Learning Conservation and Sustainable Development: An Interdisciplinary Approach

John Schelhas* and James P. Lassoie

ABSTRACT

Conservation and sustainable development (CSD) represent one of the most important new ways of thinking in natural resource management and policy. Cornell University has developed an interdisciplinary graduate minor to include this approach in its curriculum. The concept of CSD involves working toward environmental, social, and economic goals simultaneously. Although sustainability is sometimes criticized as a vague concept, CSD can be operationalized by developing indicators for different goals through collaborative processes, and seeking positive sum solutions that, while not fully solving problems of sustainability, make concrete advances across these indicators. The graduate minor at Cornell University provides students with CSD concepts and skills through: (i) a core course, "Critical Issues in Conservation and Sustainable Development," which emphasizes the conceptual underpinnings of CSD and experience working in interdisciplinary groups to apply these concepts to case studies; (ii) a "Field Practicum in Conservation and Sustainable Development," which provides an interdisciplinary, team problem-solving experience in Latin America; and (iii) elective courses that provide students with interdisciplinary breadth, rather than the depth fostered by traditional minors. Students have found that the CSD minor helps them situate their research in the context of practical environmental management and policy problems, and provides them with skills to manage complex relationships with practitioners and local communities during research.

HUMAN SOCIETY is increasingly facing a variety of complex, intertwined environmental conservation and social issues. Biodiversity conservation, watershed management, and rural development are all being carried out at larger spatial scales that bring to the forefront the complex linkages between people and the environment. In biodiversity conservation, for example, conservationists have recognized the limitations of reserves and protected areas and are reaching outward from these to include larger landscapes, ecoregions, and agroecosystems (Baydack et al., 1999; Collins and Qualset, 1998; Dinerstein, 1995; Soulé and Terborgh, 1999). At the same time, those interested in sustainable development, recognizing that development that degrades the natural resource base will be short-lived, are promoting biodiversity-related conservation to meet human livelihood and development needs (Brandon, 1998; Western and Wright, 1994). Thus, we find conservation and development efforts increasingly overlapping and laying claim to the same physical and institutional territories. This growing interface is proving to be a fruitful and diverse ecotone, spawning theoretical and empirical work that addresses both the conflicts and compatibilities between conservation and sustainable development. At an academic level, this is bringing about changes. Conservation and sustainable development (CSD) issues cut across many of the traditional disciplinary boundaries, including ecology, agricultural sciences, and the social sciences, and also require combining academic approaches with collaborative processes of governance and decision-making.

This paper describes the philosophy, organization, and instructional methods of the two core courses in Cornell University's Graduate Minor in Conservation and Sustainable Development, "Critical Issues in Conservation and Sustainable Development" and the "Field Practicum in Conservation and Sustainable Development." We begin by reviewing other efforts to develop interdisciplinary instruction in conservation and sustainability, and then describe the vision of sustainability that underlies Cornell's Graduate minor. We then provide a description of the Cornell program, along with details on the course offerings, to assist faculty at other universities in their efforts to develop similar courses or programs of study. We end by discussing some of the difficulties and benefits of the program.

CHALLENGES IN INTERDISCIPLINARY APPROACHES

Recent academic study of human–environment relationships is characterized by interdisciplinary approaches. Although the disciplinary structure of the academy itself has remained intact, there has been an increase in problem-oriented collaborations among disciplines and an emerging field of environmental studies representing the overlap or common ground between different disciplinary approaches (Benton and Redclift, 1994). Environmental issues can be placed at different points of convergence between disciplines and an evolving field of environmental studies (Benton and Redclift, 1994). For example, biodiversity conservation could be placed at the interface between ecology and several social sciences (e.g., economics, sociology, and political science), and global warming at the interface between biogeochemistry, atmospheric sciences, and the social and behavioral sciences.

A number of interdisciplinary research and education methods in conservation and sustainable development have been reported in the literature. Touval and Dietz (1994) report on an interdisciplinary graduate program at the University of Maryland that brings together biology, economics, and policy to emphasize training in practical conservation management skills. Jacobson et al. (1992) and Jacobson (1995) review U.S. graduate programs that integrate conservation and sustainable development. Uhl et al. (1997) describe an interdisciplinary approach to research on forest management prac-

J. Schelhas, USDA Forest Service, 112 Campbell Hall, Tuskegee Univ., Tuskegee, AL 36088; and J.P. Lassoie, Dep. of Natural Resources, Cornell Univ., Ithaca, NY 14853. Received 14 Aug. 2000. *Corresponding author (jschelhas@fs.fed.us).

Published in J. Nat. Resour. Life Sci. Educ. 30:111–119 (2001).
http://www.JNRLSE.org

Abbreviations: CSD, conservation and sustainable development; NGO, nongovernmental organization.

tices, policies, and regulations in the Amazon. A notable trend in all these approaches is that problem-oriented interdisciplinary research requires collaboration—both among scientific disciplines and stakeholders—in environmental problems. Zube (1982) emphasizes the need for communication among diverse groups: between and among natural scientists; among scientists, planners, and decision-makers; and local people. Getz et al. (1999) and Uphoff (1996) provide examples of programs that promote linkages between local people, managers, and scientists.

A number of authors have described the challenges associated with interdisciplinary approaches to environmental issues. The definition and interpretation of environmental problems are themselves value-driven, and may differ among disciplines (Redclift, 1987). Disciplinary language often presents a fundamental problem, deeper than merely understanding terms and jargon. Wear (1999, p. 302) suggests that each discipline has its own constitutive metaphors that crystalize the underlying theoretical grounding of that discipline, but are often only accessible and understood to the properly initiated. Zube (1982) notes the inadequacy of our conceptual frameworks for dynamically linking the social and natural sciences, and suggests that progress can best be made through "learning by doing." Interdisciplinary approaches are often undervalued in academia, but highly valued in applied work. As more and more graduate students go into applied work, and academics have increasing opportunities to focus their work on CSD problems, the development of academic programs that provide these interdisciplinary experiences is important.

