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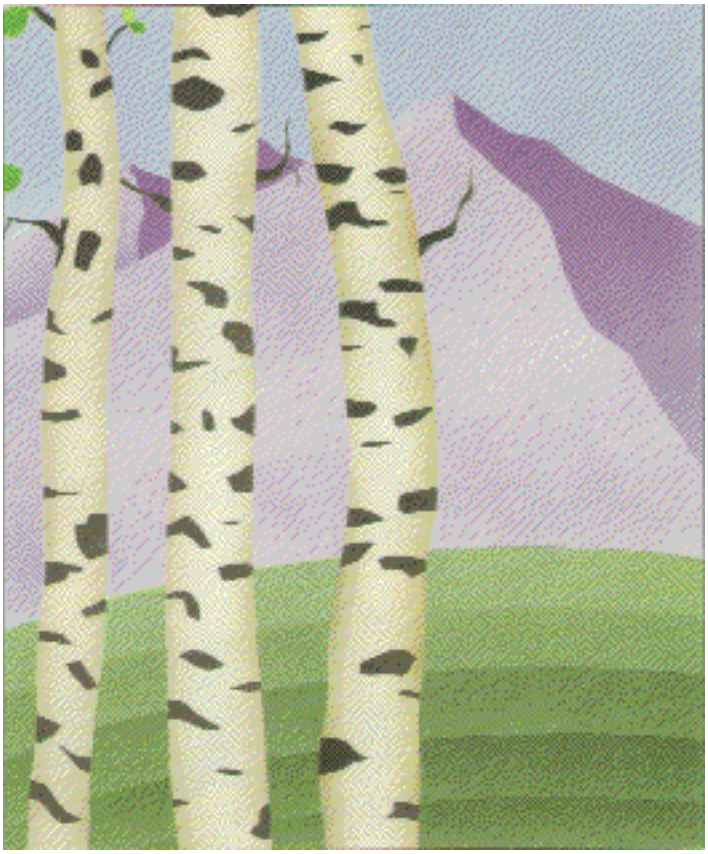

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INTEGRATED NATURAL RESOURCE PLANNING

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ABSTRACT: Deciding upon management strategies and use of natural resources becomes more challenging as urban areas expand and human population and consumption levels continue to increase. Given that a larger urban population, interestingly, seems to demand both more resources (products) and greater environmental protection, there will no doubt be a coincident heightening of conflicts over natural resource management in the next century. Making decisions on natural resource allocation and use under such circumstances will become even more complex and difficult than they are today. Skilled people will be needed who can develop an integrated approach to natural resource management that sheds light on the tradeoffs and implications of their decisions. The ability to identify and evaluate the potential consequences of particular management decisions will be critical. To help address this need, we developed a course in integrated natural resource management with funding received from the Cooperative State Research Service Higher Education Challenge Grants Program. This interdisciplinary course is team-taught and uses a combination of case studies and computerized models.

INTRODUCTION

Deciding upon management strategies and use of natural resources becomes more challenging as urban areas expand and human population and consumption levels continue to increase. Interestingly, urban populations seem to demand both more resources (products) and greater environmental protection than rural populations. As a result, heightened conflicts will occur over natural resource management in the next century. Moreover, making decisions about natural resource allocation and use will become even more complex and difficult than it is today.

NEED FOR INTEGRATED NATURAL RESOURCE PLANNING COURSE

Too many students with interests in environmental studies take advocacy positions on natural resource issues without fully considering the options and implications of various courses of action. For example, protecting large tracts of timber in the Pacific Northwest from harvesting to save the spotted owl might result in more widespread harvesting of tropical forests with the possibility of affecting many more endangered species. An efficient timber management option might have positive effects on wild ungulates, such as deer, but may adversely affect non-game bird species (Jaako Poyry 1992h). Skilled people are needed who can develop an integrated approach to natural resource management so that tradeoffs and implications of their decisions can be viewed in the context of both multiple use and ecosystem management. These people must be able to effectively use sound resource management decisions that meet societal needs. It will be critical that they have the ability to identify and evaluate the potential consequences of particular management decisions. Although most natural resource curricula have courses covering many of the components necessary for integrated resource planning, the opportunities for students to synthesize the information from these disparate courses are limited. Too many students finish their undergraduate education without the opportunity to demonstrate their understanding of multi-disciplinary relationships and of the constraints in selecting natural resource management options.

DEVELOPMENT OF A COURSE TO MEET THE NEED

The University of Minnesota College of Natural Resources includes three specialized curricula: forest resources, fisheries and wildlife and wood and paper science. Since 1989 a more general natural resources and environmental studies (NRES) curriculum has been offered and is home to the largest student group in the College. The NRES curriculum is designed for students with an interest in interdisciplinary studies focusing on the use and management of natural resources. The NRES curriculum includes a field experience and/or internship as well as a senior problem solving (capstone) course. The course we developed was to be an alternative to the existing problem solving course. Also, unlike the existing problem solving

course, which is only open to NRES seniors, this course would be open to students in forest resources and graduate students.

In the fall of 1994 we developed a course in integrated natural resource management for senior level students in our forestry, recreation resource management and natural resources environmental studies curricula. This course is team taught and students learn through a combination of case studies and computer models. Funding to develop the course was received from the Cooperative State Research Service Higher Education Challenge Grants Program.

Five major activities were carried out to develop the new course:

- Development of a specific course structure and assignment of instructional responsibilities,
- Synthesis of existing information that reviews the role of the puiblic in previous planning efforts and techniques for acquiring that input,
- Development of the computerized decision support system,
- Development of computer-aided instruction modules for specific topical areas, and
- Identification and development of a case study database with associated computer simulations.

Our course would complement more disciplinary offerings and, to some extent, bring a sense of closure to the multifaceted undergraduate program by concentrating on the reality of integrating multi-resource information in the decision-making process. This course also was designed to incorporate new instructional strategies based on active and collaborative learning experiences, and to make extensive use of computer-assisted learning tools.

We decided that an integrated, multiple-resource teaching framework would enhance students' ability to understand the complexity of natural resource management issues and to understand the tradeoffs among alternatives that are available to them before decisions are made. This integration is best accomplished by having the students work on actual case studies in which they can see how all of the various disciplines come together in developing a sound management plan. Through course assignments, students would also learn to better communicate and argue their specific concerns.

We also thought that dealing with the complexity of natural resource problems could be facilitated with the use of computer simulation models, designed to aid the analysis of specific questions. Use of computer models allows students to explore the consequences of various management decisions. Some of the more sophisticated models in particular allow planners and managers to perform long-term simulations under a number of development scenarios. These models might also lead to a better understanding of the constraints and tradeoffs of specific management actions. Models also have enormous potential as learning tools; they can help clearly define what we know, what we need to know, and what we do not know. A major component of the course would be teaching students the appropriate use and interpretation of models and their results.

Course Description

The course we developed, Integrated Natural Resource Planning, is 5 quarter-credits and has been taught for two years. It is offered to seniors in the forest resource's and NRES curricula. Graduate students may also enroll in it. The course has the following prerequisites: natural resource policy, forest management and planning, natural resource survey and measurements, silviculture, recreation resource management, ecology, and hydrology. The basic format for the class is two class lectures per week, a two-hour lab, and a one-hour recitation.

The course is team taught. Each instructor demonstrates how his/her particular expertise can be applied to the analysis of management and policy questions. In particular, students focus on two interrelated problems and the resolution of those problems. First, they look at and analyze a timber harvesting strategy for an area in northern Minnesota. Second, they look at the impacts of harvesting and other forest management practices on forest aesthetics, recreation opportunities, biodiversity and water resources. They then attempt to pull what they have learned about harvesting strategies and the impacts of harvesting on other forest resources together to arrive at a best solution. By using this approach, students are: a) provided with the opportunity to practice being professional resource analysts, b) encouraged to integrate previous educational experiences, c) provided with the necessary skills to integrate public input into decision making, d) motivated to develop a better understanding of the role of data and models in multiple resource management, e) provided with an appreciation of the uncertainty associated with data and models and how that affects the interpretation of model results, and f) Given an appreciation that all resource decisions reflect social values.

The course is organized into a number of study modules. Each module typically consists of two lectures, one lab, and a recitation. Each instructor is responsible for his/her module. But, all modules are closely integrated and use the same case study area. Students are assigned to study groups –usually four individuals—and each group is required to solve one problem for each study module. Most assignments include a group assignment and a set of questions that need to be answered by each individual. At times, students are asked to grade the contributions of individuals in their group.

Each of the modules are described below. The first four modules introduce students to natural resources planning, especially forest planning, and computer models that can aid in planning and decision making. In these modules, we

introduce an example of a general framework for natural resource planning based on the experiences of the Minnesota Generic Environmental Impact Study (GEIS). The GEIS is probably the most encompassing study in the U.S. of timber harvesting impacts on the environment. In 1990 the Minnesota Environmental Quality Board (EQB 1990) ordered the state of Minnesota to conduct the GEIS (Jaako Poyry 1992a-h). All of the instructors involved in developing this course were also lead scientists on the GEIS. In the GEIS, we developed a framework for planning that has been successfully applied in several major studies since the GEIS. The framework's main components are: inventory and market information, management objectives, models for the development and evaluation of management alternatives that can contribute to specified objectives, a scheduling model that selects among all alternatives to meet objectives in an economically efficient manner, and procedures for tradeoff and impact analysis of developed plans. The GEIS is the reference point for all of the course modules. Individual instructors used this framework to identify where their specific module fits into integrated natural resource planning.

The first four modules point out to students the importance of data in decision making. They also point out that it is rare that one would have all the data needed for decision making; therefore, the importance of being able to plan with uncertainty is stressed and modeled. Exercises students complete in these modules take them from forest stand-level decisions to forest-wide planning decisions. The next three modules (5, 6, and 7) introduce students to other forest resources and opportunities they must consider when making harvesting decisions. The purpose of these modules is to show students that forests have value beyond timber, that forests are managed to provide benefits to people and society, and that all stakeholders have a legal right to be (and must be) involved in forest management decision making. The next two modules (8 and 9) show students how to mitigate unwanted harvesting impacts and the importance of understanding the 'big picture' when developing resource plans. The last module involves the instructors and students in a panel discussion of the issues raised in the course and of the instructional methods used in the course. Student critiques are used to improve the next iteration of the course.

Module 1: Development of a modeling framework. The purpose of this module is for students to understand that, in the development of natural resource plans, a number of processes need to be followed. Furthermore, certain logically linked key components are present in any planning model. Students are first assigned the task of developing a generic framework for natural resource planning, which describes the key components, processes, and linkages. Students are then introduced to a general framework for natural resource planning based on the GEIS.

By developing a modeling framework, students learn the need to: a) clearly identify the objectives of a plan as well as the stakeholders in the plan, b) develop a wide range of alternatives, which will help meet these objectives, c) identify models and procedures that can evaluate and compare these alternatives in terms of meeting the objectives, d) gather data and information and recognize uncertainty surrounding data, and e) continuously monitor any implemented management plan.

Module 2: Data, models, and uncertainty. In module two students look specifically at the sources of information used in the GEIS, studying their scope, shortcomings and reliability. The impact of data reliability on decision making is also considered. The direct linkage between information bases and economic analyses and forest management planning activities is made explicit.

The lab portion of this module consists of three parts. In part one, each student group is assigned a supply area center (a city) with a specific annual aspen pulpwood demand. The group must use the USDA Forest Service Inventory and Analysis (FIA) database to estimate the size of the area needed to sustainably meet demand. The FIA database is accessed via a map-based, World Wide Web (WWW) interface. Using the WWW simplifies access to data and gives students experience using advanced WWW tools. The second part of the lab exercise requires students to use a growth model in conjunction with a harvest scheduling rule. Although both the growth model and harvest scheduling method are oversimplified, the link between models and decision making is made clear. Uncertainty is the focus of the third part of the lab (Hoganson and Smith 1989). Students are given a spreadsheet with 30 aspen cover type plots. The spreadsheet allows easy specification of standard deviations associated with initial conditions and individual equations of the growth model. Normal errors with the specified standard deviations are used to generate 30 alternative projections and a spreadsheet chart is used to illustrate the magnitude, pattern, and accumulation of model prediction errors over time. Groups use the spreadsheet to identify the relative importance of error components and the degree of error they would tolerate in predicting a future volume value.

Although the specific lab exercise is oversimplified, which students recognize and appreciate, they gain a taste for the complexity of working with large data sets, as well as an appreciation for error identification and computation. They must bring their professional training to bear on the problem of converting raw data to useful information, which is something most students have never done but which will dominate their future work lives.

Module 3: Economic analysis of stand-level decisions. This module emphasizes that management alternatives need to be developed no matter what the specific objectives are of natural resource planning. Whether the objectives are improved recreational opportunities, watershed protection, timber production, or a combination of several of these objectives,

alternatives, including a 'do nothing' alternative, need to be developed. Students understand that the basic management unit for which alternatives are developed can be individual forest stands or stand aggregates depending on available data and the plan's scope. Moreover, these alternatives should be technically feasible and cover a wide range of options. A scheduling model can only select from among the alternatives formulated and will generate sub-optimal solutions if good alternatives are ignored (Hoganson and Rose 1984). Management recommendations are made for each individual stand based on what is considered the 'best' alternative. Taking into account forest-wide constraints, the sum of these individual stand level recommendations makes up the forest-wide plan.

The lab portion of this module introduces students to techniques for developing and analyzing stand level alternatives. It uses a user-friendly cash flow program written by the instructor. The exercise is built around a small sample inventory. Each student group is asked to identify one or more specific management objectives and to develop specific management alternatives for the individual stands in the inventory. Students also are required to identify regeneration linkages for any stands that follow the first and any subsequent clear cuts. They must also develop management alternatives for these regeneration stands. By doing this lab exercise students gain an understanding and appreciation of the connection between management objectives and alternatives. They also learn to collect and use information necessary for describing inputs and outputs associated with alternatives including growth and yield, cost and value information, the role of discount rates, and the valuation of non-market goods and services.

Module 4: Forest-wide planning models: formulation of forest management scheduling models. In this module students have the opportunity to understand how a scheduling model, such as linear programming (LP), can be used to select among a large number of management alternatives to optimize some objective function subject to constraints on management (Hoganson and Rose 1987). The overall objective of this module is for students to understand and appreciate that the sum of optimal individual stand-level management decisions rarely produces an optimal forest-wide plan. Forest-wide constraints are usually not considered when individual stand-level decisions are made, hence the discrepancy between optimal stand-level decisions and the optimal forest-wide decision. For example, a stand might be harvested before optimal rotation because early harvesting of it will fill a gap in required harvest volume in a given time period better than other stands would.

In the lab portion of this module, students are provided with a sample, taken from the 1990 forest inventory, for which several LP formulations have been developed. Students examine the impact of changes in the objective function, discount rate, and types and levels of constraints on the ultimate optimal schedule. Students then write a critique of LP scheduling models focussing on the model's limitations as a decision making tool. At this point they are given a preview of an alternative scheduling model that can overcome some of the disadvantages of LP. They will use the alternative model in module 8.

Module 5: Biodiversity and wildlife. Natural resource managers (including foresters), as well as the public, agree that maintenance of biodiversity is important. Despite its importance, generally few specifics are included to address it in natural resource planning processes and documents. This lack of specifics can be largely attributed to the fact that biodiversity is more a philosophical rather than an operational concept (Probst and Crow 1991). This module explores strategies to integrate biodiversity issues into the natural resource planning process at both local and regional scales.

Just as all natural resource management practices affect biodiversity, they affect wildlife habitats. The evaluation of these impacts is complicated by the fact that many wildlife species have contradicting habitat needs. This module challenges students to work through an exercise and integrate the contradicting habitat needs for multiple species. Students gain an appreciation of issues regarding the integration of biodiversity and wildlife habitat quality into regional and local planning processes. They also learn that to move from philosophy to management, they must develop operational definitions for biodiversity issues. They also learn how to work with incomplete data to arrive at planning and management decisions.

