we learned to collaborate in order to develop creative objectives and solutions to accomplish our hybrid goals. The UW-REN Capstone series is a uniquely holistic way of learning that combines the teaching and learning of the theory, application, and social aspects of science." The experience of addressing real-world prob-

lems helps students with future challenges (SOM text). Faculty benefit from new teaching and research collaborations. Finally, capstone projects forge rich bonds between the university and community, and provide exemplars of college courses that deal effectively with urgent societal issues and produce workable solutions (15). That the community also finds these projects valuable is reflected in our repeat customer rate: More than 40% of our capstone projects have been with clients returning after previous projects (SOM text).

We believe this capstone approach shows how research universities can become engaged with surrounding human and ecological communities while providing students with real-world opportunities to use their education.

### References and Notes

1. National Research Council, *Facilitating Interdisciplinary Research* (National Academies Press, Washington, DC, 2005).
2. M. Hall, *Earth Repair: A Transatlantic History of Environmental Restoration* (Univ. of Virginia Press, Charlottesville, VA, 2005).
3. A. D. Bradshaw, M. J. Chadwick, *The Restoration of Land* (Blackwell, Oxford, 1980).
4. Society for Ecological Restoration, *The SER Primer on Ecological Restoration* (Society for Ecological Restoration Science and Policy Working Group, Tucson, AZ, 2002); available online ([www.ser.org](http://www.ser.org)).
5. B. Lavendel, *Ecol. Restor.* **17**, 120 (1999).
6. E. Higgs, *Restor. Ecol.* **13**, 159 (2005).
7. Programs in restoration ecology also exist at the University of Wisconsin, Arizona State University, and the University of Victoria, among others.
8. UW-REN (<http://depts.washington.edu/uwren>) was established with a Tools for Transformation grant from the UW Provost's Office. Cheryl Greengrove (UW Tacoma), Johnny Palka and Sarah Reichard (UW Seattle), and Dan Jaffe (UW Bothell) made early contributions.
9. Disciplines represented among students include biology, landscape architecture, fisheries, engineering, art, geology, urban studies, and education. Current capstone faculty represent various natural sciences.
10. Faculty from at least 12 departments at UW are involved in restoration-related research or teaching.
11. Increased faculty involvement from other disciplines and targeted advertisement should make UW-REN offerings more visible and appealing to students outside the natural sciences. Students already coming from these fields often indicate they did not know these courses existed or were accessible to those outside the natural sciences.
12. P. McManus, *Aust. Geogr.* **37**, 57 (2006).
13. Difficulties with clients include their reluctance to grant students creative independence, inability to grasp the academic nature and requirements of UW-REN projects, and irregularity of client participation. Improved communication has minimized these issues.
14. Support for capstone teaching assistants and some faculty time remain the greatest difficulties. Program courses are now integrated with existing curricula, most faculty are supported by home departments, and administration is coordinated by UW Program on the Environment.
15. The Society for Ecological Restoration International recognized UW-REN's community service contributions with the 2004 John Reiger award.

### Supporting Online Material

[www.sciencemag.org/cgi/content/full/312/5782/1880/DC1](http://www.sciencemag.org/cgi/content/full/312/5782/1880/DC1)

10.1126/science.1128088

### INTERDISCIPLINARY CONTRIBUTIONS TO PROJECT GOALS

	Goals		
	Maintaining biodiversity	Controlling erosion	Enhancing sustainability
Fields contributing disciplinary knowledge	Conservation biology; ecology; landscape architecture	Civil engineering; botany; geology; soil science	Ecology; education; business; social sciences
Relevant literature on basic science	Habitat and species diversity; ecosystem stability	Soil properties; slope stability	Succession; nonequilibrium coexistence; assembly rules
Relevant literature on real-world applications	Wildlife and bird habitat restoration	Erosion control and stabilizing slopes	Successional trajectories
Examples of solutions	Woody debris addition; microtopography; nest boxes	Bioengineering; wood structure installation	Maintenance; monitoring; stewardship

**Creating solutions through scientific knowledge.** Students call upon knowledge from the basic and applied literature of a variety of disciplines as they craft solutions to the project's challenges. Table S2 provides literature references and more examples.

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### ARTICLE TOOLS

<http://science.sciencemag.org/content/312/5782/1880>

### SUPPLEMENTARY MATERIALS

<http://science.sciencemag.org/content/suppl/2006/06/27/312.5782.1880.DC1>

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