DEFINING CONSERVATION AND SUSTAINABLE DEVELOPMENT

The term *conservation* is well established in Western thought. Conservation, when applied to natural resources, refers to the management, use, and protection of a natural resource to prevent overexploitation or destruction. In the USA, the conservation movement—which dates to the late 1800s—has encompassed both efforts to promote the wise use of natural resources as well as ecosystem preservation (Andrews, 1999). The concept of development came of age in the post-World War II era (Ostrom et al., 1993) and includes economic and social approaches (Barbier, 1987).

The term *sustainability* is more recent, rising to prominence in the late 1980s. Sustainability is generally defined as "meeting the needs and aspirations of the present and future generations without compromising the ability of future generations to meet their needs" (IUCN–UNEP–WWF, 1991; WCED, 1987). Sustainability can be thought of as a bridging concept between conservation and development, which have often been seen as contradictory.

Sustainability has been criticized as a vague and meaningless concept. Some see it as the "odd delusion of being able to have your cake and eat it, too" (Soule, 1995, p. 159), a concept that is broad and fuzzy enough to be appealing to everyone but masks fundamental contradictions (Redford, 1992). Yet, the term and associated approaches have spread rapidly and widely. International and government agencies and committees on sustainable development have been established at the highest levels, while, at the other end of the spectrum, grass roots organizations espousing sustainable development have sprung up in rural and urban communities worldwide. While some find the vagueness of the term sustainability problematic, the ambiguity, multivocality, and condensation of meaning in the term sustainability are themselves characteristic of powerful symbols (Kertzer, 1988) and are central to the term's power and prominence.[1] As such, sustainability can be seen as embodying and symbolizing the interconnectedness among people and nature, and the importance of pluralistic, interdisciplinary, and participatory ways of resolving environmental and development problems.

Yet, to endure, sustainability must be more than a powerful term or symbol in social and political discourse. Operationalizing and applying the concept of sustainability requires some common understandings and tools. Sustainability is commonly defined as seeking to optimize a variety of diverse goals across the biological and resource system, the economic system, and the social system (Barbier, 1987), both within and across generations (Dixon and Fallon, 1989). What these exact goals are, however, has been the subject of considerable debate. What follows is the general approach that guides the CSD courses at Cornell, which can be modified as appropriate to suit other purposes.

At least six dimensions of sustainability can be identified in the literature: (i) avoiding land degradation; (ii) conserving biological diversity, including species and ecosystems; (iii) maintaining ecological services, including watersheds, estuaries, and the global atmosphere; (iv) socio-economic sustainability, or sustaining and improving human livelihoods; (v) the wise use of agrochemicals and fossil fuel inputs to avoid human health impacts, effects on ecosystems, and overdependence on finite resources; and (vi) equity and fairness among the developed and lesser developed countries, urban and rural populations, racial and ethnic groups, and gender (Schelhas, 1994). Within each of these dimensions, specific measurable indicators can be developed to concretely evaluate sustainability. For example, numbers of bird species found in a landscape may be a partial indicator of the biodiversity dimension, and increasing household income or improving health status could be partial indicators of the socio-economic dimension.

As difficult as it may be to develop a set of manageable indicators, prioritizing and optimizing among indicators is an even more difficult task. The different dimensions of sustainability are value oriented, and in effect represent different value spheres that are incommensurable, or have no common denominator by which they can be compared. This means that there are multiple ways that the sustainability dimensions can be traded-off, none of which is necessarily inherently better than the other (Redclift, 1987). Thus, issues of sustainability cannot be definitively resolved independent of place and goals. Any attempt to do so seems to only produce endless argument; since different people, each using impeccable logic, can derive different conclusions, or recommend different solutions, to their differently defined CSD problems (Redclift, 1987).

Because of the value-oriented and indeterminate nature of CSD decision-making, it can also be viewed as a *process* that seeks to make incremental improvements across a broad range of indicators by shifting from a win–lose approach to a col-

[1] The concept of sustainability shares these characteristics with the concepts of conservation and development.

laborative problem-solving approach that is focused on a specific geographical area. Although CSD must have a problem and a place as its focus, it also deals with issues of concern to people across the full range of the local to global continuum. In fact, the distribution of the costs and benefits of resource use among different stakeholder groups is often an underlying source of conflict in complex resource management problems. For example, there are often tensions between farmers and downstream landholders, fishing interests, and coastal tourism facilities in watersheds—and between local people and international conservation interests around national parks and other protected areas. The multiple perspectives of these stakeholder groups can be taken into account through dispute resolution and collaborative problem solving. Campbell (1995, p. 125) has suggested the real challenge of sustainability is not to define it (or develop indicators), but to develop processes, forums, and modes of inquiry and learning that can support a broad societal debate and decision-making about the goals and actions of conservation and sustainable development efforts. If we view CSD as incorporating both processes and indicators, then it is the stakeholder groups themselves, often through a facilitated process, that together select the appropriate indicators for their particular situation.

This is not to claim that participation and collaboration are ever complete or perfect, or that solutions can be developed that fully meet the objectives of all stakeholders. Some possible resource uses must always be forgone to meet the needs of other interest groups or to provide for sustainable resource use over the long term. There are often winners and losers, and change may be most likely to occur when coalitions form and develop enough strength to advance their interests. But groups who are left out of agreements or whose needs are not fully met generally continue to be heard from, creating an incentive to strive for full participation and a recognition that most complex issues are managed rather than resolved. Conservation and Sustainable Development is a broad, interdisciplinary, multiparty approach involving social learning and adaptive management. All this points to a "fundamentally messy, contingent, and ambiguous intermingling of knowledge, power, interests, and chance in the workings of the world" (Parsons and Clark, 1995, p. 457). Yet, in spite of the complexity and lack of definitive resolution to many problems, strategies can be developed that bring about real improvements in environmental and social indicators (Parsons and Clark, 1995).