The biodiversity exercise follows an outline similar to that presented by Lautenschlager (1996). Students develop a list of potential natural resource or asset concerns for a component of the biodiversity definition. These concerns can be biotic (species or species group), abiotic (aggregates, aesthetics) or biotic/abiotic processes. Components of the biodiversity definition include topics such as ecosystem functions or ecological structures on a local or regional scale and variety and abundance of communities and ecosystems. For each potential concern the students generate a list of data needs. The data needs are then compared with the data available through the Eastwide Forest Inventory Data Base (Hansen et. al. 1992). Finally, students discuss the discrepancies and look for approaches that bridge the gap between the data needs and availability.

The wildlife exercise starts with a general discussion about quantifying wildlife habitat quality on a regional level. Special attention is paid to the different scales at which habitat quality for various species is determined. Students develop a separate list of strategies to mitigate harvest impacts for two species. Species are chosen that have partially opposing habitat needs (e.g., young versus old forest) and cover both stand level and forest wide issues.

Module 6: Water resources and planning. This module begins with an overview of the hydrologic consequences of timber harvesting with a focus on Minnesota conditions (Verry 1986). The hydrologic model used in the GEIS to estimate harvesting impacts is described (Jaako Poyry 1992f), and the problems of interfacing the timber stand model with the hydrologic model are discussed. The benefits of using a model that is specifically designed to interface with other resource components are discussed with reference to a Lake State model developed by Ffolliott et al. (1984). Students are given a problem that requires them to: a) examine the impacts associated with current and potential future elevated levels of statewide timber management and harvesting activity on water and related resources, b) develop strategies to mitigate such impacts where existing or potential significant impacts are identified, and c) gain an understanding of the methods used, the data and informational requirements, and the constraints that exist in trying to quantify impacts of forest management options on water resources.

The lab portion of this exercise requires students to develop a matrix in which important water related characteristics of concern (parameters) are identifies that would be impacted by timber harvesting. Certain parameters may be more important for one system (e.g. a lake) than for another system (e.g. a stream). Groups are asked to be specific in defining each parameter. For example, water quality is a very broad parameter that must be further defined into key components of interest to be meaningful. In each matrix cell the group indicates four things: the relative response to harvesting of the parameter as either increasing (+) or decreasing (-); and ranks from 1 to 5: the relative magnitude of change, the response variability, and the relative uncertainty of the response. In all cases '1' represents the smallest change, least variability or least uncertainty. For example, the annual water yield of streams is expected to increase in response to harvesting with a potential large magnitude of change, moderate variability of response, and low uncertainty. The matrix cell for that parameter would be (+,5,3,1).

Once students complete the matrix they indicate five issues/ impacts that should receive the highest priorities and provide a justification for their assessment. They also quantify the effects of harvesting on their top five priority areas of concern and suggest mitigation strategies for unwanted impacts. They learn and appreciate the need for site specific analyses and the use of stream channels and watersheds as units for assessment, the need to consider cumulative effects, the influence that issues of scale have on their assessments, and the need for well-defined linkages among the various resources and changes that are expected.

Module 7: Harvesting impacts on recreational opportunities. The purpose of this module is to give students an appreciation and understanding of the impacts of timber harvesting and forest management on recreation opportunities provided on public lands within an ecoregion and statewide. Students are presented with data gathered for and analyzed in the GEIS (Jaako Poyry 1992i). These data show the distribution of recreation opportunities, recreation activities, and hours of engagement per recreation activity for each ecoregion in the state. Data are also given to the students that show the magnitude and level of significance of harvesting activities on recreation experience opportunities and activities.

In the lab exercise, students are given a forest area in which they must remove a specified amount of timber from one or more of five specified areas containing one or more stands. For each of the five areas they are given information on soils, slope, wildlife, water resources, current levels of recreational use and recreation experience opportunities provided. Three harvest alternatives are suggested: 1) harvest equal amounts of timber from each of the five areas over the given time period, 2) harvest all of the timber from the two most accessible areas and conduct no harvesting during the summer months, and 3) harvest two-thirds of the timber from the two most accessible areas and the remainder from any combination of the other 3 areas and allow no harvesting during the summer months.

Students are assigned to one of six groups. Using the constructive controversies technique, two groups are assigned a harvest alternative. One group develops an argument in support of the alternative and the other group develops an argument against the alternative. In their arguments students must address the following questions: a) what recreational experience opportunities and activity opportunities are improved through harvesting activities and in what ways are they improved, b) what recreational experience opportunities and activity opportunities are diminished through harvesting activities and in what ways are they diminished, c) what new recreational experience and activity opportunities are created in the areas where harvesting occurs, d) what changes occur in the relative availability and accessibility of recreation opportunity settings within the forest where harvesting occurs, and e) what changes occur in the supply of recreation opportunity settings within the ecoregion and statewide? Groups assigned to the same harvest alternative present their arguments to each other. They then reverse roles and develop arguments for the opposing side and present those arguments to each other. At this point, both groups are asked to work as one large group and, based on the arguments they have presented both pro and con for the harvest alternative given to them, to develop what they believe is a harvesting alternative that will not significantly impact recreational opportunities and the resources they depend on (visual scenery, wildlife, water, and so on) within the area. If significant impacts cannot be avoided, they develop a mitigation plan to address them. Once the large groups have developed their harvest alternative, the class comes back together and each of the three large groups presents their proposed alternative. The class then works together to arrive at an alternative they can all agree upon.

Students learn that several harvesting alternatives may be feasible within a given area. They also learn and appreciate that differences, both real and perceived, among the alternatives are related to their impacts on other resources and resource uses, in this case recreational opportunities. Finally, they understand that the alternative selected is based on social choice driven by technical, as well as nontechnical concerns.

Module 8: Impact mitigation and tradeoff analysis. This module demonstrates directly how a forest management scheduling model can be used as a learning tool for a range of forest management issues (Hoganson and Rose 1984). It is linked to the other modules in that they all contributed to the modeling framework and data used for the GEIS analysis. This module applies the GEIS modeling framework to examine a variety of potential concerns. In this module students use what they learned from modules 3 and 4 in terms of linear programming, cash flow analysis, shadow pricing and basic financial measures to compare stand level management alternatives.

The lab portion of this module introduces students to the DTRAN model used to develop various harvesting scenarios for the GEIS. Several model runs are used to illustrate the statewide effect that potential harvesting policies on national forest lands could have on statewide timber markets in the region.

Module 9: The importance of spatial concerns in resource planning. Spatial aspects of forest management are one of the most challenging aspects to address in forest planning. In this module students demonstrate their understanding and appreciation of the complications involved when spatial arrangement factors are addressed (Kapple and Hoganson 1991). They learn how to coordinate management decisions for adjacent forest management units, and they learn how a detailed spatial management plan for a subregion might be linked directly with a broader regional planning model. Students are also introduced to a new spatial modeling approach for forest management scheduling. This new model is under development by some of the course instructors.

The lab portion of this module focuses on the timing of harvesting on adjacent lands. All of the examples students work with in this exercise use simple checkerboard forests where stand conditions mimic the aspen forest type in Minnesota. In the first part of the exercise student groups are given data for a 50 stand forest and are asked to develop an approach for scheduling stands for harvest to maximize net present value under the constraint that no two adjacent stands are harvested in the same period. Next each group is introduced to a dynamic programming (DP) approach to the same problem. Each group is asked to consider two larger 1,000-stand forests to examine the performance of the DP approach. By using successively larger model formulations, students explore how large formulations may need to be if good solutions are to be developed. Finally, each group uses this modeling framework in a forest-wide module that also includes constraints on the acres harvested each decade.

Module 10: Class summary and critique. The final week is used to review and pull together the previous nine modules. Students also formally critique the class.

BENEFITS OF THE COURSE TO STUDENTS AND INSTRUCTORS

Student Benefits

The individual modules were arranged as much as possible in a logical sequence such that each module built upon one or more previous modules. Through module 1 students gained an insight into key elements of natural resource planning models. Module 2 exposed students to the importance of data and information as well as an understanding of the role of uncertainty. Module 3 introduced them to the importance of developing a wide range of alternatives that can help meet specified management objectives. It also gave them procedures to evaluate and compare alternatives. In module 4, students were introduced to linear programming formulations of management schedules. These formulations helped students understand the role of LP models in finding optimal solutions and the impact of changing constraints as well as other assumptions on model outputs.

Modules 5, 6, and 7 introduced students to the impacts of harvesting and other forest management activities on other forest resources. In module 5 students learned to separate philosophical from operational concepts. Students learned that measurable criteria need to be developed to evaluate philosophical concepts if these concepts are to be integrated into planning processes. They also learned that the current inventory system was not set up to address biodiversity issues directly, but provides data that can be used to develop biodiversity criteria. In addition, students gained an understanding and appreciation of conflicting habitat needs. The latter can also be seen as a surrogate for conflicting demands of society. In module 6 students quickly realize that harvesting impacts on water depend on many factors that do not necessarily coincide with ecoregions—watersheds and stream channel level assessments are necessary to deal with water issues such as stream temperature, flooding, and instream flow during specific periods of time. The incompatibility of timber inventory models and methods with water models becomes evident. In module 7 students addressed the impact of timber harvesting activities on recreational opportunities forests provide. They quickly realize that recreational data exist at a variety of scales, are seldom available statewide, and are infrequently updated. They also learn that much can be gleaned about forest recreation use from the literature and from selected FIA

variables. They also come to understand that the primary use of many of Minnesota's forests is recreational use and that the benefits accruing to people and society from their recreational experiences sometimes outweigh the benefits of harvesting a particular stand. Balancing the needs of society for forest recreation opportunities and forest products is complex. Students come to understand that a variety of alternatives are possible to meet those needs and that a number of alternatives must be examined to arrive at an optimal forest plan that balances harvesting and other forest management activities with other forest uses. Finally, they learn that regardless of the alternative chosen, it is a reflection of social choice at a particular point in time.

Modules 8 and 9 bring students back to forest planning for timber harvesting but, in these modules, students were introduced to models that may help them to arrive at optimal forest plans taking into consideration other forest uses. They realized first hand how complicated the management situation is in Minnesota—many interacting aspects and few simple answers. In module 8 even though all data and model input files were developed for them, students gained a better appreciation for all the work involved in comparing model runs and attempting to draw insights to explain results. They found that some background in forestry was extremely helpful for interpreting results. To many students, the complicating aspects of mixed-species, multi-product stands managed over a multi-period time frame with multiple market locations made the exercise seem overwhelming at times. Yet, despite not always understanding the nuances and intricacies of the model, students learned that their insights on the type of interactions that might occur were likely correct. The modeling tools were helpful to them in estimating the extent of those impacts and pointing to the interactions of most concern. In module 9 students gained a better understanding of the complexity of spatial problems and associated difficulties in planning. Students recognized that the computer and computer models were excellent tools for examining potential solutions. But, they had difficulty in understanding why some forest issues and uses were more easily modeled than others. Some students seemed somewhat surprised with the difficulties of addressing spatial interactions with current models.

Instructor Benefits

In developing and teaching this course, instructors developed new skills through collaboration with other faculty and in the development of computer assisted instructional materials. Although computer assignments have been a common part of many College of Natural Resources courses over the years, the use of computer programs specifically for instruction and information delivery has not been extensively developed. Students better appreciate the need for using advanced technologies to store and analyze the massive amount of information required for making good decisions. The experience instructors gained with the new course will help them transfer the new ideas and tools developed to educational programs of other natural resources colleges. Furthermore, instructors involved in developing and teaching this course jointly have gained insights into the research of their colleagues and have enhanced cooperative efforts. Several instructors have developed innovative instructional software to aid in delivering their research to undergraduate and graduate students.

Student Critique

Each group of students provided written feedback on the course. The two most common critiques students gave were that they had learned quite a bit from the course and that they appreciated the hands-on experience with data and models. Although they thought they had learned a lot, they also expressed concern that they felt ill prepared to take the course. In some cases they were not properly prepared for a course such as this. Many of them lacked one or more of the course prerequisites. They suggested that in the future we *"… better advertise the course along with its prerequisites."* They also thought that courses, which are prerequisites for this course, should be advertised as such. On the other hand they may have felt ill prepared because planning and managing natural resources is a complex task. As one group noted: *"As seniors in NRES we all went into the class knowing that natural resources are very difficult to manage due to the many different components involved."* Yet another group offered, *"After working through each module, we understood how hard it really is to integrate all the different aspects of natural resources."* And, another group said, *"We learned that the planning process is very complicated and that decisions that seem simple at first can quickly become very complicated as the scope of the problem expands."*

The hands-on experience was especially well-received by students. Many believed that they were now better prepared for their future jobs –*"We had hands-on experience trying to prepare management plans ourselves and know first hand the extent of work that is involved—on a much smaller scale of course."* Another group said that, *"Models are useful to look at trends or generalizations and to help choose the best alternative to use."* However, they were quick to point out that models, while useful, could not be counted on to answer all their questions. They would still need to rely on their technical knowledge and expertise to arrive at many natural resource solutions--*"The problem with models is that they are just models and do not take into consideration natural disasters, fire, disease, etc."*

Most students also noted that they had a better understanding and appreciation of the values people have about natural resources. They realized that it is not only important to know who the stakeholders are, but that they must also know how stakeholders perceive the resource, the benefits they attain from the resource, and what type and level of management they will support. Groups offered that,*"It is hard to manage*

natural resources because there are so many different view points involved," and *"Some people place a higher value on non-market goods such as recreation, biodiversity, and aesthetics than others. We now realize that these are important issues and that economics is not the only issue."*

Many groups thought that they had gained more than just academic knowledge and skills from the course. Many thought that the active and collaborative learning format was invaluable to them in terms of what can be learned from and accomplished with a group of colleagues in a short amount of time. They said, *"Beyond all the scholastic knowledge we gained in Integrated Natural Resource Planning, we obtained many group oriented skills as well as problem solving skills. We learned how to coordinate our schedules to fit with other group members; to meet deadlines; to work well in groups with people we did not know before; and to express concerns and ideas in an effective and efficient manner."* Another group mentioned that it was exciting to work together to get the labs done because the labs allowed them to collectively tie *"…a lot of information from other classes together and we liked the fact that we each had to contribute our individual knowledge on the subjects that we are specializing in to complete the assignments."*

Several groups commented positively on the instructors. Although each student previously had taken courses from one or more of the instructors, very few, if any, had taken courses from each of the instructors. They liked being exposed to a variety of instructors and would have liked to have had the opportunity to have taken other classes with these instructors.

Instructor Critique

A primary concern of all the instructors was the lack of preparation of many students for this course. Very few had the prerequisites. The first two years the course was taught, we allowed students to remain in the course even though they were lacking the prerequisites. We allowed them to stay because, for many of them, this course was taken during the last quarter of their degree program. We enforced the prerequisites the third time the course was offered. The result was that we did not have enough students signed up to offer the course. Some students readily admit that they do not pay much attention to a course's prerequisites. If the course looks interesting, they sign up for it. Apparently, there are no checks in place to stop registration if a student is lacking course prerequisites. The level of performance of groups who had several members lacking some of the prerequisites was below average. As this is a 'capstone' type course, the instructors were not inclined to 'water down' the course to meet the needs of the least prepared students.

The second major concern of the instructors was the amount of time each of us had to devote to his/her module(s). Perhaps we were over ambitious in developing the course, or perhaps is was the lack of preparation we noted in the students, but none of us thought we had enough time to adequately teach each module. We especially felt that we had far too little time to integrate the modules. To many of us, we felt the modules appeared to 'stand alone' rather than appear to be well integrated with the other modules. It might also be that devoting 80% of the class time to collaborative or active learning methods was uncomfortable for us. Many of us were not sure if students were learning what we thought they should be learning from the course. Students tended to agree with us when we expressed concern about whether they understood the linkages among each module. In particular, students and we thought that there needed to be a time, after a module was completed, to talk about how that module built upon or was linked to other modules. The format of the course did not allow us to address these linkages in any detail until the last week of the course. In fall of 1999 we will move to semesters. The added time we will have once we begin teaching this course in semesters will largely be used to discuss and more fully explore those linkages.