A practical CSD approach needs to go beyond indicators and collaborative processes to also include contributions from science and technology. Advances in technologies can point the way to new solutions or greater benefits that may in themselves help to catalyze collaborative problem-solving. For example, forestry, agroforestry, and agricultural practices exist and can be developed that simultaneously improve both biodiversity conservation and economic returns in human dominated landscapes. Agricultural practices often can be developed that have sufficient soil and watershed conservation benefits to enable people to farm some sensitive areas with few downstream impacts. Social science research can help illuminate issues of power, gender, and racial inequity that influence conservation and sustainable development, and understand the micro-level decision-making processes and behaviors of rural people. Economic research can help compare values and provide one basis (economic value) for making tradeoffs. Ethics can provide guidance in making choices among different resource uses, avoiding the difficulties of considering all competing claims on a resource as equally valid.

In the end, CSD is multifaceted. It requires a broad awareness of the perspectives and knowledge of other disciplines, of practitioners, and local and nonlocal stakeholders. Its practitioners must have skills and experience in group process and participatory techniques. Solutions often require knowledge generation and development of new "technologies." Its fundamental nature is seeking positive sum progress on concrete and measurable, mutually agreed-upon indicators to address jointly defined, geographically anchored problems.

CORNELL'S GRADUATE MINOR IN CONSERVATION AND SUSTAINABLE DEVELOPMENT

The graduate minor in conservation and sustainable development was formed at Cornell University in 1991 to provide graduate students with the opportunity to acquire an interdisciplinary perspective on environmental problems and learn interdisciplinary problem solving skills.[2] The minor recognizes the importance of traditional disciplinary expertise, while at the same time promoting a holistic perspective grounded in familiarity with other disciplines, experience in analyzing real-world conservation and rural development problems in interdisciplinary teams, and skills in building collaborative relationships with local natural resource managers and communities. All students in the minor must meet the following expectations: (i) participation for credit in the core CSD course, Critical Issues in Conservation and Sustainable Development (Natural Resources 618); (ii) involvement in an interdisciplinary problem-solving experience, such as the Field Practicum in Conservation and Sustainable Development (Natural Resources 619); and (iii) completion for credit of at least two recommended electives. To address this third requirement, Cornell courses closely related to conservation and sustainable development have been grouped into three subject matter areas: (i) biological–ecological–physical; (ii) social–cultural–economic; (iii) and policy–management–legal (see Table 1). Each student is required to take one elective from each of two subject matter areas that are outside the emphasis of his or her major course of study. The electives are an important part of the program, in that they enable students to take a set of courses outside of their disciplinary area of study that meets their individual needs and which could not be otherwise undertaken under most traditional disciplinary minors.

CORE COURSE: CRITICAL ISSUES IN CONSERVATION AND SUSTAINABLE DEVELOPMENT

The purpose of the core course, Critical Issues in Conservation and Sustainable Development (NR 618), is to establish a conceptual foundation for, and practical experience in, analyzing and addressing conservation and sustainable development issues from an interdisciplinary perspective. This

[2] The establishment of this program was supported in part by a Grant from Pew Charitable Trusts and two Research Training Grants from the National Science Foundation (BIR-9113293, DBI-9602244).

Table 1. Suggested electives for CSD minor field.

Biological–ecological–physical subject matter area	
ABEN 371	Hydrology and the environment
ABEN 471	Geohydrology
BioS 441	Crop evolution
BioS 455	Insect ecology
BioS 457	Limnology
BioS 461	Population and evolutionary ecology
BioS 462	Marine ecology
BioS 463	Plant ecology—lectures
BioS 469	Food, agriculture, and society
BioS 473	Ecology of agricultural systems
BioS 478	Ecosystem biology
Ento 444	Integrated pest management
Ento 456	Stream ecology
NatR 301	Forest ecology
NatR 304	Wildlife ecology concepts
NatR 415	Principles and practices of agroforestry
NatR 450	Conservation biology
SCAS 321	Soil and water management
Social–cultural–economic subject matter area	
ABEN 754	Sociotechnical aspects of irrigation
ARME 450	Resource economics
ARME 464	Economics of agricultural development
ARME 651	Economics of resource use
ARME 666	Economics of development
BioS 301	Biology and society: Social construction of life
CRP 442	Society and political studies in science
CRP 546	Conflict resolution in community and environment.
Govt 648	Political economy of change: Rural development in the Third World
Intag 402	Agriculture in tropical America
Intag 602	Agriculture in developing nations
NatR 400	International environmental issues
RuSo 324	Environment and society
RuSo 408	Human fertility in developing nations
RuSo 438	Social demographics
RuSo 440	Social impact of rapid resource development
RuSo 640	Community, property and society
RuSo 660	Social analysis of ecological change
RuSo 661	Sustainable agriculture and development
RuSo 721	The sociology of environment and development
Policy–management–legal subject matter area	
BioS 661	Environmental policy
CRP 551	Environmental law
CRP 552	Urban land-use planning I
Intag 603	Administration of agricultural and rural development (Gov 692)
NatR 308	Natural resource management
NatR 402	Natural resources policy, planning, and politics
NatR 428	Landscape impact analysis
NatR 615	Seminar in agroforestry
RuSo 418	Population policy

Field abbreviations: ABEN = agricultural and biological engineering; ARME = agricultural, resource, and managerial economics; BioS = biological sciences; CRP = city and regional planning; Ento = entomology; Govt = government; Intag = international agriculture; NatR = natural resources; RuSo = rural sociology; SCAS = soil, crop, and atmospheric sciences; STS = science and technology studies.

course was first offered in 1991, building on a previous seminar entitled "Marginal Lands, People and Sustainability" (Buck and Lassoie, 1992). Since then, it has gone through a number of changes to: (i) fine-tune the balance of group experience vs. knowledge transfer, (ii) find a mix of guest faculty and instructor-led discussions that provide both breadth and coherence in the course material, and (iii) generate a case study approach that meets the goals of the course.

In its current form, this 3-credit-hour course meets for 2 h twice a week. It is oriented to graduate students, although a limited number of advanced undergraduate students are admitted each year. The objectives of the course are for students to:

- Gain insight into the complexities of conservation and sustainable development through exposure to diverse points of view. Become familiar with the inherent contradictions, ethical dilemmas, and practical difficulties of operationalizing conservation and sustainable development.
- Become familiar with the key tenets, approaches, methods, and contributions of key integrating disciplines, such as conservation biology, natural resource economics, ethnobotany, agroecology, political ecology, and natural resource economics.
- Become familiar with how knowledge generation, transfer, and application processes are evolving to address conservation and sustainable development goals.
- Develop skills in interdisciplinary problem solving and research as applied to conservation and sustainable development issues.

Organization of the Course

The content of the core course focuses on the social, ecological, and agricultural issues at the interface of human occupied and influenced agricultural and forest systems. Although this is only a small segment of what could be examined under the rubric of conservation and sustainable development, it still encompasses a very broad range of material. Because this area is very broad for a single course, and because information changes rapidly, the course is not oriented primarily to transferring a fixed body of knowledge to students. Instead, it seeks to foster interactions among students and faculty members around a sampling of relevant information and around several case studies that foster critical thinking skills related to CSD. Under this approach, everyone brings some knowledge to the course, including the students, the guest instructors, and the instructor–course coordinator. The course focuses on developing skills in group problem analysis, and synthesis and application of knowledge and experience.

The course is divided into four sections: (i) conservation and sustainable development concepts; (ii) social issues, policies, and processes; (iii) conserving biological diversity; and (iv) sustainable agriculture and forestry (see Table 2). Each section includes guest presentations, group activities, discussions, readings, and an out-of-class group project. Each section of the course ends with a class session devoted to discussion and activities related to a group project. Two class sessions, one at the middle and one at the end of the semester, are devoted to synthesizing knowledge and perspectives on CSD.

Presentations, Discussions, and Activities

The regular class sessions are a mix of guest presentations, discussions of readings, and activities. The course is too broad to be taught by any one person, and the guest faculty provide an opportunity for students to interact with Cornell faculty members with diverse areas of expertise. The standard format for guest faculty is a 1-h presentation, and then, following a short break, a 1-h discussion. Faculty presentations may address interpretation of a current issue, a review of the state of knowledge in a field, or a case study that highlights an issue relevant to the course. Questions and discussion range widely, but tend to focus less on discussions of facts and theories than on the underlying assumptions of a presentation, the perspective of the guest on certain issues, and how the information presented fits in with other course materials. Value conflicts are common, as students and faculty seek to make sense

Table 2. Sample syllabus for "Critical Issues in Conservation and Sustainable Development."

Conservation and sustainable development concepts
1. Introduction
2. Conservation and sustainable development—concepts
3. Conservation and Sustainable Development—practice
4. Social science and CSD
5. Conservation biology and CSD
6. Agriculture and CSD
7. Presentation of frameworks

Social issues, policies, and processes
8. Conflict management
9. Participatory approaches
10. Case study presentation: Wildland protection in the Adirondack Park
11. Population
12. Political economy
13. Case study discussion—Adirondack Park, New York
14. Midterm assessment/discussion

Conserving biological diversity
15. Interactions between natural and agricultural systems
16. People and biodiversity conservation
17. Cost benefit analysis of environmental preservation
18. Case study presentation: Introduced species
19. Sustainable use?
20. Case study discussion—Braulio Carrillo National Park, Costa Rica

Sustainable agriculture and forestry
21. Agricultural change and intensification
22. Trade, development, and the environment
23. Sustainable agriculture case study: Iroquois agriculture
24. Social aspects of watershed management
25. Agroforestry
26. Case study discussion—Machakos District, Kenya
27. Conclusion

out of the many different perspectives that are a part of the course and learn that not everyone shares their assumptions and perspectives. Each section of the course also includes several class discussions of readings, which familiarize students with some of the important issues and debates in the CSD literature. When appropriate, class sessions are devoted to role plays or other participatory activities that address or reinforce concepts important to the course. Two readings, chosen by the course coordinator or the guest presenter, are assigned for each class session.

Group Projects and Case Studies

One of the most important components of the course is a series of four out-of-class projects, which are done in small, interdisciplinary groups. During the third class period, students divide themselves into groups of four for work outside of class over the duration of the semester. Students are asked to make a final decision as to whether or not they will be taking the class by this time, since late drops disrupt the groups. When the class is not a multiple of four, some groups are permitted to have five people. This is preferable to groups of three, since late drops are always a possibility. Rearranging groups once they begin to work together is difficult, since the group activities are cumulative and personal relationships and investment in the groups are generally very strong. Because students spend so much time working in the groups, they are allowed to form their own groups with the only stipulation being that they be interdisciplinary.

There are four group projects, and group leadership rotates for each project. Students discuss the cases in their groups, but, for each project, one person is responsible for organizing the group, leading their discussions, and leading the writing of the group paper. Rotating leadership is a useful strategy for equitably balancing the work load within each group. Since each student knows that he or she will serve as leader, an incentive for full participation in all activities is created. This is also more typical of a real-world situation than the leaderless groups that are common in many academic courses. Although each student receives a grade for each project, leadership grades are weighted more heavily in final grade computation.

In the first project, students develop a framework for analyzing conservation and sustainable development cases (Table 3A). The assignment is for students to define conservation and

Table 3. Group projects and final exam for critical issues in conservation and sustainable development (reading lists available on request).

A. Framework. First group project

Work in interdisciplinary groups of four people to:
1. Identify the key aspects of a conservation and sustainable development approach.
2. Develop a framework for analyzing case studies (situations or problems at the landscape level) from a conservation and sustainable development perspective.

Select a leader for your group for this project. The leader should direct the process and write the report. Leadership should rotate between members of your group for each of the four projects (that is why the groups should ideally consist of four people).

B. Adirondack case study

This is the first of three case studies that your group will analyze in this course. The principal objective of these case studies is to allow you to apply and refine your framework for analysis of conservation and sustainable development cases. A related objective is to provide an opportunity to integrate important concepts from the various disciplines that have been presented in the class readings and lectures. Cite ideas from the course readings and the case study readings as appropriate.