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SO YOU'RE NOT A NATURAL RESOURCES MAJOR: TEACHING A GENERAL STUDIES COURSE FOCUSED ON FOREST HISTORY

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ABSTRACT: When compared to our undergraduate majors, students taking environmental courses to fulfill general education (or general studies) requirements have different knowledge bases, different interest levels, and different motivations for studying natural resources topics. Unlike foresters or wildlife managers or environmental scientists, typical business management, psychology, or accounting students are not inclined to memorize scientific names of X number of tree species or learn how to calculate hard mast yields per acre or care how to precipitate organic compounds from a sample solution. So how and what can we teach these students? How do these differences affect choices of appropriate teaching strategies, lecture topics, reading selections, assignment types, and testing? This paper will address pedagogical issues and rewards discovered while teaching a course titled *Forest History, Technology and Society*, a course that fulfills a general education requirement for students from across campus. The course time frame spans from western civilization's beginning until the contemporary period. Topics include an eclectic mix chosen to prompt examinations of values, perspectives, scientific understandings, and utilization alternatives affecting the status of forests at particular points throughout the span of history. This paper will examine how the interaction of that immense time frame and the eclectic range of potential topics necessitates identification of key concepts on which to focus the course. It will discuss the techniques used in designing assignments and creating examinations for its diverse student clientele with diverse interests and learning styles.

INTRODUCTION

My class roster last semester included students majoring in accounting, animal science, pre-vet, business management, mass communications, and wildlife biology. They ranged from first semester to senior students. Actually, one student had returned to earn a B.S. degree after earning a Masters and taking Ph.D. classes in philosophy. The students' only apparent common trait was that they elected to enroll in FOR 248, which fills a slot in university general education requirements. In that respect, this class is similar to the mix of students one could find in many humanities or social science elective courses taught across campus.

But it is a different student mix than typically enrolls in our other forestry or natural resources courses. Compared to our undergraduate majors in forestry or natural resources, these students have markedly different knowledge bases, different interest levels, and different motivations for studying natural resources topics. They shy away from memorizing scientific names of X-many tree species or learning how to calculate hard mast yields per acre or how to precipitate organic compounds from a sample solution. Still, they have a pervasive sense that the environment matters.

So how and what can I teach these students? How do their differences affect choices of appropriate teaching strategies, lecture topics, reading selections, assignment types, and testing? This paper addresses pedagogical issues and rewards discovered while teaching Forest History, Technology, and Society.

COURSE STRUCTURE AND CONTENT

FOR 248 is a typical 3-credit, 3 fifty-minute meetings per week, no laboratory class. Two texts (Perlin 1991, Ponting 1991) currently provide the core reading material, supplemented with a fairly extensive optional reading list. Grading in the course comprises several components (Table 1). After a semester or two, I found that several quizzes and a final examination rather than just a mid-term and final examination worked better to keep everyone on track with the syllabus—me included. I also found that rather than one large-scale research project, several more specific assignments and a smaller-scale research paper helped students better understand some key concepts in the course and prompted them to keep abreast of the reading.

Table 1. Components of FOR 248 course grade

Component	%
Formal assignments (4 @ 5%)	20
Quizzes (3 @ 10%)	30
Project paper	20
Final examination	20
Homework and class participation	10

The course content spans from the dawn of western civilization in the ancient Near East through the contemporary period. However, brief attention to the twentieth century really only concludes the course. I do spend enough time introducing the consequences of modern forest management to dispel some typical misconceptions students bring into the course. Overall, though, course content includes an eclectic topic mix chosen to prompt examinations of values, scientific understandings, and utilization alternatives (Table 2).

For a semester or so, I tried a chronological structure because the main text (Perlin 1991) is essentially a chronological narrative. However, I found myself either plodding or racing through the ages. We could spend most of the semester on the ancient world and then cover the last five hundred years in a few weeks. Instead, we are now addressing themes Perlin touches on in every age and thereby connecting facts and examples from ancient to modern times. My current aim is to develop a central understanding of how forests, technology and society have continually interacted. We tease out the core issues of local versus national interest in wood supplies, domestic versus industrial demands, and utilitarian versus ideological perspectives at work in each time period.

Table 2. Fall 1997 class session allocation to topics

Lecture Theme	# Classes	Assignment Focus
History and Myth : Technology and Science	2	
Phenomena and types of evidence	1	
Agriculture and its effects	5	Universal Soil Loss Equation
Charcoal: the universal fuel	3	
Industry, trade, and development	3	
Resource allocation and political power	3	Optional Readings Summary
Resources, economics and culture shifts	5	
Transportation and wood	5	
New world perspectives	3	Old Growth Site Visit
Wood extraction and extractives	3	
Changing utilization standards through time	3	
Preservation and conservation laws	3	
US introduction of forestry	2	Website Exploration
Forestry's century	2	

This change also resulted from a chance discovery I made while searching for a better way to frame key concepts on which to ground the course. I encountered a list of questions posed by conferees at two meetings convened by the NE Forest Experiment Station to address global change issues (Emery and Paananen 1995). Emery and Paananen's list was developed to guide human dimensions research related to global change. But from that list I extracted ten key questions for my course and students (Table 3). We now proceed through the topics in Table 2, by semester's end accumulating sufficient evidence to answer the questions in Table 3.

Table 3. Key concepts addressed (adapted from Emery and Paananen 1995).

What are the effects of human actions on forested ecosystems?
How do demographic trends affect forest use?
How do various technologies affect the ways people use forests?
How will changes in forested ecosystems affect technologies?
How do people respond to changes in forested ecosystems?
What are the differential effects of forest management actions and environmental changes across social groups and time?
What are the tradeoffs among benefits and costs of management and policy options for various stakeholders?
What methods can be used to identify and evaluate tradeoffs among benefits and costs of management and policy options for various stakeholders?
What are the interactions between environmental values and changes in forested ecosystems?
How do social constructions of the relationships between nature and humans affect options for responding to change in forested landscapes?

Along the way, I supplement the Perlin and Ponting texts with information from a wide variety of sources. For instance, a chapter from Hughes (1975) provides an overview of Mediterranean ecology, which helps students understand the dynamics of environmental change in the Hellenic and Roman periods. Nora Chadwick's excellent work on the Celts (Chadwick 1971) provides insight about conditions across Europe beyond the pale of classic cultures. I use slides from

the Harvard Diorama series to illustrate impacts of European settlement and subsequent economic developments on the eastern seaboard and a figure from Trimble (1974) to show effects of erosion on the Southeastern piedmont. Two of my own research projects provide examples illustrating relatively recent changes in North American forests. A project concerning Western Maryland demonstrates changes resulting from transportation and industrial developments since the 1770s. The other project treats profound changes in the South's longleaf ecosystem, as a result of naval stores production, hog foraging, agricultural conversion, and timbering as late as the turn of this century.

TEACHING STRATEGIES

As I indicated above, unlike most of our forestry and natural resources classes, FOR 248 does not involve a laboratory. I therefore deliver most of the material in lecture-discussion format, with as much emphasis on discussion as possible. At this point, I want to touch on several assignments and features I have incorporated to stimulate greater student involvement in the learning process. I need to emphasize that nearly all of these assignments are still under construction or renovation. I also assign impromptu overnight homework when I want the class to be especially prepared with a particular section of the reading.

Universal soil loss equation. This assignment I make in conjunction with examining effects of early agricultural and industrial development on forests. It requires that students use procedures for deriving variables in the USDA soil loss equation. They then develop a spread sheet to calculate soil loss values in tons per acre per year for several different soils in North Carolina, under varying canopy conditions. I have them write a brief summary report about their results. The purpose is to emphasize the factors that can and often have led to catastropic effects from deforestation or poor management practices following timber harvesting. Perlin, of course, presents abundant historic examples, but this exercise tends to reinforce the take home message that cutting trees alone is not so much the problem as what follows the cutting.

Charcoal and Potash Yields. Last year, in conjunction with our discussion of metallurgy's development over several thousand years, I assembled tables and information from the *Forestry Handbook* and generated several problems to calculate amounts of charcoal and potash yielded and the amounts of energy available if using different types of fuelwood. The problems require definitions of terms and understanding of changes in the distillation process over time. We also can discuss differences in wood properties and their effects on utilization.

Eastern Old-Growth Forests. When we begin to shift our focus to North America and European colonization, I introduce Leverett's (Davis 1993) criteria for identifying old growth stands. I invite the students to visit a site noted in Mary Byrd Davis's survey and to report on what they see, specifically noting the presence or absence of the typical characteristics we have discussed. This fall I scheduled the assignment so they could make these visits over mid-semester break if they wanted to go farther afield.

Website Exploration. This assignment posed a number of questions that required students to visit selected websites to find needed information. For example, from the North Carolina Division of Forest Resources site, they needed to find the price list for seedlings and calculate what it would cost to acquire seedlings for various kinds of plantations. From the Cradle of Forestry website they were to identify states whose National Forest maps were available through the Cradle of Forestry in America Interpretive Association. Next semester I will probably make this one of the early assignments and expand the number of sites they visit, including the USGS Land Use History of North America site and others whose addresses I have recently encountered.

Project Paper. The project paper assignment gives each student the chance to delve into a subject area of personal interest in greater depth than is possible for the whole class. The assignment objectives are to (1) encourage interdisciplinary thinking and investigation, (2) provide experience in developing literature review skills, (3) satisfy intellectual curiosity (mine and theirs) regarding a chosen subject, and (4) provide opportunities for reporting findings in writing. I expect the topic to involve an aspect of history related to forest resource use, an industry utilizing forest resources, or a socio-cultural development impacted by availability of forest resources. Papers typically range between five and ten pages. Table 5 lists some of the representative topics chosen over several semesters.

Table 5. Sample personal research paper topics in FOR 248.

California Redwoods: a look at early logging
Developments in logging and transportation in the Lake States
Fire Towers in North Carolina
Forests of Cuba 1954-1997
Greek Beliefs and Culture vs. Their Relationship With the Environment
Government land regulation and endangered species
Principio Iron Works

In addition to formal assignments, I also take advantage of unplanned situations that arise. For example, this fall our campus art gallery exhibited two shows that related to my class. One was a local potter's work produced in a wood-fired kiln. The other show, called "Fabulous Furniture," featured a number of pieces fashioned in wood. I took the class to the shows while we were discussing utilization standards and wood properties. Most had never even been to the campus gallery, and few would probably have made a connection between the shows

and this course, so we spent a class period connecting forests and art in a tangible way.

COMMUNICATING WITH THE PUBLIC

Surveys reported in the mass media suggest that as many as 80 percent of the U.S. public may identify themselves as concerned about the environment. But the same types of surveys tend to undercut this number's significance. When excesses of consumerism butt up against realities of conservation practice and consumer self-denial, hypocracies of American environmental consciousness surface. Thus, one of my intentions is to raise my students' awareness about our collective and their own consumptive patterns with relation to forests.

Trade-offs, as we in natural resources management know all too well, exist. This course asserts that they have always existed. Because I believe that only through informed management of our domestic forests can we hope to sustain productivity for the multiplicity of uses demanded for the foreseeable future, I attempt to inform each semester's small sample of forest products users about costs associated with their choices. According to comments made by my students in response to several of the assignments, this course changes the way they see the forest and think about its management.

FOR 248 is a course that draws students from across the spectrum we in the natural resources professions refer to as "the general public." The students remind me of myself at a distantly past age (and growing more distant all the time). Most come in somewhat naive or misinformed about forest management and the status of our forests, some are pretty idealistic about how resource decisions should or can be made; but to varying degrees all are curious and willing to stretch themselves to understand what affects our forests. They leave changed in some small degree and, I have some evidence to suggest, better understanding issues and facts affecting forest management decisions.

CONCLUSION

Developing and teaching this course has been fun. Its subject matter intrigues me, continually posing questions for which I personally want to seek answers. Perhaps to an extent the curiosity and enthusiasm have been infectious. The students suggest that they are consistently surprised by their "discoveries" in the class. When asked whether the course meets their expectations, they often express surprise at how much different it has been from what they thought it might be. Their performance on quizzes and tests is predictably arrayed along that bell curve we academicians keep in the back of our minds. But all seem to have gained something.

I think my inclination to experiment, my personal move into this area of research endeavor, and the variety of perspectives students bring to the course all interact to create a dynamic environment for learning something. I have not codified what exactly that something is beyond the variety of answers one may offer in response to that list of key questions in Table 3. Maybe the something is merely what I call the essence of education—satisfying our curiosity.

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THE "SAGE ON THE STAGE" IS NOT SUSTAINABLE: PARTICIPATORY PEDAGOGY FOR A CHANGE

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ABSTRACT: At the cusp of the 21st century natural resource educators face a bewildering variety of crises and contradictions. First, tomorrow does not replicate today, let alone yesterday. So not much is achieved by maintenance learning - the learning of fixed rules for recurring patterns. Secondly, learners are apt to behave like consumers and can secure access to education without having to endure the indignities of tyrannical teachers, capricious requirements, lectures or other manifestations of a "transportation model" of education. Thirdly, there is doubt about the extent to which "progress" can be wrought from the calm certitudes of "tested knowledge" and "objective" science. Indeed, in some places, there is suspicion that natural resource education is part of the problem - corporatism, environmental degradation, collapse of communities - and not part of the solution to what ails the planet. With these factors in mind the author maps approaches to education about natural resources and argues that there should be a migration from techno-rational or functionalist perspectives towards humanist, radical humanist and radical functionalist approaches.

INTRODUCTION

University teaching and other forms of pedagogy are not neutral, benign or innocent. Despite the fact some educators still think education involves the "sage on the stage" delivering lectures, at the dawn of the 21st century, pedagogy is a fractious, contested, difficult and exciting process.

The situation is particularly perilous for natural resource educators called upon to teach about matters for which there are no easy solutions. For example, at the time of writing (February 6, 1998) the local, national and international media are carrying this headline - "Fish Stocks Disappearing World-Wide, Scientist Says" (*Globe and Mail,* February 6, 1998, p. A1). Using nearly 50 years worth of U.N. data, a team at the University of B.C. Fisheries Centre claims that because of "industrial fishing" many stocks will be eliminated in 25 years. "The collapse of cod stocks on the East Coast and the shocking decline of salmon in both the Pacific and Atlantic led many to worry that industrial fishing had reached unsustainable levels," says the story.

Sockeye salmon lie at the centre of B.C. coastal identity and the "Cloverleaf" trademark defines western Canada with the same resonance as grizzly bear, rain forest, fiords, mountains. By confronting corporatism and the excesses of techno-rational or "industrial" modes of fishing, these UBC researchers will incur some wrath. Around the world, corporate spin-doctors will challenge the methodology of their study and then move to stunt its impact on the industry. The corporations will cite the importance of jobs and the imperatives of global competitiveness. When these researchers face their classes on Monday morning students will have questions. The conversation that results should be interesting and demonstrate that education is a political process.

There is no such thing as "neutral" education. Somebody's interests are always being served. Even those who claim they merely provide "facts" or are "professing" about what are only "technical matters" are taking a position. Education is ideological and denials are themselves evidence of an ideology - which, in natural resource education, is too often nested in an uncritical acceptance of corporatism, western-style notions of progress and development, an embrace of globalisation and international competitiveness and a refusal to see that program content and pedagogical processes are shaped by the context in which they occur.

Purpose

Many of the factors shaping natural resource education are the same as those influencing the rest of the university. We live in postmodern times where education is increasingly constructed as a commodity and students as consumers. Cuts, the commodification of education and the emphasis on performativity are shaping all parts of the university. Moreover, the arrival of concepts like distributed learning and the uncritical and rapid embrace of the World Wide Web and "virtual universities" disturbs face-to-face higher education.

As well, powerful factors unique to the natural resources field are shaping education. The days when natural resource education rested on almost universal respect for and acceptance of objective science, techno-rational discourse and positivism, have almost disappeared. What remains are contradictions, serious issues and few easy solutions. At the turn of the century universities are engaged in fierce competition with each other and their authority is in doubt. Moreover, learners have other options. As well, there is no one way to engage in pedagogy and educators should be wary of the latest fad, bandwagon's thundering through the academy or the seductions of the latest metanarrative. As Chairman Mao was apt to say, these are "interesting times."

The purpose of this paper is to raise issues pertaining to university education in natural resources at the dawn of the 21st century. Our focus is on program content and pedagogical processes. There is no one right way to do pedagogy but numerous issues merit consideration. Hence, in this paper the focus is on issues, not solutions to the problems of pedagogy.