In general, your analysis should follow your framework. In your discussion or separately, you should also address the questions below.
1. What are the key conservation and sustainable development issues in the Adirondacks?
2. Describe the interests of different groups of people associated with the Adirondack Park. What areas of fundamental disagreement and common interest exist between different groups?
3. Should private land owners in the Adirondacks have been or be compensated for the land use restrictions imposed on them? Consider ethical, legal, political, economic, and environmental arguments.
4. Critique the planning and implementation processes that have been used in the Adirondack Park. How do you think the processes could have been better and how could it be improved in the future?

C. Costa Rica case study

The northern sector of the Braulio Carrillo National Park–La Selva Biological Station complex, a part of the Central Volcanic Cordillera Biosphere Reserve in Costa Rica, presents a conservation and sustainable development case study that highlights biological conservation issues while having an indispensable human/rural development component.

Please analyze this case study using your group's framework for analysis. Include in your paper answers to the following questions:
1. What are the biological conservation issues related to Braulio Carrillo–La Selva protected area complex?
2. What are the key human issues related to biological conservation? What are the key rural development issues?
3. Recommend a conservation and sustainable development strategy for the Braulio Carrillo–La Selva complex and adjacent lands.

D. Kenyan case study

Agriculture and Soil Conservation in Machakos, Kenya

The Machakos District in Kenya has been portrayed as a conservation and rural development success, where a population growth rate of 3% has been accompanied by even greater increases in agricultural productivity and widespread use of conservation practices. Use your group's framework to analyze the case of the Machakos District, paying particular attention to the following points:
1. Do you agree that the Machakos District is a conservation and sustainable development success? What aspects do you think have been most successful? To what do you attribute these successes? What issues have not been adequately addressed? What new initiatives would you recommend to address these issues?
2. What do you think is the long-term prognosis for conservation and sustainable development in the Machakos District? What needs to be done in the long term?
3. Discuss the transferability of the conservation and sustainable development successes and approaches to other places (you may draw on your own experiences).

sustainable development, and to develop a framework for applying this definition in the evaluation of real cases. Frameworks typically vary extensively as people with different backgrounds and experiences struggle to operationalize the many elements of CSD. Therefore, each group presents their framework to class to share the many creative and original approaches that are developed. Each group of students then applies their framework to a set of three different cases, each emphasizing the aspect of conservation and sustainable development that is being covered in that segment of the course (Table 3B–D). Because the purpose of each case is to foster interdisciplinary discussion around a geographically grounded issue, students are not expected to do library research for the case study analyses. Instead, each group is given a packet of four or five articles that cover different aspects and issues of the current case. There are relatively few cases for which high quality, concise, interdisciplinary published literature is available. Three cases that highlight different key issues in conservation and sustainable development have been chosen.

The Adirondack Park in New York represents a case in which conservation has been oriented toward scenic beauty, rather than ecological values, and where conflict between the many communities within the park boundary and the park management agency has been bitter (Table 3B). The case shows park–people interactions and conflicts that date back >100 yr, in contrast to the shorter histories of many developing country cases. It highlights conflicts between local people and conservation planning, and presents a dramatic example of the problems that can be created by top-down planning.

The Costa Rican case, the Central Volcanic Cordillera Biosphere Reserve, is an example of a national park that has been expanded twice to include habitats in different altitudinal zones and to provide connectivity with a world-renowned biological research station (Table 3C). In spite of park expansion, the national park has significant biological conservation limitations that can only be addressed by promoting conservation on adjacent private lands. For example, the perspectives and livelihoods of the inhabitants of these lands must therefore be taken into account. This case highlights ecological issues related to the size and shape of protected areas, and the conflicts and compatibilities that can exist between biological conservation and agriculture in park buffer zones.

The Kenyan case, focusing on soil conservation in the Machakos District, examines an area that has been characterized by population increase accompanied by increased use of soil conservation measures and increasing tree cover (Table 3D). The materials cover several different conservation and development approaches that have been tried in the Machakos district, and highlight the differences between conservation to meet local human needs and biodiversity conservation. The case presents an example of apparently increasing sustainability of land use practices concurrent with rapid population growth, illustrating inadequacies of simplistic population–environment relationships, highlighting conditions under which sustainable agriculture may develop, and showing the incomplete nature of real-world sustainable development.

These cases, taken as a group, illustrate three important but distinct aspects of CSD: governance, biodiversity, and sustainable rural development. They also are diverse enough to illustrate parallels and differences between lesser developed and developed countries, and some of the possible real-world situations where CSD approaches are being implemented. The use of the frameworks (which are expected to evolve during the course) to analyze the cases provides a systematic approach to analyzing and comparing the cases.

After the groups have completed their analyses, a class period is devoted to summarizing each case. These case study discussions are planned with the group leaders before the class, and may include role plays, small group activities, or a group discussion. Simply discussing the cases among the whole class proved to be frustrating, since it tended to repeat the discussions that took place in the small groups. To avoid this problem, the group leaders are encouraged to develop role plays and other activities that draw on and apply what students have learned about each case. For example, the Adirondack case is generally discussed through a role play of a planning meeting convened by an outside facilitator for the Adirondack Park Agency. For the Costa Rican case, each group is asked to develop and present a proposal for a conservation and sustainable development project (including research and action components) for the site. For the Machakos case, several approaches have been taken. Some semesters there have been African students in residence at Cornell, who are familiar with the case, and they have been recruited for a roundtable discussion. In other years, the case has been used as a starting point for a discussion of practical strategies for promoting more sustainable rural land use. Most importantly, the cases provide opportunities for discussions about conservation and sustainable development that are firmly grounded in real-world situations.

Final Exam

Students are given an open-book, take-home exam, in which they are asked to discuss the meaning and application of conservation and sustainable development. They are encouraged to interpret this question in the way that best helps them sum up what they have learned in the course, and in a way that lets them think more deeply about what they have learned and how they might apply it in the future. For students who are overwhelmed by such an open question, some optional guidance is provided by listing some of the questions and issues they might want to cover in their answer (see Table 4).

Discussion

The core course provides a broad exposure to the concepts and practices of conservation and sustainable development. One key lesson is in how different disciplines define and approach conservation and sustainable development, and the importance of making these different definitions and their underlying value choices explicit in interdisciplinary group work. Students also become familiar with some samples of knowledge from different disciplines, which pushes them beyond their prior assumptions and awareness of CSD knowledge. By becoming aware of the body of knowledge that underlies different disciplinary perspectives on CSD, students are encouraged to avoid simplistic approaches to CSD and to work with scientists from other disciplines.

Table 4. Sample final essay assignment.

The final assignment of the semester consists of an essay discussing or applying what you have learned in the course this semester. I particularly want you to write an essay that lets you think more deeply about what you have learned in this course and how you might apply it in the future. Therefore, I encourage creativity in the approach that you take to your essay. There are, of course, some guidelines: (i) I would like you to write something that integrates several themes from the class, although I do not expect that anyone will evenly draw on everything we covered. (ii) I expect that your essay be thoughtful, directly relate to the course, and be well written. (iii) You are expected to draw on the readings, presentation, discussions, and group projects from this semester. Extensive literature citations are not required, but any reference materials used should be properly cited. (iv) Several options for organizing your essay are presented below. If you want to do something substantially different from any of these options or have any questions or doubts about what you want to do, please discuss it with me via email or in person.

While there is flexibility in length, I am expecting each essay to be about 10 pages long (double-spaced). Please do not exceed 12 pages of text. This is an individual, not a group assignment.

Some options:

1. Discuss the meaning and application of conservation and sustainable development.
2. Apply what you have learned in this class to a case or issue of your choosing, either from the literature or from your personal experience (for example, your current or planned research site, or somewhere you have worked in the past). Be sure you have sufficient information about the case or issue on which to base your essay, and be sure your essay is clearly tied to the material we covered in this class.
3. Discuss in-depth one of the issues we have covered in class (e.g., free trade, participation, biodiversity conservation, agricultural intensification). Your discussion should also identify relationships to other topics we have discussed.
4. Evaluate your group's framework and group process. This might include a discussion of how your framework evolved or changed, lesson's learned about group processes for working on conservation and sustainable development, and discussion of how this group process might be used in the real world.

The case studies provide important experience in CSD processes. There are practical skills in interdisciplinary analysis and group work that can only be gained through hands-on experience. The most successful groups find a delicate balance between individual and group work. For example, the group must first, through reading and discussion, come to a common understanding of the issue and problems presented by the case. Students learn the importance of developing a clear outline and timeline for the process for their project. Writing and analysis is generally best done by individuals, but must then be presented to and discussed by the group. Individuals who do not complete their assignments on time can slow or halt the group process. Groups members must be invested in the process, but willing to be flexible enough to accept and work with the contributions of other group members.

While presenting an array of information and seemingly contradictory goals that at times can be confusing, the course provides benefits that lead to greater understanding and better group problem-solving skills. Exposure to diverse disciplinary perspectives forces the development of a questioning stance: questioning underlying values and objectives; questioning how we can measure or know what is "true" in a way that diverse groups can agree on; questioning why paradoxical or conflicting approaches or studies exist; and questioning simplistic claims or *magic bullet* approaches. At the same time, the hands-on experience with group processes provides students with experience in interdisciplinary communication, group problem solving, and creating a product out of what may be near-chaos in time to meet a deadline. These are invaluable experiences in preparation for real-world interdisciplinary problem solving. In spite of the frustrations of dealing with a large body of conflicting information and the challenges of group work, to a remarkable degree, students in the course have formed cohesive, small groups and developed a sincere appreciation for the benefits of interdisciplinary work.

Table 5. Practicum sites and topics, 1993–1999.

1993	Nizao River Watershed, Dominican Republic. Watershed management and smallholder agriculture (Schelhas, 1993).
1994	Coto Brus, Costa Rica. Biological and socio-economic aspects of the proposed Coto Brus corridor (Schelhas and Artuso, 1994).
1995	Los Haitises National Park, Dominican Republic. Resource conservation and resettlement in the Los Haitises National Park buffer zone (Schelhas, 1995).
1996	Coto Brus, Costa Rica. Sustainable landscape management in the community of Siete Colinas (Schelhas, 1996).
1998	Carchi, Ecuador: An interdisciplinary analysis of the Yascon irrigation canal (Schelhas, 1998).
1999	Armando Bermudez National Park, Dominican Republic: Relationships between Armando Bermudez National Park and the community of La Cienega, Dominican Republic (Schelhas, 1999).

FIELD PRACTICUM IN CONSERVATION AND SUSTAINABLE DEVELOPMENT

The concepts and skills basic to graduate education in conservation and sustainable development must be taught in real-world situations as well as in the classroom, and a field practicum has been developed to serve this end. The field practicum provides an interdisciplinary, team problem-solving experience in association with a site where Cornell researchers are working.[3] Each practicum is developed in collaboration with a local nongovernmental organization (NGO) or government agency, focusing on a specific conservation and development problem. The field practicum is a 3-credit course, open to 12 students chosen to represent multiple disciplines. The practicums[4] have taken place in Latin America: Costa Rica, the Dominican Republic, and Ecuador (see Table 5).[5] Each practicum has a 2-wk field component, which takes place during the January intersession, and then meets half-time (once every other week) during the spring semester. In addition to the course coordinator, two or three faculty members from different disciplines accompany the group on the field trip.

The Field Practicum has five related objectives: (i) to provide the opportunity for interdisciplinary teams of faculty and graduate students to apply methodologies and models to analyze specific conservation problems; (ii) to broaden participants' understanding of the interrelationships among different disciplines in the analysis and management of conservation and development problems; (iii) to provide hands-on experience in research methods, including specific disciplinary techniques and interdisciplinary research approaches such as rapid rural appraisal and participatory rural appraisal; (iv) to gather and synthesize information useful to scientists, managers, and policy makers responsible for the situations being studied; and (v) to identify potential research questions and encourage graduate students and faculty to develop research projects that address them.