Increasingly, natural resource education program content and pedagogy are being shaped by

* Rapid change
* The commodification of education
* The arrival of distributed Learning
* The collapse of disciplines and loss of confidence in "scientism" and functionalist discourse
* A need for theoretical pluralism

RAPID CHANGE

It has become almost a cliché to note that change is the only constant of our time and many scholars or popular writers (such as Toffler, 1970; Naisbitt, 1982; Valaskakis et.al., 1979) coined aphorisms like "future shock," "megatrends," and the "conserver society" that are now part of popular discourse.

Rapid change is stressful and calls for novel responses. University educators have been slow to respond and many behave as if tomorrow will simply repeat today. But education is about the way things are now no longer suffices. The fact things will not be the same in the future is difficult to comprehend and usually dismissed with aphorisms like "we'll cross that bridge when we come to it." For example, who heard one word about HIV/AIDS during their high school or university years? And to what extent did the Newfoundland cod fishery collapse because, in the interests of short-term expediency, too many people decided to "cross the bridge when we come to it."

As well, the time lag between the invention and application of technological or conceptual innovations has drastically decreased. More than 90 percent of scientists and inventors in all of human history are alive today. It took 112 years to develop practical applications arising from the discovery of principles of photography. In contrast, only two years separated the discovery of principles associated with and production of solar batteries. Rapid change is accelerating, rather than diminishing. In times of rapid change, and as the future becomes more complex, there is a tendency to adopt fundamentalist beliefs. Fundamentalism, by definition, is the opposite of learning. It is a reaction to undigested complexity and, in some parts of the world, gnawing at the social fabric with such insistence that entire nations are threatened with catastrophe.

Many people profess fundamentalist beliefs that have little apparent impact on their behaviour. But what makes the situation disturbing is that fundamentalism in politicians is isomorphic with the psychological vulnerability of the entire populace. Sometimes, it is easier to psychologically retreat to refuge provided by prior learning or simple-minded beliefs. Psychologically, this is comparable to the fear of freedom Fromm (1941, 1949) used to explain the reactions of the German populace to the fundamentalist and fascistic exhortations of the Nazis.

The widespread recourse to fundamentalism is probably related to uncertainty evoked by economic uncertainty and psychological despair. Optimists hope the present economic and associated psychological crisis will pass and soon it will be business as usual. This is a forlorn hope and, in the meantime, the widening gap between complexity and the human capacity for learning could be fatal; there will be no chance to view the present situation from a long term perspective. When Botkin et. al. (1979) warned about the dangers of learning by shock, we knew nothing of ecological refugees from Newfoundland, the AIDS crisis just ahead or 26 million inhabitants of India (equivalent to the entire population of Canada) displaced from their homes by "development" of natural resources (Sainath, 1996).

The inability of some to learn about the HIV/AIDS virus has cost millions of lives, almost wiped out certain occupational groups in North America and threatens the existence of entire countries. In the same way, Newfoundlanders are witnessing the unravelling of a 500 year old outport culture because of the failure of the cod fishery. Whatever learning occurred there was too little and too late. Learning by shock is deeply-rooted and expressed in aphorisms such as "wait until the crisis comes" or "cross that bridge when you come to it."

It is the complex and interrelated nature of psychological, energy, economic, natural resources, educational and other issues that constitute the world problematique that preoccupies the Club of Rome and gave rise to the notion of innovative learning. Fundamentalism is related to unemployment. Unemployment is related to economic conditions, and so on. Education pervades all issues and has become a prerequisite for survival.

New Approaches

The notion of innovative learning was elaborated in a book cunningly entitled *No Limits to Learning* (Botkin, et. al., 1979). Although it echoed many of the themes of lifelong education and *Learning To Be* (Faure, 1972) its focus was on the future. It exhorted citizens to be proactive and challenged educators bought up with the notion that their job was to "satisfy needs."

The argument runs like this. Reactive education that responds to the homeostatically-motivated needs of learners, communities, or nations might be acceptable in times of slow change or social inertia. Today, rapid change has created a gap between complexities in the socio-cultural and technological environments and the human capacity for learning, understanding and action. This is a man-made human gap (most women will agree). Unlike earlier times when citizens were barely conscious of events in the global environment, people are aware of contemporary change. Planet Earth is in the midst of a transformation more profound than the iron age or Copernican revolution. The situation can be portrayed as in Fig. 1. Earlier this century the gap between the human capacity to learn, and complexity in the environment that had to be comprehended, was much smaller than the one prevailing today.

The Club of Rome has frequently asserted that steps taken to resolve the world problematique must involve people with different values working together and it appears that traditional maintenance approaches should be supplemented by innovative learning.

Maintenance Learning

Maintenance learning is a problem-solving process designed to help individuals adapt to external pressures. It is necessary for societal stability and harmony and maintains existing systems and the established way of life. Maintenance learning involves the acquisition of fixed rules for recurring patterns. As noted, it is appropriate during times of slow change or social inertia. But it will not adequately equip people for a future characterized by turbulence and shock. It is well understood since it resembles present educational arrangements. Needs are diagnosed and students supposedly filled-up with available knowledge. They are then literally and metaphorically capped and sent into the world. Much education is also maintenance-oriented since it focuses on knowledge designed to satisfy existing needs. It is often delivered in a pedestrian manner by the "sage on the stage" who thinks education is a process of information-transmittal.

Innovative Learning

Innovative learning is a necessary prerequisite to the solution of global problems and a means to prepare individuals and societies to cope with, anticipate, and create, new futures. Much work needs to be done on its theoretical foundations and practical implications but, for present purposes, two features are of critical significance. The first concerns anticipation which runs counter to the biological and homeostatic, notion of adaptation.

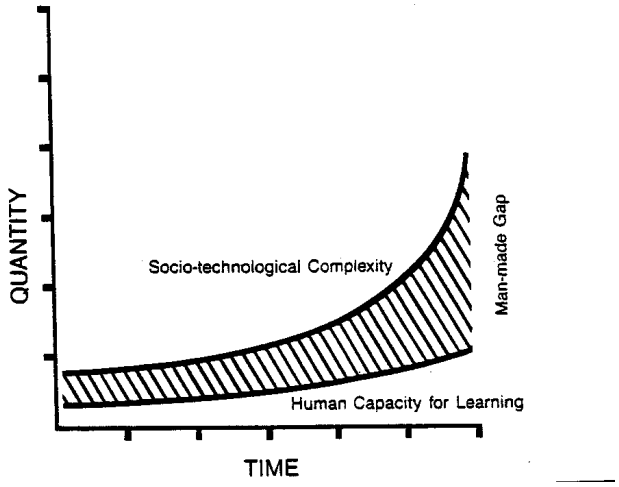

Figure 1. Gap between complexity and the human capacity to learn

Anticipation. Whereas adaptation suggests a reactive adjustment to external pressure, anticipation implies a need to prepare possible contingencies and long-range future alternatives. Thus, the anticipatory part of innovative learning requires that people use techniques such as forecasting, simulations, scenarios and models. As Botkin et al., noted " it encourages them to consider trends, to make plans, to evaluate future consequences and possible injurious effects of present decisions, and to recognize the global implications of local, national and regional actions. Its aim is to shield society from the trauma of learning by shock. It emphasizes the future tense, not just the past. It employs imagination but is based on hard fact. When the gradual deterioration of the physical or social environment does not move those who should be alarmed, then anticipation either is not present or is not given sufficient priority. The essence of anticipation lies in selecting desirable events and working toward them; in averting unwanted or potentially catastrophic events; and in creating new alternatives" (1979, pp. 12-13). The future will not be a linear extension of the past so maintenance-oriented educators that merely react as needs emerge had better adopt a new posture. Educators can no longer behave like ambulance drivers showing up after the accident has happened. For example, it is better to learn about cod before they disappear.

It is useful to administer first aid at the scene of an accident, so a certain amount of maintenance learning will be required, but better to prevent problems by selecting and working toward desirable and less accident-prone futures. Moreover, people should not feel overwhelmed by the massive and apparently intransigent nature of global problems because it is

the accumulated effects of local decisions that make or break us.

Participation. Another feature of innovative learning is participation. This has been a long-standing preoccupation of educators who have treated it as a prerequisite to, and consequence of, adult education. Regrettably, "participation" is not a prominent part of pedagogy in university natural resources departments. In a democracy, participation is associated with power and influence. Thus, by failing to participate in the organized group life of their community, many people disenfranchise themselves. Today, the demand for participation is felt by governments, communities and nations everywhere. Third World countries desire equal participation with the developed world in decisions that affect them; rural populations demand facilities taken for granted by urban people; workers want participatory democracy on the factory floor; indigenous people want a voice in and control of decisions pertaining to their land, resources and place in society; many women are fed up with patriarchy.

It appears that people are committed to something as a function of the extent to which they were consulted in its creation. As a result, adult but not higher educators generally stress participatory techniques that actively involve and use the experience of learners. The university professor may happily expose students to lecture after lecture from notes that grow yellow as the years pass. But adult educators, somewhat more responsible, come equipped with simulations, role playing exercises, games, case studies and other materials that actively engage the learner in "participatory" ways.

Those enamored with electronic technologies often do not recognize that the one-way transmittal of information is not participatory. It is like throwing water at a bottle; most lands on the floor because response or feedback - the essential element of participatory learning - is missing. This is a timely point because there is nothing particularly innovative about using technology to deliver maintenance learning. It is just a new way of maintaining the status quo and provides people with a splendid excuse to hack at institutions where learners actually gather in groups and participate together. The much-vaunted capacity of the Internet to foster participation is often abused. Instead of encouraging learners to engage with the deep structures of the course, architects of many Web courses confine "participation" to the banalities of the "chatroom" (Boshier, et.al., 1997; Wilson, 1998).

EDUCATION AS COMMODITY

Perhaps the most significant factor shaping pedagogy in university natural resource programs is commodification of education and stress on performativity. In more tranquil and utopian times university scholars and their loyal band of students laboured at the frontiers of ignorance in an ivory tower more or less insulated from the town on the flats below. When town met gown it was for a glass of wine at the faculty club. These days universities are preoccupied with budget cuts, restructuring and upstart competitors in colleges or, god help us, private corporations.

Globalisation and internationalization has also brought a new set of challenges in the form of distributed learning. Just a few years ago, universities offered face-to-face courses. Distance education or open learning was the more or less exclusive preserve of open learning institutes or universities specifically created to do it (e.g. the Open University of the United Kingdom). The motivation for these earlier forms of correspondence or distance education and the later notion of open learning was nested in a democratisation discourse. Programs were designed to serve the "hard-to-reach" or other folks who preferred to study at home. Regrettably, far too many academics in face-to-face universities looked down their noses at these allegedly inferior providers of distance education. When given the opportunity to play in this field the answer was usually "no." Little did they know that by the late-1990's the boundaries between face-to-face and distance education would collapse and the once despised providers would be in their back yard. The maligned "they" are now us.

World Wide Goldrush

Contrary to what techno-utopians and editors of *Wired* magazine have to say, the World Wide Web does not represent a paradigm shift and is not the dawning of a new age in education and learning. However, there is a race to create virtual universities and market courses to learners in distant locations and these will help shape the future character of education about natural resources.

Contrary to popular belief, the Web is not World Wide. It is largely American and, even there, a creature of the metropole. The earliest navigators had to identify the middle of the world in order to calculate longitude. With a fair modicum of colonial temerity, the British persuaded those interested that the middle of the world ran through Greenwich in East London. To this day, it is a thrill to stand astride the meridian with one leg in the western hemisphere and the other in the east. In earlier times "west" meant civilization while the "far" east was exotic and dangerous. In the same way, the meridian of the Web runs along the west coast of America. In starts just south of Vancouver, Canada, in Redmond Washington where rich Microsoft employees are transforming what was once a Seattle suburb. It's centre is in the San Francisco Bay area, Palo Alto and the sprawling industrial park of Netscape. The spine then snakes through the Los Angeles basin and ends in San Diego at the border with Mexico. Unlike Greenwich, it's greatest influence is to the east - across the U.S. mainland and on to Europe.

Whereas correspondence, distance education and open learning were infused with preoccupations about equity and access, the atmosphere around distributed learning resembles a

goldrush. In this goldrush prostitutes flourish, learners buy fools gold and there is a sense that educators who don't join will be left behind and suffer an early demise. Unlike earlier goldrushes when staying home was an option, this time educators are mounting the wagon with unseemly haste. They don't know much about what lies along the trail, the destination is obscure, there is scant research to guide their journey and marauding corporations have already staked claims. But it isn't boring and almost anything can happen.

These things are happening because the Web is alluring and, for folks tired of tyrannical teachers, capricious administrators and the other tedium of face-to-face education, the notion of securing education from their own home is attractive. Despite serious and profound problems associated with providing or securing an education on the Web, a curious coalition of interests stills voices that would otherwise raise awkward questions.

Neo-Liberal Perspective

Neo-liberal or rightwing politicians like the Web because it seems efficient. It nicely fits the exhortation to "do more with less." Moreover, because it straddles national boundaries, the Web coincides with the interest in "internationalizing" education within the context of the "global economy."

Large numbers of fee-paying learners both on and off-campus can be reached all at the same time with materials written by a course designer whose employment was very likely terminated when the course was ready. Indeed, the most malevolent of the neo-liberals anticipate a day when there will be no difference between on and off-campus education, much (or, if possible, nearly all of it) will be mediated by computers which don't form unions, go on strike, complain about inferior food services, demand new books or need a place to park a car. At the University of B.C. in Vancouver distributed learning is even being touted as an instrument to cut down on the number of vehicles that wind through affluent suburbs (wherein politically well-connected people have their abode) on the way to campus.

While putting one hand into the learner's wallet to extract a substantial "cost-recovery" fee for the privilege of doing the Web course, in the other hand the Director of Distributed Learning holds a placard upon which is written the word "access." In other words, the language of lifelong education, of equity and access, is used to obscure the fact Web learning and education is a salient aspect of commodification. Is the World Word Web a code for World World Profit?

Anarchist-Utopian Perspective

For entirely different reasons anarchist-utopians who have no time for globalisation discourses or the excesses of neo-liberalism also like the Web because it enables them to subvert unequal power relations that infest much of formal education. In the 1970's Ivan Illich (1979), a leading anarchist-utopian, condemned the self-serving nature of formal education and called for the deschooling of society. In many ways the Web exemplifies the ethos of deschooling and, around the world, indigenous people, women and others typically locked out of formal education, applaud the opportunity to form solidarity-relationships with like-minded folks elsewhere. With money-minded neo-liberals and left-oriented anarchist utopians supporting it, Web learning and education is enjoying rapid growth. If there are murmurs of dissent they are muted.

Beware of Techno-Utopia

Distributed learning is a close descendant of familiar folk - correspondence study, distance education and open learning. But, whereas the first three generations of this family were nest in a democratizing discourse, their offspring - distributed learning - is a dodgy character. The prime force driving development of distributed learning is profit. Equity, access, the problems of the hard-to-reach are in the "vision" and "mission-statement" but there as window-dressing, part of an effort to drive single-mode distance education operators out of business. Those who previously dismissed courses offered at a distance as second best and declined opportunities to form what are now euphemistically called "partnerships" with open learning agencies, correspondence education providers or distance education institutions, now want not part, but **all** the action. In this flotilla, advocates of distributed learning have inherited elaborate videoconferencing facilities, still produce traditional courses packed in ringbinders and produce video and audiotapes and many of the other accouterments of the so-called older forms of distance education. But the Web is their flagship.

Technology-mediated distributed learning, like all forms of education, is not simply a matter of moving information. Nor is it ideologically benign or politically neutral. Regrettably, there is far too much American influence on the Web (Wilson, Qayyum and Boshier, 1998) and little regard for the interests or learning styles of indigenous people or those living outside the metropole (Boshier, Wilson and Qayyum, 1998). Moreover, despite all the talk of empowerment and "solidarity-links" between environmental activists, popular educators involved in struggles over land, resources or agrarian reform and the possibilities for decentralization, there's more to it. For example, Mander (1996) claims technology is a powerful instrument for centralization and a potent weapon in the colonization of states that hitherto have been out of reach. On the surface, distributed learning looks like a sexy and innocent newcomer. But as is so often the case there's more to it. What's needed in natural resources education is a map, with a GPS or loran, that can guide the unwary through the labyrinths of educational technologies, theory and practice.