The typical format of the field segment of the practicum is: (i) a day of presentations and discussions with host country scientists and professionals at a local university or agency;

[3] Students may meet the graduate minor's requirement of participation in an interdisciplinary problem solving experience with this or either of two other courses, or by showing other evidence of interdisciplinary problem solving experience.

[4] A precursor of the field practicum, a 2-wk rapid rural appraisal in the Dominican Republic, was offered in 1991.

[5] See Schelhas (2000) for a more detailed discussion.

(ii) 3 d of visits and field exercises in association with existing research activities and conservation and rural development projects; (iii) 3 d of rapid appraisal activities at the study site; and (iv) 3 d of more focused individual and small group projects at the study site, which build on the previous activities. At the end of the field period, students present a summary of practicum activities and preliminary findings to host country community members, professionals, and scientists. This is important to avoid any perception that the group is only there to extract information. After returning to the Cornell campus, students write individual and small group papers that combine their field experiences with reviews of relevant literature, which are then presented to the class. Discussions and a group paper then combine the individual and disciplinary perspectives and make recommendations for research and practice. The practicum report, along with a nontechnical Spanish summary, is then given to national and local collaborators.

The Field Practicum increases student understanding of the complexities of environmental problems and helps them to contextualize their own research. By providing training in field research methods, it has helped students develop the skills required for working in rural communities and landscapes. It provides, through experiential learning, a better understanding of the complexities of applying the ideas generated during the core course, and provides a field-based experience working in an interdisciplinary group. Many students have conceptualized their thesis or dissertation research project during the practicum, through the process of bringing together field experience and literature review within the context of a larger, interdisciplinary problem. The interdisciplinary interaction has proved particularly useful in identifying new research questions that are closely tied to real-world conservation problems, but which have not been addressed by traditional disciplinary research.

The practicum also exposes conservation and development professionals and community members to new ideas and research approaches. Their experiences with the Cornell group during the rapid appraisal creates and builds a common understanding of the situation that both increases the practicality of the Cornell group's recommendations and increases practitioner and community members' receptivity to those recommendations. The written report provides documentation and support for the new ideas.

DISCUSSION

The practicum allows students to take CSD concepts out into the field and apply them while interacting with government agencies, NGOs, and local communities. At the level of interdisciplinary education and research, students benefit in many ways from this real-world experience. First, students are faced with the real-world complexities and constraints of a problem. Real-world problems are not as neatly packaged as those in the literature, and interaction with different stakeholders makes clear both the complexity of a real-world problem and the many different ways that people define problems. By collecting some general and specific data students also develop a somewhat paradoxical appreciation for, on the one hand, how much general information one can learn in a short time, and, on the other hand, the difficulties of collecting valid scientific data to address a specific problem.

The ongoing interdisciplinary process throughout the practicum involves learning different disciplinary perspectives on the situation, developing a group problem definition, deciding what information and data can be collected during the field period to address this problem, and writing a thematic and integrative report. These processes all require students to listen to the perspectives of others, balance their own disciplinary perspectives with those of others, and work productively toward group goals in the face of value and scientific differences. Integrating the practicum into ongoing CSD projects and programs in the field also provides important opportunities for learning. The process of interacting with local community members and managers is more delicate and ambiguous than learning in the classroom and library, and students have opportunities to gain experience in this setting, and to also learn by observing other students and faculty members with different knowledge, skills, and experiences. Students learn many practical skills related to conducting meetings, group interviews and activities, household surveys, and simple field measurements.

Students learn the importance of working with, and providing information to, local people. Several students have reported that these skills have enabled them to develop the relationships necessary to carry out their field research, even when community involvement was not part of the actual research. Furthermore, students also learn something of the difference between ground-level, field perspectives and the academic perspectives from the university, and the importance of balancing these. This is reinforced by the experience of combining field problem analysis with library research during the campus-based part of the course.

CONCLUSION

Cornell's CSD program represents an effort to train graduate students to address complex environmental problems in interdisciplinary teams. While students are exposed to both theories and empirical findings from different fields, the program places most of its emphasis on processes of interdisciplinary problem analysis, field work, and writing. These skills are intangible and difficult to teach, but the courses' emphasis on learning-by-doing, both on campus and in the field, provides learning opportunities.

Students from fields as diverse as ecology, soil and crop science, rural sociology, agricultural and resource economics, and natural resources have undertaken the CSD minor pursuing disciplinary graduate degrees. The minor and courses appeal to students interested in the interface between academic research and the complex environmental problems facing society today. Students who have completed their degrees with CSD minors have found employment in academia, government, and NGOs. Although we have not systematically surveyed these students about the CSD minor, many have reported that the CSD courses and minor provided skills that were very helpful in both obtaining and performing the duties of their jobs. These courses, however, may not be for everyone. Some students prefer the narrower view of one discipline, and work better alone rather than with others. There are many frustrations involved for the students in negotiating among their different values and perspectives, helping each other understand the empirical findings that form the core of their

field, and dealing with inevitable interpersonal conflicts. But for graduate students with an interest and commitment to working on current and future environmental problems, the program provides invaluable knowledge, experience, and skills in an interdisciplinary approach to conservation and sustainable development.

REFERENCES

Andrews, R.N.L. 1999. Managing the environment, managing ourselves: A history of American environmental policy. Yale Univ. Press, New Haven, CT.

Barbier, E.B. 1987. The concept of sustainable economic development. Environ. Conserv. 14:101–110.

Baydack, R.K., H. Campa III, and J.B. Haufler. 1999. Practical approaches to the conservation of biological diversity. Island Press, Washington, DC.

Benton, T., and M. Redclift. 1994. Introduction. p. 1–27. *In* M. Redclift and T. Benton (ed.) Social theory and the global environment. Routledge, London.

Brandon, K. 1998. Parks in Peril: The social context of threats. p. 415–439. *In* K. Brandon et al. (ed.) Parks in peril: People, politics, and protected areas. The Nature Conservancy and Island Press, Washington, DC.

Buck, L.E., and J.P. Lassoie. 1992. Critical issues in conservation and sustainable development: Design and evaluation of a pilot course. Natural Resources Research and Extensions Series 38. Cornell Univ., Ithaca, NY.

Campbell, C.A. 1995 Landcare: Participative Australian approaches to inquiry and learning for sustainability. J. Soil Water Conserv. 50:125–131.

Collins, W.W., and C.O. Qualset (ed.). 1998. Biodiversity in agroecosystems. CRC Press, Boca Raton, FL.

Dinerstein, E. 1995. A conservation assessment of the terrestrial ecoregions of Latin America and the Caribbean. World Bank and World Wildlife Fund, Washington, DC.

Dixon, J.A., and L.A. Fallon. 1989. The concept of sustainability: Origins, extensions, and usefulness for policy. Soc. Nat. Resour. 2:73–84.

Getz, W.M, L. Fortmann, D. Cumming, J. du Toit, J. Hilty, R. Martin, M. Murphree, N. Owen-Smith, A.M. Starfield, and M.I. Westphal. 1999. Sustaining natural and human capital: Villagers and scientists. Science (Washington, DC) 283:1855–1856.

International Union for the Conservation of Nature–United Nations Environmental Programme–Worldwide Fund for Nature. 1991. Caring for the earth: A strategy for sustainable living. IUCN–UNEP–WWF, Gland, Switzerland.

Jacobson, S.K. 1995. Evaluating impacts on graduate education: The conservation and sustainable development initiative. Environ. Professional 17:251–262.

Jacobson, S.K., J.G. Robinson, T.C. Moermond, K. Hansen, J.G. Schmitt, J.D. Allan, and K.H. Redford. 1992. Building graduate programs: Integrating conservation and sustainable development. Environ. Professional 14:284–292.

Kertzer, D.I. 1988. Ritual, politics, and power. Yale Univ. Press, New Haven, CT.

Ostrom, E., L. Schroeder, and S. Wynne. 1993. Institutional incentives and sustainable development: Infrastructure Policies in perspective. Westview Press, Boulder, CO.

Parsons, E.A., and W.C. Clark. 1995. Sustainable development as social learning: Theoretical and practical challenges for the design of a research program. p. 428–460. *In* L.H. Gunderson et al. (ed.) Barriers and bridges to the renewal of ecosystems and institutions. Columbia Univ. Press, New York.

Redclift, M. 1987. Sustainable development: Exploring the contradictions. Methuen, London.

Redford, K. 1992. The brief barren marriage of biodiversity and sustainability. Bull. Ecol. Soc. Am. 73:36–39.

Schelhas, J. (ed). 1993. Conservation and sustainable development in the Nizao Watershed: Opportunities for Interdisciplinary research and management. Cornell Program in Ecological and Social Science Challenges of Conservation, Cornell Univ., Ithaca, NY.

Schelhas, J. 1994. Building sustainable land uses on existing practices: Smallholder Land use mosaics in tropical lowland Costa Rica. Soc. Nat. Resour. 7:67–84.

Schelhas, J. (ed.). 1995. An interdisciplinary analysis of park–people relationships, Los Haitises National Park, Dominican Republic. Program in Ecological and Social Science Challenges of Conservation, Cornell Univ., Ithaca, NY.

Schelhas, J. (ed.). 1996. An interdisciplinary analysis of sustainable landscape management in the community of Siete Colinas, Coto Brus, Costa Rica. Program in Ecological and Social Science Challenges of Conservation, Cornell Univ., Ithaca, NY.

Schelhas, J. (ed.). 1998. An Interdisciplinary analysis of the Yascon Irrigation Canal, Carchi, Ecuador. Program in Ecological and Social Science Challenges of Conservation, Cornell Univ., Ithaca, NY.

Schelhas, J. (ed.). 1999. Relationships between Armando Bermudez National Park and the community of La Cienega, Dominican Republic. Program in Ecological and Social Science Challenges of Conservation, Cornell Univ., Ithaca, NY.

Schelhas, J. 2000. Catalyzing sustainability: Cornell University's field practicum in conservation and sustainable development. p. 155–171. *In* W.L. Filho (ed.) Communication sustainabilty. Peter Lan Scientific Publ., Bern.

Schelhas, J., and A. Artuso (ed.). 1994. An interdisciplinary analysis of the Coto Brus Corridor, Costa Rica. Program in Ecological and Social Science Challenges of Conservation, Cornell Univ., Ithaca, NY.

Soulé, M.E. 1995. The social siege of nature. p. 137–169. *In* M.E. Soulé and G. Lease (ed.) Reinventing nature: Responses to postmodern deconstruction. Island Press, Washington, DC.

Soulé, M.E., and J. Terborgh. 1999. Continental conservation: Scientific foundations of regional reserve networks. Island Press, Washington, DC.

Touval, J.L., and J.M. Dietz. 1994. The problem of teaching conservation problem solving. Conserv. Biol. 8:902–904.

Uphoff, N. 1996. Collaborations as an alternative to projects: Cornell Experience with university–NGO–government networking. Agric. Human Values 13(2):42–51.

Uhl, C., P. Barreto, A. Veríssimo, E. Vidal, P. Amaral, A.C. Barros, C. Souza, Jr., J. Johns, and J. Gerwing. 1997. Natural resource management in the Brazilian Amazon. BioScience 47:160–168.

Wear, D.N. 1999. Challenges to interdisciplinary discourse. Ecosystems 2:299–301.

Western, D., and R.M. Wright. 1994. Natural connections: Perspectives in community-based conservation. Island Press, Washington. DC.

World Commission on Environment and Development (WCED). 1987. Our common future. Oxford Univ. Press, Oxford.

Zube, E.H. 1982. Increasing the effective participation of social scientists in environmental research and planning. Int. Social Sci. J. 24:481–492.