Innovative learning, distributed learning and all the other attributes of pedagogy in the modern university - problem-based education, cooperative education, internships, lectures, semi-

nars, colloquia - do not serve all interests equally well. Moreover, they're based on varying conceptions concerning the nature of reality. None of them are innocent methods or techniques. All bristle with ideological baggage.

It has become increasingly difficult for educators to take refuge under the cover of "objective science" because, as well as representing a positivist epistemology, it too is an ideology. It is necessary that educators take a position concerning natural resources. It is inevitable that this position will be expressed in program content and teaching processes. With this in mind we now present a map of theory that identifies different world views concerning program content and teaching/learning processes.

MAPPING THEORY

The model presented below embraces four world views that offer different ways of thinking about education concerning natural resources. It was originally developed by Burrell and Morgan (1979) to explain organizational behaviour but has since been deployed to analyse different approaches to AIDS education (Boshier, 1989), adult education (Boshier, 1994) and the cause and prevention of fishing vessel accidents (Boshier, 1996). The version shown here is a postmodern elaboration by Paulston and Liebman (1994) and Paulston (1996) which has been used to study comparative and international education and has the potential to analyze a broad array of phenomena.

There are two axes laying beneath Fig. 2 that lie in an orthogonal (right-angled) relationship to each other. Treat them like latitude and longitude on a nautical chart. The first concerns ontology - assumptions about the nature of reality and the way people perceive or construe things in the world. The second concerns the importance of power relations (e.g. between different interest groups, government and environmentalists, First Nations and Europeans, men and women). Think of this map like Microsoft windows. The ontology and power relations axes are lain down first. They exist at right-angles to one another. On top of this window Paulston has lain down two overlapping circles. The top layer, which comprises the third window to be opened, are various theoretical fragments, theories, and conceptualizations contained in the two circles. When reading this map it is important to note the ends of the two axes that frame the model (*transformation versus equilibrium* orientations on the vertical power-relations axis; *idealist-subjectivist versus realist-objectivist* orientations on the horizontal ontology axis).

Ontology

The horizontal axis concerns ontology - the essence of phenomena. Researchers, teachers and citizens vary with respect to the extent to which they think there is an objective "reality" - out there - external to the individual. For some, there is an objective world inhabited by lawfully interrelated variables. Most of us brought up in the positivist tradition believe this. For others, such as many feminists or indigenous people, reality is essentially a subjective phenomenon that exists within consciousness. It exists "in the mind." On the left end of the ontology (horizontal) axis are "idealist-subjectivist" orientations. On the right end are "realist-objectivist" orientations.

Power relations

The vertical axis concerns power and self-interest. Power relationships lay at the centre of education about natural resources. Every instance of education about natural resources serves some interests better than others. Teaching about the "management," "conservation" "exploitation" of natural resources is not a neutral, technical or benign process. It involves all kinds of struggles - between environmentalists and capitalists, local communities and trans-national corporations, men and women, different ethnic or occupational groups and so on. Somebody's interests are always being served when education programs are mounted.

Most forms of education occur in the bottom part of this model and, as such, tend to reinforce extant power relations. Where the educator claims to be neutral and just "delivering facts" they are reinforcing extant power relations. However, those "teaching against the grain" from a neo-marxist, critical or radical humanist perspective or a more materialist or radical functionalist perspective are challenging extant power relations.

Using the Map

The model contains four world views that, if adopted, would require different kinds of program content and pedagogical approaches. The four world views in Fig. 2 help natural resource and other educators in a variety of ways. First, the map shows the interrelationship between most of the theoretical "-isms" that inform education theory and practice. Secondly, this mapping of discourses and territorial disputes provides space for a plethora of perspectives. It avoids the seduction of proposing some singular or universal approach to education. Thirdly, like a nautical chart or geographic information system, it provides the academic traveler and exhausted teacher with landmarks in what can be a hostile academic world. As well, it enables an academic to locate themselves and get an aerial view of those in close proximity or on the other side of the ontological or power relations divide. If a traveler is not happy with their current location this map, like a loran or GPS, shows the way to alternative destinations.

Before analyzing how each of the world views inform the work of natural resource educators, it is important to point out that this map is neither neutral or benign. Functionalism is the epistemological servant of globalization and global competitiveness. Particularly in the U.S., but also in Europe and Oceania, there is an obsession with performativity, "pragma-

tism" and "what works." Functionalism is the dominant discourse of the late twentieth century and, in many natural resources circles, so taken-for-granted it doesn't merit attention, let alone critique. However, as many exponents of postmodernism have stated, pragmatism and functionalism (and it's corollaries, instrumentalism, performativity, and the notion of an applied discipline) produced Chernobyl, Bhopal, Nagasaki, the collapse of the Newfoundland cod fishery and a host of other horrors.

The problem with functionalism is that there's more to it. By providing a map with four equal-sized zones Paulston could create the impression that the "alternatives" in this map (i.e. everything other than functionalism) have a more-or-less equal impact on education. This should be the case but isn't. In late twentieth-century universities, academics (particularly in natural resource units) are strongly encouraged to produce practical answers to pressing problems. A functionalist world view prevails. In B.C., natural resource issues are paraded across newspaper front pages most days and there is no shortage of acrimony and accusation about the collapse of the fisheries, non-sustainable forestry, the degradation and misuse of agricultural land, damage caused by mine tailings, the theft of native land, misuse of waterfront and many other matters. Politicians and the public want answers. Sooner, rather than later.

FUNCTIONALISM

Functionalism provides an essentially "rational" (or "realist-objectivist") explanation for what needs to be done with natural resources. It is the dominant ideology of our time and characterized by a concern for social order, consensus and social integration. Its epistemology tends to be positivist. Functionalists want practical solutions to practical problems and are usually committed to scientific engineering as a basis for change with an emphasis on gradualism, order, and the maintenance of equilibrium. Functionalists attempt to apply models derived from natural sciences to human behaviour. They struggle to derive "facts" and "theory" immune to local disruption or refutation. Generalization across contexts is desirable. Within this world view a good theory is testable, parsimonious and significant. Hopefully it will explain and predict phenomena everywhere.

Related Theory

Evolutionary perspectives, neo-evolutionary theory and systems analysis are all part of a functionalist world view. Education informed by functionalism includes most government training, reskilling programs, most so-called upgrading programs, most continuing professional education, nearly all tech-

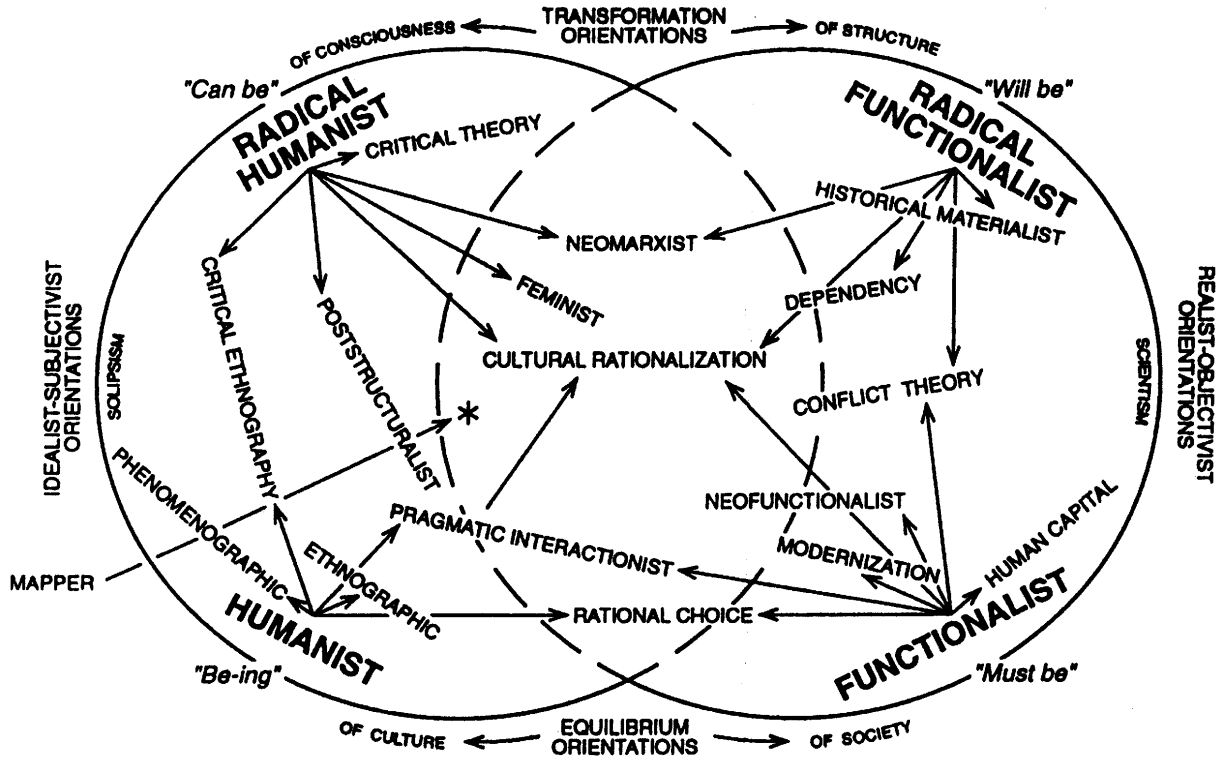

Figure 2. Paulston's "global mapping" of discourse and territorial disputes that frame educational theory and practice

nical or vocational training and basic education run by schools, colleges and other school-like institutions.

Natural Resources Education

In natural resources programs a functionalist is preoccupied with how things work (rather than with why they work this way and whose interests are served). Functionalist oriented programs of education about natural resources would be nested in a discourse of "exploiting" natural resources or "man over nature." Functionalists have an uncritical (sometimes unwitting) committment to extant power relations and are untroubled by the notion of preparing students to work harmoniously in what others might regard as predatory corporate structures. Functionalists will invoke notions of sustainability and can fairly claim to be working for the public good. But the politicality of sustainability has been gutted from their deliberations and, ironically, functionalism turns out be not so functional!

HUMANISM

Humanists are subjectivists in that "reality" is what it is construed to be. Great effort is devoted to adopting the frame of reference of the participant. Social "reality" is a network of assumptions and "shared meanings." The subjectivist ontological assumptions shared by humanists stem from the notion that human affairs are ordered, cohesive and integrated. Humanists use interpretivist methodologies and are more concerned with understanding subjectively construed meanings of the world "as it is" than with any utopian view of how it might be.

Related Theory

Movements, perspectives and authors located in this corner include Mezirow (1989, 1990), with his concern for perspective transformation which involves the modification of meanings ascribed to everyday situations. For example, after attending a consciousness-raising course, people might ascribe a different set of meanings to land-use planning or colonial appropriation of indigenous land. Another example would be a course designed to cause foresters to appreciate the importance of what First Nations people regard as spiritually significant sites. Each summer on Gabriola Island B.C. there is an "oceans festival" where learners are invited to attach spiritual and other meaning to waterscapes, the seabed, marine mammals and other creatures found at sea. The focus here is on what the ocean means.

Others in this world view include the Swedish phenomenographers (Marton, 1981; 1986) and the notion of andragogy (Knowles, 1980) which has considerable regard for the way adults construe their experience within an independent self concept. There is a flourishing brand of psychology concerned with discourse anchored in humanist world view (e.g. Harre and Gillett, 1994; Potter and Wetherell, 1987) that pertains to research where investigators try to see discursive formations that limit or enhance the learner's capacity for education.

Natural Resources Education

A humanist natural resources education program would manifest respect for ways in which people differentially construct meanings attached to, say, fish and fishing, trees and forestry, rangeland and pasture. There would be a foregrounding of and respect for the perspectives of indigenous people and others who fall outside the dominant white, usually Eurocentric, male constructions of natural resources and western notion of progress and development. Examples from within this world view include bioregional mapping (Aberley, 1993) and an "ecology of hope" (e.g. Bernard and Young, 1997). In these programs there is respect for subjectivity but no significant challenge of extant power relations.

RADICAL HUMANISM

Radical humanists want to upset extant power relationships but are anchored within a subjectivist ontology. Those in this paradigm are usually anti (or post) positivist. But, unlike humanists, radical humanists want to overthrow or transcend existing social arrangements. Many radical humanists employ concepts developed by the young Marx to describe how people carry ideological superstructures which limit cognition and create a false consciousness which inhibits fulfillment. Radical humanists want to release people from constraints - which largely reside in their own cognitions. They seek transformation, emancipation, and critical analysis of modes of domination. They want people to reconstruct their view of reality and take appropriate action. Thus education involves praxis (reflection followed by action).

Related Theory

Popular education and Freire's (1972, 1985) notion of conscientization are the clearest exemplars of this world view. Participatory research, popularized by the International Council of Adult Education, springs from similar ontological and ideological roots. Advocates of participatory research are critical of the top down nature of much university or traditional research. Their second apprehension concerns research that has insufficient regard to ways in which people subjectively construe their world, relying instead on the imposition or use of "external" values or measurement devices. Participatory research is based on praxis - reflection followed by action. It tends to unmask and then attempt to do something about unequal power relations.

Giroux's (1983, 1988) and Aronowitz and Giroux's (1991) analyses of resistance theory are other examples. Dropout from education or unwillingness to believe scientific "facts" has

typically been explained from an individualized "blame-the-victim" perspective. The learner dropped out or resists because of a lack of motivation, inferior intelligence or a bad attitude. But, resistance theory turns this on its head and there is persuasive research that demonstrates how "dropout" is often a political act or resistance. A parallel in natural resources education is where an indigenous group dismisses or actively resists "scientific studies" and its claims about "objective reality" and "truth" and, as such, render illegitimate local, indigenous or non-objectivist perspectives.

Most movements that employ education for cultural revitalization, whether amongst Maoris in New Zealand, Indians in Latin America or the Lap people in the Nordic countries, are informed by radical humanism. Education informed by this perspective has immense respect for local and culturally constructed "ways-of-knowing" and is committed to a transformation of consciousness.

Feminism is interesting because although some feminist scholars claim commitment to a subjective ontology there have been recent elaborations of more objective feminisms and a discernible sharpening of interest in marxist or structural feminisms (see Nicholson, 1990). Hence, in Fig. 2 feminism is in radical humanism zone has a leg in radical functionalism. There is also an exceedingly active branch of feminism nested in the postmodern.

Critical theory (Geuss, 1981) is also rooted in this world view. Critical social theory refers to a brand of western marxism and is exemplified by a range of writers but most notably Habermas and others associated with the Frankfurt School. Collard and Law (1991) describe the impact of critical theory on the New Left in the late 1960's and its preoccupation with subjectivist ontology. They claim that while critical theory influenced New Left politics (e.g. environmental activism) its influence on the academic analysis of education was muted until Freire's (1972) concern with the need to build a critical consciousness reached North America. These days Freire's neo-marxist radical humanism, partly derived from the work of Fromm (1941, 1949) has an enormous influence in North American graduate programs. For those wondering about how to translate critical theory into research methodology there is an analysis, with practical suggestions by Morrow and Brown (1994).

Critical pedagogy is another radical humanist orientation significant for natural resource educators. Activist intellectuals gathered under this banner advocate educational reform and draw sustenance from critical theory and Freire and, in recent years, post-modernism. They claim traditional education systems primarily serve the interests of corporate elites (Korten, 1995) and, in recent theoretical elaborations, slammed the insidious inclinations of popular culture, global advertisers (such as Benetton) and predatory trans-national corporations involved in extracting natural resources. Recent representations of critical pedagogy include *Politics of Liberation* (McLaren and Lankshear, 1994), *Critical Literacy* (Lankshear and McLaren, 1993), *Paulo Freire: A Critical Encounter* (McLaren and Leonard, 1993).

Natural Resources Education

A good example of approaches to natural resources education informed by a radical humanist perspective is Freire's (1985) analysis of cultural action and agrarian reform. It would be a mistake, he claims "to reduce this transformation to a mechanical act by which the system …. yields a new system … as when someone mechanically substitutes one chair for another ….. agrarian reform demands permanent critical thinking focused on (the) act of transformation and its consequences" (1985, p. 29).

Irrespective of whether plans are derived from "technicists" or peasants agrarian reform is culturally conditioned (Freire, 1985). Those committed to an objective reality should not view peasants as "empty vessels into which one deposits knowledge. Quite the contrary, they too are subjects of a process of their own beliefs." Hence "an increase in agricultural production cannot be seen as something separate from the cultural universe where the increase takes place" (1985, p. 30)

Another example of education about natural resources from within a radical humanist perspective is the work of DAWN (Development Alternatives with Women for a New Era). In their programs of education this feminist group in India deploys an analysis that shows how class and gender are complicit in the production of systemic crises involving natural resources (Sen and Grown, 1987).

A similar emphasis is in the work of LEAP, the "Learning for Environmental Action" project of the International Council for Adult Education, publishers of *Convergence*[2] which carries articles on natural resources and education constructed from within a radical humanist world view.

Another valuable perspective is found in the radical humanist perspective of Rahnema's (1997) *Post Development Reader.* This book contains chapters by leading theorists of natural resources education as well as critics like Illich. It deploys a Third World perspective to question meanings ascribed to development and Western ideas concerning progress. In an earlier but equally critical radical humanist perspective Roxborough (1979) attacked the tendency to make massive generalizations about the relationship between natural resources and development and, to illustrate his point, examined underdevelopment in several Latin American countries.

RADICAL FUNCTIONALISM

Radical functionalists share fundamental assumptions that buttress functionalism but are committed to the overthrow of social structures that build "false consciousness." If radical

humanists focus on consciousness and meaning, radical functionalists focus on structures, modes of domination, deprivation, contradictions within an objective social world. Education construed from within a radical functionalist perspective would show how struggles over natural resources arise from objective socioeconomic circumstances.

Within this world view are those who focus on deep-seated internal contradictions within society while others focus on power relationships. But common to all theories here is the notion that each society is characterized by inherent conflicts and, within these, lie the basis of change. The later Marx was the chief architect of this position.

Related Theory

A good example of this perspective was Bowles and Gintis's (1976) analysis of *Schooling in Capitalist America* wherein the authors shows how social and educational structures reproduce elites and underclasses. In the U.K. writers at the Centre for Contemporary Cultural Studies at the University of Birmingham link a critical radical functionalist perspective to the particularities of everyday experience. They claim all experience is "vulnerable to ideological inscription" but maintain that theorizing outside of everyday experience (the material facts) produces work that is overly formal and deterministic.

Good examples of a fusion of radical functionalist and postmodern sensibilities are Willis's (1977) *Learning To Labour* - about how working-class kids learn to accept (and not challenge) their class origins. Another example, on a similar topic was *Knuckle Sandwich: Growing Up In The Working-Class City* (Robins and Cohen, 1978).

Natural Resources Education

An example of a radical functionalist perspective on natural resources is found in the work of the Highlander Folk School in Newmarket, Tennessee. A materialist analysis of issues pertaining to natural resources is Gaventa's (1980) *Power and Powerlessness: Quiescence and Rebellion in an Appalachian Valley*. In this book the author shows how corporate and structural power has as much to do with preventing decisions as with bringing them about. Gaventa shows the linkage between state and corporate power and examines the "culture of silence," powerlessness and loss of natural resources experienced by workers and other residents of Appalachia.

FISHING WITH ATTITUDE

Thus far we have argued that natural resources educators consider adopting the principles of innovative learning, have regard to the possibilities of and pitfalls associated with the collapse of boundaries (between face-to-face and off-campus education) nested in the notion of distributed learning and, most important, produce program content and pedagogy that reflects a theoretical perspective broader than the "scientism" of functionalist ideology and theory.

Natural resources education must embrace a broader array of perspectives and phenomena. A focus that reaches beyond a functionalist perspective would draw less on curriculum materials (typically contained in ring binders, lecture notes and handouts) and more on the individual and collective experience of learners. Excellent case studies are available and a theoretically expanded approach to education would spawn programs and approaches that are experiential and participatory and likely involve exploration of issues pertaining to class, race, gender, culture and other aspects of power and ontology.

"Natural resources" means one thing in the U.S. and something different in Canada and other places. However, fishing is on everyones plate. Some of the most acrimonious discussions concern the need for international action to save species and, in Canada, a way of life that goes back 500 years. Although fishing and over-fishing differ from place to place, most folks are aware it is a problem. Teaching about fishing involves much more than natural "science."

Fishing is currently the lead-issue in B.C. politics[3] and the author knows something about it. Hence, if we agree that functionalism has limitations and, as university teachers, want to cast a bigger net - sufficient to reach humanist, radical humanist and radical functionalist perspectives, what would pedagogy look like? To bring the foregoing analysis down to sea level we now visit four classrooms with different teachers in each.

Functionalist Fishing

Despite the fact commercial fishing is a contested matter involving claims from different nations, aboriginal groups, local and foreign fishers, when taught from within a functionalist perspective, it is rendered as a matter for "science." After scientists find "the truth" politicians will be advised and encouraged to make the "right' decision based on "the facts."

The functionalist teacher will have heaps of "data" - much of it from corporate, government and university sources - give erudite lectures and, using technologies, shows "facts" pertaining to different species, migration patterns, catch rates for different gear types and, for extra fun, graphs showing pesky problems caused by El Nino. Education is a based an a "transportation" or "banking" model. There is a body of information to be moved. "Facts" will be communicated, probably through a lecture, with the occasional video or guest speaker to liven things up. The participants are passive, their views are not relevant.

The teacher is the expert; the learners are passive recipients of information and "knowledge." The First Nations learner in

the back looks uncomfortable but had better know "the facts." The women also look unhappy. But these are scientifically-derived "facts" and what different kinds of learners might think is beside the point. The "facts" are legitimate because people who gathered them all have research grants and Ph.D's. Fishing is akin to "going to war." Although nobody says so, there is a sense in which fishing is a "man's world."

If this teacher was told "there's more to it" he or she would likely say "I just teach the facts … this is 'tested' knowledge …. Are you suggesting I start stating my own opinions … pretty soon I'd be into politics." However, this teacher is already deeply immersed in politics of the kind that support extant power relations. The insistence that "facts" are neutral, benign or derived from science ignores the context and power/knowledge 'regimes of truth' nested in his or her discourses. Moreover, their wagon is hitched to modernism and the widely-disputed notion that "enlightenment" and "progress" can be wrought from science. Since World War II the modernist project has become an increasingly ramshackle wagon and some of the most stunning intellects of the late twentieth century (e.g. Foucault, 1977; Miller, 1993) claim the wheels have already fallen off.

Humanist Fishing

Same classroom, different teacher. According to this teacher the fishing "problem" stems from the male proclivity to try and "subdue" or "conquer" nature. Considering fish as objects to be "harvested" reduces them to mere economic units. In this class, learners work on case studies, make visits and get to meet indigenous and other people who regard fish as more than an economic unit to be harvested.

If this classroom was in British Columbia, Alaska or Washington State the teacher would have learners read books like Drucker (1965) *Cultures of the North Pacific Coast* about the meaning and significance of First Nations fishing rituals and rhythms. As well, they'd examine Hutchison's (1950) landmark volume about a fishing river *The Fraser.* They might also look at Blyth's (1991) analysis of B.C. salmon canneries and their meaning for coastal life. For an understanding of what fishing means to the fisherman the student could learn from Iglauer's (1992) charming study of *Fishing With John,* Jensen's (1995) *Saltwater Women* and Haig-Brown's (1993) lavish *Fishing For A Living*. Apart from reading which is a solitary activity, learners would do projects wherein they develop an appreciation for multiple meanings ascribed to fish and fishing.

Radical Humanist Fishing

"Scientism" doesn't occupy much space here. Learners come from contrasting backgrounds and struggle to establish the legitimacy of different viewpoints. They variously come from coastal First Nations, Balkan countries, Scandinavia or, has been the case in B.C. in recent years, Vietnam and other Asian countries. Whilst the learners and the teacher ascribe different meanings to fish and fishing (the ontology axis), they are committed to change (the power relations axis).

The present situation cannot continue. From within this theoretical perspective, change will not be wrought from a full-frontal attack on fish companies or government. Rather, the purpose in this class is to critically reflect on the nature of the problem and then, with new meaning perspectives in place, organize for action. The operative word is praxis (reflection + action).

To the outside observer, this is the most interesting of the four classrooms. Most talking is done by the learners not the teacher. The teacher appears to act as facilitator. Learners work in groups and use cards, sheets of paper or other devices to make varying responses to questions or tasks set by the class or teacher. When it comes time to report back to the larger group the teacher probes for the deeper meanings that lay behind the drawings, words or stories presented. There do not appear to be any right or wrong answers - only varying perspectives on the problem. Most importantly, the teacher is respectful and inclusive. He or she ensures all points of view are recorded and analysed. The learners are animated, active and appear to be enjoying themselves.

Mr. Nervous is disturbed when, about half way through this activity the teacher asks learners to elaborate a plan of action based on their earlier analysis of and reflection on the problem of fishing. One is heard to say that it is not the role of the university to encourage "politics" or action. However, a companion reminds Mr. Nervous that this class is being "taught" (i.e. facilitated) from with a radical humanist perspective.

"Well …. who does he think he is …. Paulo Freire?" snorts Mr. Nervous

"Very likely," says the friend

In this course the learners would deploy participatory techniques to learn about community control of natural resources. If in Canada there would be examination of the Evangeline Cooperative (Wilkinson and Quarter, 1996) on Prince Edward Island, the Antigonish movement in Nova Scotia with its charismatic leaders (Lotz and Welton, 1997) and, in B.C. the *Pacific Coast Fishermen's Mutual Marine Insurance Company* (Sorbo, 1995).

Radical Functionalist Fishing

In this classroom there is a focus on the "objective facts" of fishing. But they are not the same as those shown in the functionalism class. Instead, the focus is on corporatism, who owns what, a history of appalling labour relations, the mistreatment of workers, attempts at union busting, the misuse of foreign workers in fish-packing houses and "rape of the sea."

The instructor is heard to say the fishery is being destroyed by predatory capitalism. But despite the fact the instructor calls for the emancipation and empowerment of workers, smaller family-owned fishing vessels and elimination of "vacuum cleaner" company owned draggers, trollers and seiners, the teaching techniques are like those of the functionalist. [Some of the most oppressive teaching techniques are deployed by those espousing emancipation].

However, the reading list is provocative and there is much from a union or workers point of view. For these authors there's much more to fishing that catch-rates, gear types and objective science. There are readings from Marx, Habermas (1971), critical theorists, historians and political economists, First up is Meggs (1995) *Salmon: The Decline of the British Columbia Fishery* and Meggs and Stacey's (1992) *Cork Lines and Canning Lines,* a critical study written from a political economy perspective. Next is Glavin's (1996) *Dead Reckoning: Confronting the Crisis in Pacific Fisheries*. In the foreword to this critique of fisheries science and expose of political fumbling, environmentalist David Suzuki bemoans "alarming signs of environmental degradation" and says it is "clear that the economy and social issues are inextricably inter-twined." This is not news for natural resource educators but, in this course, the instructor persistently foregrounds the issue of power and focuses the teaching on who is doing what to whom and "who benefits?"

In the groupwork and case studies examples are drawn from local struggles but filtered through a neo-Marxist or critical theory lens. There are special efforts to include the voices and perspectives of marginalized groups typically "written out" of university coursework (e.g. indigenous people, women, workers). The focus is more on material facts than subjective constructions or meanings ascribed to fishing. However, like in the radical humanist room, an action plan is developed.

CONCLUSION

Natural resources and their management lay at the centre of political debates all over the world but particularly in large countries with resource-extraction economies. As such, numerous interests are involved, there are many competing claims and it is not possible (and nor should it be) for natural resource educators to take refuge in protection afforded by the dubious "certainties" and "truth" of positivist science. Universities are changing. Although change can be scary and debilitating, it also presents opportunities to practice a more engaged, participatory pedagogy.

In this paper we have argued that because tomorrow will not repeat yesterday or today there is a need to supplement maintenance learning (the learning of fixed rules for recurring patterns) with what the Club of Rome called innovative learning. Innovative learning involves anticipation and participation. Next, we showed how distributed learning is leading to a breakdown of the distinction between face-to-face (on-campus) and off-campus education. We welcome the Web but question the extent to which it will democratize education.

Lastly, we claimed that education about natural resources is political. We questioned the hegemony of functionalist discourse that constructs pedagogy in most natural resource departments. We showed how this discourse, with its recourse to "science" and "facts," is also political. For the purposes of this argument we deployed a model where "power relations" were in a vertical and "ontology" in a horizontal axis. Four world views are nested in the zones of this map..

We did not say functionalism should be ditched but suggested natural resource educators deploy a broader array of theoretical perspectives than is the case at present. Constructing pedagogy within the framework of humanism, radical humanism and radical functionalism produces contrasting perspectives concerning program content and teaching techniques. We illustrated how program content and teaching techniques by visiting classrooms where the teaching/learning process was informed by one of the theoretical perspectives canvassed here.

We expect a bimodal response to this analysis. For one group, it will be disturbing and even repugnant to contemplate the depth of engagement implied by the three alternative perspectives. But, in natural resource education, functionalism no longer exerts the authority it once had. Another group will share our apprehensions about how much "progress" that can be wrought from further fine-tuning of a functionalist perspective.

Many natural resource educators already deploy a participatory, respectful and engaged pedagogy and have willingly embraced subjectivist ontology. Exciting pedagogy resides in the alternatives and high levels of satisfaction can be derived from trusting learners, involving them and foregrounding their perspectives on power relations and reality (ontology). Moreover, an embrace of the future (innovative learning) replaces perambulations about the past and is probably a necessary corollary of planetary survival.

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[3] Roger Boshier was a New Democratic Party candidate in the 1996 British Columbia elections. "Fishing" was at the centre of what turned out to be a closely fought election campaign where the NDP prevailed with a slim majority.

[4] New Society Publishers have a large catalogue of books broadly framed by a Humanist or Radical Humanist worldview. P.O. Box 189, Gabriola Island, B.C., V0R 1X0, CANADA [http://www.swifty.com/nsp/]

NEW IDEAS FOR TEACHING NATURAL RESOURCES MANAGEMENT: IMPLICATIONS OF, AND RESPONSE TO, THE FEDKIW PAPER

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ABSTRACT: The ideas presented in the paper and emerging book by John Fedkiw have some interesting implications for college-level education. Several questions are raised by his paper and the book. This response, or companion, paper discusses these questions and offers some suggestions for incorporating the ideas into coursework. The questions discussed are as follows: 1. How different are the ideas from those presented in contemporary college-level natural resources teaching? 2. Given that there are some important differences, how can these ideas be incorporated into higher education? Several alternatives appear, namely, as specific courses, as topics in ongoing courses, as examples, or as a reorientation of thinking across all courses. 3. Is this the time to argue for a specific forest history course? 4. What are the advantages and disadvantages of a functional versus a technical definition of forestry and forest management in the context of higher education? 5. What are the implications of the new ideas for courses in forestry for nonforestry majors, such as liberal arts or environmental studies majors? 6. What teaching methodologies might be appropriate here? The entire forestry profession has been struggling to define ecosystem management and to develop ways to teach it. Fedkiw might suggest that we do what we have been doing. He might argue that the USDA Forest Service has been practicing ecosystem management in an incremental fashion all along. Foresters responsible for it were a product of the forestry colleges. The paper and the presentation will attempt to be provocative and stimulate further discussion and thinking rather than offer precise solutions for higher education.

INTRODUCTION

Dr. John Fedkiw has presented some very interesting and potentially far-reaching, ideas in his paper and the forthcoming book on which these are based. We are intrigued by these ideas and offer a response by two long time forestry educators.

College education for the professions embodies different kinds of education. Within courses there are specific techniques, theories, principles, applications, and examples presented and examined. However, across courses and threading through curricula are the underlying philosophy, theory, and dogma that gives a particular profession its overall character and uniqueness. Finally, underlying the entire educational program are some basic understandings about the nature of and means to structure, the profession; in the present case the profession of forest management.

Fedkiw presents three ideas namely:

- a functional rather than a technical definition of forest management,
- the important learning experience accompanying management,
- the movement along a pathway toward a fully holistic approach to managing forest resources and their e cosystems.

These ideas have some particular relevance within specific courses, however, we see the biggest influence in how the overall forest curriculum is structured and presented, and the underlying definition of the profession. These ideas cannot be fully implemented without further discussion and elaboration. In addition, there are several critical points that need to be reexamined.

THE FUNCTIONAL DEFINITION IDEA

Fedkiw redefines forest management as Fitting and maintaining multiple uses and services into ecosystems according to (1) their capacity to support them (2) compatibility with other uses on the same or adjacent lands, and (3) in ways that assure the permanence of the uses, the resources, and their benefits for future generations. Remember

that Fedkiw's experience is primarily as an active observer and critic of public forest management, particularly the National Forests of the USDA Forest Service. Does this definition pertain to other lands? Can industry and private nonindustrial owners subscribe to this definition? Is the definition meant to be global, or pertain just to the U.S.? This definition is certainly in line with current thinking about landscape-level planning and management but why does the private owner have a responsibility across property lines? Or is this just a responsibility of the forester working on those lands regardless of employer? Given that forestry is becoming more inclusive in its mission, is this definition really or just a restatement of what is felt to be the current definition? The definition seems to carry with it the same problems as present definitions, namely, how to implement it. That is, do we view this definition as applying on each acre, each ownership, or across landscapes? This has been the age-old problem with other concepts such as sustainability, ecosystem management, and multiple-use management.

One implication of this new definition is that perhaps forestry education should be reoriented from its historic emphasis on science and planning to uses. Perhaps core courses should be timber harvesting, downhill and cross country skiing, camping and hiking, how to hunt more effectively, etc. It is increasingly true that the majority of forestry students come from urban areas, and even if from rural areas, have very little experience in actually participating in the "uses" of the forest. How can they manage without direct knowledge and experience in the uses for which they are managing? This same criticism is often leveled at counselors and the clergy, namely, how can they work to solve family problems if they have never been a parent, etc. Finally, it should be noted that the forestry profession, over its almost 100 years in this country, has often attempted to develop a definition that fits with the nonEuropean conditions we have in America.

A second implication of this new definition for education is that we should teach management and not holistic overall planning. This flies in the face of much current rhetoric and discussion on ecosystem management. However, the emphasis on holistic planning gives the student the impression that this is actually how it is done, instilling a philosophy that is at variance with actual practice, as Fedkiw amply shows. On the other hand, the profession believes we should think holistically. How does this functional definition get us there?

Concentrating on uses rather than planning further raises the question as to whether or not forestry education has responsibility for teaching "What is the proper way of managing forests?" Getting away from this would change students perceptions that there is something like "Good silviculture," or "Good economics" when in truth these are just subjects that can only be taken in the context of a particular situation. Nevertheless, we have all heard students, and professional foresters, use these terms in trying to justify their own actions or criticize those of others. However, if students are not given some ethical background they will either fall back on their own pre-educational biases and perceptions, or have no sense of right or wrong.

Fedkiw argues that a clear functional definition would help clarify the debate on optimum levels and combination of uses and environmental services by focusing policymaking on uses and ends rather than on management, and we would add, process. We applaud this reason for a functional definition. Much, if not most, efforts by public foresters at present are aimed at process and completing forms, environmental impact forms, checking for endangered species, etc. not, we would argue, primarily for their effect on~the use of the area but to comply with some regulation to forestall litigation and shutdown of their forest operations. However, it is precisely the process that can be attacked, not the direct use. It is the method of reaching the decision that is subject to question. This is a long held principle of litigation. If you do not like an action, you attack the process. Changing the definition will probably do little to change this. People will continue to attack process and American forest management will continue to be mired in court cases, appeals, injunctions, and stop-orders. Perhaps what is needed is a reorientation of education to give students the overall philosophy that rules and regulations are not procedural but substantive. This however, may require a change of philosophy by the educators themselves. How many of us feel the EIS is a necessary planning tool, or that the Endangered Species Act can be helpful as opposed to being just another hurdle to conquer in pursuit of what we "know is good forest management?"?

Finally, Fedkiw suggests that perhaps the time has come for reconciling the conflicting perceptions and to recognize that the harvest and removal of trees from time to time is a normal and productive management practice in managed, healthy forests. But what is a healthy forest? We tend to agree with Fedkiw on this point but if so, then it raises a much more fundamental question, namely, to whom should forest management be taught? Indeed, a major conclusion we come to after studying these new ideas of John, is that we are teaching forestry to the wrong audience. Instead of concentrating on professional foresters we should be educating the public, special interest groups, the masses! (Hereafter we will use the term "the public" to include all persons other than students in resources management programs and professional forest managers.)

THE LEARNING EXPERIENCE IDEA

A very important point made by Fedkiw is that his examination of how forest management evolved over time gave him a different perspective on the current situation and what has happened. He further elaborates on the different philosophies surrounding public forest management over the last 100 years. The implication for education of professional forest managers, and the public also, is that we should teach

more history. Dr. Ernest Gould, long-time forest economist and educator at the Harvard Forest, often said that the most important thing we could give students is a sense of history. He advocated teaching many subjects, including forestry, from the viewpoint of history. We would do well to consider this in further discussion.

The example of predator control, and by implication fire control, is presented by Fedkiw to illustrate the changing views on proper forest management. However, John does not point out that while the public learned the first lesson very well, that predator control was good, foresters never used the same public relations and Madison-Avenue approach to preach the second lesson, namely, that predator control was not good! It is often the public's perception that affects forest management, not the professional forester's education. Foresters must be educated to deal with perceptions and values and the everpresent fickle and changing public. A small point, perhaps, but we wonder what John means when he refers to changes in management in favor of more desirable elk behavior?

"Learning to do it better" and "Adaptive management" are terms that are put forth in John's paper. These terms certainly apply in the dynamic field of natural resources management. However, a strong implication for college education in forest management is to emphasize for students that much of what they learn today will be outdated! Wow. This is a major "Catch-22". On the one hand we want students to be attentive and learn diligently. On the other hand we want to impress them that the world is constantly in a state of learning and that they will have to constantly learn. This conflict makes for very interesting arguments by students as to why they should work on any unpleasant or time-consuming assignments. How do we handle this? Perhaps the answer is to revise the entire curriculum from its present emphasis on concentrating on learning material, to, instead, a concentration on how to learn, how to acquire new learning, and how to put that new information into practice. This is quite a different approach to our current practices. We would like to know how the medical profession handles this, for here is an area that is rapidly evolving and changing. There has been talk and attempts to incorporate more problem-analysis and problem solving in education. However, given human nature, and that of forestry students, the students really seem to pay attention when some directly relevant technique or local example is discussed, in spite of the fact that the approach may be already outdated.

In this section of the paper Fedkiw offers an answer to the question we posed earlier, namely, whether or not forestry education should include anything on "What's proper?" He says that more explicit emphasis on the unending learning component of forest management can produce more perceptive and effective forest managers and also produce a more constructive framework for a collaborative stewardship approach versus the unending debate as to what constitutes the proper use. Perhaps it will, in any case what harm is there is trying?

THE PATHWAY TOWARD A HOLISTIC APPROACH TO FOREST MANAGEMENT IDEA

Fedkiw contends that, "National forest management has always been on a pathway toward a fully holistic ecological approach to resource management—or ecosystem management.. He alleges that this has also been true of all professionally planned forest management generally "by virtue of the concern and emphasis of professionally trained foresters on sustaining wood flows and assuring waterflows." If these statements are true, why then have there been so many claims that foresters have not taken a holistic look? Is the emphasis on timber? We think not, for now foresters are being accused of not even sustaining the wood flow. We as foresters and educators may believe Fedkiw's statements but unless the students and the public also believe it we will continue to be mired in false claims and uphill fights with our many adversaries (including many students in our programs and especially in closely related environmental studies curricula.) Perhaps forestry was not on a pathway to holistic forest management but merely reacting to political and public pressures of the time—pressures that emphasized first this then that particular use or concern from fire control to water quality to wood flow to sustainability.

We do like and fully support Fedkiw's statement that, "It is impossible to achieve fully holistic management of forests and natural resources in one great leap since uses grow and change incrementally use-by-use, site-by-site, year-by-year, decade-after-decade.'' However, he goes on to say that "We do not have the science yet for fully holistic ecosystem management...nor do we have the institutional framework for managing...across multiple ownerships that constitute ecosystems" To this last statement we respond that we will never have the science fully in hand because, 1) new information and techniques will be constantly evolving, 2) changing uses and shifts in supply and demand will always occur, and 3) the very nature of the U.S. political and social structure favors private property ownership and many individual rights that work against strong centralized decision-making. Thus although we disagree with some of the contentions, we agree with the final statement that "The ecological approach to forest and resource management will continue to be incremental and adaptive as it has been in the past."

CONCLUSION

In conclusion, the ideas embodied in the paper and book by Dr. John Fedkiw are not specifics that can be incorporated into any one course for a "quick fix". Instead they are philosophical concepts that must be examined and discussed. To implement

them may require a departure from traditional biases held by many of us. The ideas also suggest much more education of the masses as to what forest management is-or is this just our imposition of our incorrect perceptions on a world that has already been subjected to many incorrect perceptions? Perhaps we are like Lewis Carroll's Cheshire Cat. When all else is removed there is nothing left but the smile—or is it a sardonic grin.

FISH BRIEFS AND BUCKETS OF FISH: CONFORMING ICHTHYOLOGY TO NEEDS OF STUDENTS WITH NATURAL RESOURCE CAREER PATHS

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ABSTRACT: Traditional ichthyology courses often focus on objectives related to fish evolution and skills required for museum work. Students in natural resource disciplines often perceive these objectives and skills as having little relevance to their future careers. In some ichthyology courses, memorization of fish taxonomy and phylogeny may outweigh emphasis on the development of critical thinking skills. Guided by objectives to develop critical thinking and information gathering skills, we have developed two instructional methods that incorporate the practical needs of students in natural resource disciplines without sacrificing important subjects in the ichthyology course offered at Michigan State University. The first method consists of a requirement to write two brief papers (500 words or less) that address a specific question of interest to the student. The objectives for this assignment are to develop professional skills involving information retrieval and interpretation and to write a concise, but thorough product. Students are given specific requirements for format and information quality, and are provided assistance in focusing the question so that it is answerable in a brief format. First drafts go through a peer review process to check on aspects of clarity, conciseness, and completeness and students may incorporate the comments and revisions in the final draft. In the second exercise, Buckets of Fish, students are presented with specimens from the Great Lakes fauna (100 species) and are assigned to learn to identify these species with identification keys provided by the instructor. They have four laboratory periods to study specimens and then four examination periods to demonstrate their proficiency in identifying a collection of these species. In the examinations, students work in two-person teams and have one laboratory period to identify a collection of fish specimens in a jar of unknowns. This exercise is meant to simulate the experience of bringing a sample of fish back from the field and then identifying the fish in the sample. Student proficiency in identification increases through the examination series. In both of the instructional methods, the relevance and focus of the assignment generated greater student interest in learning information basic to an ichthyology course, and developed critical thinking and technical skills needed for students directed towards research or natural resource management career paths.

INTRODUCTION

Natural resource professionals require a solid foundation in the biology and ecology of the organisms that form the basis of renewable resource use and management. Most fisheries and wildlife curricula require students to complete at least one advanced course in the study of a group of vertebrates. Traditional ichthyology, ornithology, mammalogy or herptetology courses focus on the anatomy, physiology, behavior, systematics, distribution and evolution of the targeted vertebrate group. Laboratory exercises typically emphasize skills required for museum work at the expense of field skills (*cf.* Caillet et al. 1986). Detailed morphometrics and meristics exercises, and quizzes over taxonomy and species recognition can be tedious and repetitious, and students in natural resource disciplines often perceive these skills as having little relevance to their future careers. Similarly, emphasis in lecture on memorizing phylogeny and the finer points of biogeography may outweigh an emphasis on the development of information gathering and critical thinking skills which are needed for careers in natural resource research or management.

In response to repeated requests from natural resource students to make ichthyology more relevant to their interests and career aspirations, we have incorporated several new techniques in the ichthyology course offered at Michigan State University. These adjustments were intended to meet the objectives of challenging students to develop skills that they want to develop, and to do so in a way that is appealing to the students, and does not sacrifice the content needed in a course on the biology of fishes.

In particular, we were interested in techniques that would develop information gathering and critical thinking skills in connection with the lecture portion of the course, and fish identification skills in the laboratory portion. These are in contrast to exercises that we used previously that emphasized

memorization of information dispensed in lectures and memorization of distinguishing traits of fish species, along with their common and scientific names and their habitat requirements. We were guided in part by research that demonstrates that testing formats which emphasize understanding and self-motivation rather than memorization of details lead to better retention of learned information (Marton and Saljo 1976).

INSTRUCTION AND ASSESSMENT METHODS

Ichthyology (Fisheries and Wildlife 471) is a four credit semester course at Michigan State University. The class meets for three 50 minute lecture/discussion periods and one 170 minute laboratory period each week. As a 400-level course, it draws junior and senior level undergraduates and some graduate students. Most students are pursuing majors in Fisheries and Wildlife or Zoology.

Fish Briefs

The exercise that was intended to develop information gathering and critical thinking skills is called "Fish Briefs" in the course syllabus, and consists of a requirement to write two brief papers (500 words or less) that address a specific question of interest to the student. This is designed to simulate a work-related situation in which a citizen calls the local fish and game agency office and asks a specific question about fish. The circumstances might be a junior high school student who is pursuing a potential science fair project, an adult who is trying to settle a debate with a fishing buddy, or a television viewer who believes that some nature program has just transgressed the truth of nature.

Students are given a list of over 100 questions from which they may select their choice for the assignment. They may also pursue a question of their own interest, providing the instructor gives prior approval based on its relevance and conciseness. The questions are divided into two categories: organismic or evolutionary/ecological, and are wide ranging in topic (Table 1). Each student is required to submit one brief on a question from each category. The two briefs account for 17% of the course grade.

Table 1. Examples of questions for Fish Briefs exercise.

Organismic Questions:
How do scales influence the swimming efficiency of fish?
What is the function of the axillary process in herrings and salmonids?
Which is the more hydrodynamically efficient form of ventilation, ram or buccal ventilation?
Evolutionary/ecological Questions:
Do bluegills select prey on the basis of actual prey size or apparent prey size?
Why is parental care exhibited by males in more species than by females?
What has caused the rapid extinction of so many cichlid species in Lake Victoria, Africa?

Students are given instructions in how to research questions such as these by use of primary and secondary scientific literature. Each brief must cite a minimum of four references, two of which must be primary sources. In addition, the briefs are evaluated on the basis of accuracy in representing the literature, completeness in addressing the answers likely to be found in the literature, and conciseness (no more than 500 words). Format, sentence and paragraph structure, and grammar are considered in the grading, but are weighted less that the other four criteria.

Students participate in a peer review process before submitting their brief for evaluation. They use a review form to structure the process, after the instructor describes the process, rules of conduct, and criteria for guiding the review (Table 2). Reviewers are required to summarize their review with three constructive recommendations, and authors are required to respond to these recommendations in a form that accompanies their final draft. They may incorporate the comments and revisions from the peer review into their final draft, or may decline to incorporate them, but they must explain their reasons in the event that they decline to follow their reviewer's advice.

Table 2. Framework provided for students using the peer review process to preview Fish Briefs.

A. Purpose of the Review Process
To provide second view on and improve structure & organization content assessing : completeness, conciseness, accuracy, authoritativeness, analysis, and logic.
B. Rules of Conduct
1. Provide constructive criticism, respect the author's work, and assume credibility
2. Ask questions rather than giving answers
3. Suggest alternatives
4. Provide at least 3 recommendations for improvement
5. Do not plagiarize
C. Protocol for Review
1. Use groups of 3 for review and proceed in a round-robin fashion
2. Read paper thoroughly first, then go back and review
3. Present review to both the author and third person in the group
4. Complete all 3 presentations for the group

5. Write down the 3 recommendation on review and return to author

D. Protocol for the Author's Final Draft
   1. Consider and address various comments of the reviewer
   2. Make necessary changes, including additional literature review if necessary
   3. Address the 3 recommendations on the provided review form
   4. Turn in the final draft and the review form but not the rough draft

Our evaluation of the Fish Briefs exercise consists of observations from 8 years of using this exercise, along with comments from student evaluation forms completed at the end of each term.

Buckets of Fish

The Buckets of Fish exercise is designed to develop fish identification skills in a setting that simulates a common task for a fisheries biologist in the field: identifying all of the fish in a sample taken from a lake or stream. Students prepare for the exercise in a series of four laboratory sessions. The purpose of these sessions is to introduce students to the diversity of the Michigan fish fauna, and to give them practice with the identification tools that they will use in their quizzes. Students also have practice quizzes to use in testing their skills during the period. The practice quizzes are small collections of 12 – 16 fish that represent a variety 5 – 8 species. They can receive answer keys to the practice quizzes after completing the quiz. After the four survey laboratory sessions, students have a quiz in laboratory period in each of the next four weeks. Students work in two-person teams on the quizzes, and teams remain fixed for the four quiz series. For the quiz, each team is given a bucket of preserved fish specimens, and is assigned the task of identifying all 30 fish in the bucket. The number of species in the bucket ranges from 10 to 17. Teammates must work together, but they have the option of turning in separate and disagreeing answer sheets. Students are allowed to use their notes and keys, as well as any other reference book in the laboratory classroom. The answer sheet must consist of the scientific name (spelled correctly) of each species and the number of fish representing that species in the bucket. Family names are required for each species as well. Each fish in the bucket is worth 1 point, but to earn that point, the family name and species name must be completed.

To evaluate the Buckets of Fish exercise, we present data on responses to questions on a standardized University student evaluation form and on student performance on quizzes. In both cases, we compare results from years when quizzes required students to memorize fish identity and nomenclature (1992-1994) with years when the Buckets of Fish quizzes were applied (1995-1997). In addition, we tested for increased competency with experience by comparing mean quiz scores for the class from the first to the second and last quizzes of the series in each year.

RESULTS

Fish Briefs

The Fish Briefs exercise has been an effective means of developing students' information-gathering skills, critical thinking skills, and their writing skills. The information-gathering aspect has been particularly dynamic over the past eight years. Each year, the guide to finding information in the literature has required revision in order to accommodate new technological tools for finding information in scientific literature. From 1989 to 1997, the guide has changed from being strictly a guide to use of card catalogs and published abstracting services to a guide for use of CD-ROM, World Wide Web-based searches and other technological aides.

Critical thinking is required of students to evaluate which materials are pertinent to answering the question, and to discern between alternate explanations. They feel compelled by the context of the assignment to have a single answer to the constituent's question, yet they dare not overlook the multiplicity of explanations available for fear of being graded down on completeness. The peer review process and feedback from the instructor help to further develop the students' abilities to evaluate alternate answers to a question.

By far, the greatest challenge to the instructor in this assignment is the need to grade and provide useful feedback to students in a timely manner. In particular, students seek feedback quickly so they can incorporate instructor suggestions in their second brief assignment, which is due four weeks after the first brief. Students address this in their comments on course evaluations at the end of the semester, and frequently state that they would have learned even more from the assignments with faster return of their graded assignments.

Aside from the timeliness of feedback, most student comments on the Fish Briefs are positive. Comments collected from 113 students from 1992-1996 regarding the fish brief assignment ranged from a single critical comment:

> "....this is a 400 level course, by now we know how to use the library, find journals, etc....."

to dozens of positive comments, such as:

> "The fish briefs are good and two is a good number."

> "The fish briefs were work, but really a good way to learn to use the library resources... Having to research subject matters is a good way to learn...most of that information will stick."

"Fish briefs were very good learning exercises"

"The library assignments (fish briefs) helped me a lot with learning the library, although at times it was a pain"

"Fish briefs greatly advanced knowledge of research techniques"

Buckets of Fish

Student performance on fish identification quizzes improved after adoption of the Buckets of Fish model. Quiz scores from the years 1992-1994 (pre-Buckets), standardized to a 100 point scale, were significantly lower (82.43) than in the years 1995 – 1997 (Buckets), 88.61 (t = -2.708, d.f. = 27, $p < 0.01$). The variance of scores for the pre-Buckets years was nearly twice that of the Bucket years (49.55 vs. 29.43), largely due to the fact that most teams submitted one set of answers for the team, rather than splitting their answers apart. Furthermore, students showed definite improvement with experience in the Buckets of Fish model, but not in the previous model. The mean difference between the first and last quiz score in the series was 0.53 in the pre-Buckets period, but increased to 6.52 in the Buckets period. Much of the improvement during the Buckets period was between the first and second quiz, when scores increased by 4.11 points.

Another indication that student performance improved with experience in the Buckets period is the decrease in the time needed to complete the quiz from the first to the last quiz of the series. We only collected time data on quizzes in 1997. The mean time to complete the first quiz was 134.1 minutes and for the last quiz the mean had dropped to 101.1 (t = 2.653, d.f. = 24, $p < 0.01$).

Student comments about laboratory quizzes were much more positive in the Buckets period than in the pre-Buckets period. Students clearly disliked the pre-Buckets quiz format, and indicated in a few representative comments from course evaluation forms:

"I thought the lab quizzes were not very helpful in learning about fishes. The material was forgotten 5 minutes after the quiz, and they were hard. I did learn general families and genuses, but I doubt I'll remember many species"

"I did learn a lot about identifying Michigan fish, but I find that I have trouble remembering fish from the 1st few weeks of class. I guess studying for a quiz every week did not encourage me to put the information into long term memory"

"The only comment that I have is that there was too much emphasis put on memorizing the huge Michigan Fish fauna. I think the lab could do with less memorization of these fish."

"The way lab is currently run, emphasis is placed on short term memorization of species names. I myself serve as an example of this- I would estimate that I remember less than 20% of the fish that we were required to memorize. ...students should be taught how to key out the fish with priority placed on the recognizing the physiological structures necessary in their identification. Instead, we were encouraged to blindly memorize the minimum amount of information necessary to pass the quizzes."

Comments regarding the Buckets of Fish Exercise in 1995 and 1996 included two critical comments:

"Lab quiz format needs review. Not sure much is learned other than how to key out fish. Not practical for field. Total memorization is not essential but need to learn/memorize a little more"

"I think the lab would have been better if the fish quizzes weren't open book. I would have studied the fish more if I had had to know them".

By far, the comments regarding the Buckets of Fish method were more positive than negative:

"Lab was well done, wish there was more time for descriptions (overview of species). The quizzes were a great learning experience. My grade increased each time indicating that I was learning to key them more accurately. "

"I liked the way quizzes were set up. Avoided memorization of family and species...Important to me because was not required in my degree program)"

"..thought the buckets-o-fish were a great way to learn. They could have been more challenging, maybe a time limit. Out in the field, you really don't take that much time to key out fish. Forcing us to learn family, genus and maybe some species would have helped me"

"I think the fish jar quizzes are an excellent idea. I learned many, many more fish than I had known coming in..."

"I think the lab approach was very successful. It seemed to be more fair to everyone, and more practical. I can now ID most fish quickly by just looking at them. That came about through repetition and using the key. Just memorizing scientific names would not have accomplished this. The lab was a realistic presentation of the species of our region. I feel my knowledge had multiplied exponentially. Whether or not I could stand aboard a ship and call out catch identifications with confidence I do not know. But, even if I could, I'm sure that memorizing this information, it would leave me in a matter of weeks/hours."

In spite of these perceptions of improvement, the overall evaluations of the course did not improve from the pre-Buckets

period to the Buckets period. We evaluated responses to two standard questions on the student evaluation form, "This course increased my knowledge in this subject" and "This course deserves an overall rating of ___?" For each question, students could mark one category from a range of five that extended from "superior" to "below average". Students only used the top three categories across the years 1992 – 1996 (1997 data are not available at time of publication), and the majority of responses were in the "superior" category. The distribution of responses among the three categories did not differ among years for the first ($X^2 = 3.93$, d.f. = 8, $p > 0.10$) or second question ($X^2 = 9.27$, d.f. = 8, $p > 0.10$).

DISCUSSION AND CONCLUSIONS

The Fish Briefs exercises met the objectives of developing information-gathering, critical thinking and writing skills. Students reported that it takes much less time to gather information for their second brief assignment than for their first. In addition, advances in information technology have made the process more focussed on identifying the issues related to the question and less focussed on the techniques of finding articles and books that address the issues.

Kurfiss (1988) argued that "learning by doing" in structured and guided exercises enhance the ability of students to develop critical thinking skills in science-based courses. The Fish Briefs exercise is moderately structured, but allows for individuals to pursue topics that they find interesting. Further, by having a structured set of criteria for evaluation, students are motivated to review their and peer briefs in ways that require higher levels objectives associated with critical thinking, including analysis, synthesis and evaluation (Bloom 1956).

The groups used for peer review were formal groups (Johnson et al. 1991) created for the short-term goal of reviewing group members' Fish Briefs. New groups were constituted for review of the second Fish Brief in a semester. The cooperative efforts required in these groups further refined students skills in critical thinking and writing, and these benefits accrue to all three students involved in the review triad.

Grading of the Fish Briefs was expedited by use of structured criteria for evaluation. Even with this, it is difficult to get feedback to students as quickly as they would like to have it. Providing generic feedback to the class with anonymous examples excerpted from student papers in previous years helps to address students' immediate concerns and allows for the more lengthy process of reviewing and evaluating individual briefs.

One other aspect of the Fish Briefs exercise suggests that students value this approach to learning. The list of questions for Fish Briefs is appended with new ones each year, but old questions remain on the list. As a result, students may write on a question that another student wrote on in previous years or even earlier in the same semester. Yet, we have not documented a single case of plagiarism over the eight years in which we have used this exercise.

The Buckets of Fish technique provided the students with an opportunity to develop and practice tedious but necessary skills in a simulation that gave the experience relevance. McKeachie (1994) argues that simulation can be powerful a tool in learning because it involves students as active participants in the learning process. Student achievement is higher in the Buckets setting than in the previously used setting, and their performance clearly improves with experience. As with Fish Briefs, this exercise uses small groups (dyads) to foster collaboration among learners. The number of fish and the number of potential species for the quiz (104) are great enough that it would be difficult for either individual in the dyad to complete the quiz in the allotted time (170 minutes). By consulting and collaborating together, team members can expedite the work required and can check each other for accuracy in assigning fish to species and checking spelling of names and families.

We have found that the Buckets quizzes exert a greater demand on the collection of fish specimens used for teaching. We need more specimens, and need to replace specimens more frequently than under the previous system. Students handle the specimens more and examine them more carefully, resulting in dried fins, loss of scales, and deterioration of mouth parts, all key traits used in identifying fish. In short, students wear out the fish more rapidly because they use them in the way they should be using them to learn the skills needed for identifying fish.

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TEACHING CORE VALUES: SOME QUESTIONS

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Education, I fear, is learning to see one thing by going blind to another (Leopold, 1966; 168).

That the discipline of agriculture should have been so divorced from other disciplines has its immediate cause in the compartmental structure of the universities, in which complementary, mutually sustaining and enriching disciplines are divided, according to "professions," into fragmented, one-eyed specialties (Berry, 1977; 43).

In 1996 a New York paper carried the following story:

"NEW YORK – A retired firefighter who illegally cut down seven trees in a case of 'premeditated arboricide' was sentenced to 500 hours of community service.

City officials said Andrew Campanile destroyed the trees in Astoria, Queens, to increase the visibility of some billboards.

"Mr. Campanile's crimes constituted arboricide in the first degree, premeditated arboricide,' said Park's Commissioner Henry Stern.

—The Associated Press, 1996"

Just as you may be, I was taken aback by the concept of "premeditated arboricide" – especially since there was an actual legal conviction. But laugh, scoff, or be dismayed, there it is; it happened.

I'm not here today to offer many answers about teaching core values, rather I mostly want to ask questions. First, are we as educators ready to deal, except at a superficial level, with the moral values of the kind that lead people to the ethical conviction that "premeditated arboricide" is a crime? Should we be? Second, are we preparing our students to be able to deal with values: their own, their professions, and those of the many-faced publics? Should we and do we explicitly challenge ourselves, our colleagues, and our students to understand the sources, validity, and consequences of the values each holds?

The Society of American Foresters (SAF) has begun a study of the core values of the SAF and its members, and I will use it as a springboard for discussion of teaching core values in natural resource education.

The SAF Study:

Ethics, particularly land ethics, have been a topic of intense interest to the SAF for at least the last 10 years. Much dialogue and debate led to the adoption of a land ethic canon and other changes in the SAF Code of Ethics in 1992 (SAF 1996; I-1). This was followed by the release of an SAF Task Force Report on 'The Long-Term Health & Sustainability of Forests" (SAF, 1993). This report came out in favor of ecosystem management, and was such a hot issue that there was talk of a group splintering from the SAF and starting a new association of foresters. Beyond questions of the process followed by the Task Force, and the "correctness" of the science in the report – or some claimed the lack of science, I contend that the real issue had to do with the cherished American *value* of private property rights. Coupled with such flash-point items as spotted owls vs. jobs, clearcutting and ecological reserves, the yet to happen renewal/revision of the Endangered Species Act, and other similar media events, the question of ethics and the values on which they are based has continued to be of real importance to foresters and the SAF. It is in this context that the SAF study of core values was initiated. Specifically,

the Critical Issues Forum (CIF) at the 1996 National Convention included in its list of priority items the question, "Given the diversity of cultures and views within the profession, do we have a core set of values we can proactively articulate as an organization?" At the same convention, the House of Society Delegates, a treeroots advisory group in the SAF, recommended that the SAF Council:

- do a study of core values, and
- study the SAF Code of Ethics to determine its current relevance, especially in light of the results of the study of core values.

Since values are the basis of ethics, and since it is part of the charter of the SAF Ethics Committee to monitor and make recommendations on changing the SAF Code of Ethics, this Committee was assigned both tasks. Before looking at the results of the study to date, some definitions and brief remarks about why we should care about core values are in order.

Definitions & Reasons:

As an operational definition, Xu and Bengston called forest values "…relatively enduring conceptions of the 'good' related to forests and forest ecosystems" (1997; 44). Without going into their level of detail, they identified such *held* values as falling into two broad categories, instrumental and non-instrumental. Under instrumental they included economic/utilitarian values – ranging from needs to preference satisfaction – and life support values, such as air, water, soil, flora and fauna, and genes. Under non-instrumental they identified aesthetic values, such as beauty, rarity, and fragility, and also moral/spiritual values such as respect, love, other, and topophilia, or love of place.

Following a content analysis of a large mass of newsprint media stories, Xu and Bengston concluded that there has been "a shift in forest values away from easily defined and measured economic values toward values that are much more difficult to measure and that have often been neglected or ignored" (1997; 55). They also found that foresters had a lower expression of aesthetic and moral-spiritual values when compared to environmentalists, and see this as related to conflict. Do we let our students know such things? Do we let them know that a simple, pragmatic reason for studying values is that we really have no choice, because without knowledge and appreciation of our values and those of others, and without active involvement in ethical discussions, we are likely to march to the beat of drums played by others?

There is another way that values are defined, that is in what we often call ethical principles. These are captured, at least in part, in Oscar Arias' belief that, "As a basis for ethics, love, along with dignity, justice, and equality/freedom, are core values that transcend cultures and are manifest in leadership" (in Kidder, 1994; 271). These, and other values, are usually held in a hierarchical structure, a structure that may change with the situation, thus they often seem to be in conflict. Conflicts between equality and freedom are among the best known examples in policy struggles to meet social goals, especially in dealing with societal values in contrast to individual rights. There can also be conflicts involving a single held value, such as loyalty to an employer vs. loyalty to society.

The SAF study seems to imply something more, because it asks about "core" values. Webster's calls "core" the part (of an individual, a class, an entity) that is basic, essential, vital, or enduring as distinct from the incidental or transient" (1967). The philosopher, John Ferguson, says core values, ".. are values that are not instrumental to some greater goal but are good in themselves… A core value is something for which no quantity of any other value will compensate its loss," as in "We hold these truths to be self evident" (1997; 1).

For a professional society such as the SAF, a core value can thus be seen as a value that is central to practice, that is enduring, and that does not need justification on the basis of how it can be used but rather is good in itself. Do we know what these values are in the various natural resources professions? Do we specifically set out to teach them?

Each of us has a personal value system, but core ethical values transcend individuality and even differences in culture, religion, levels of socio-economic status, and ethnicity. This becomes evident in looking at international agreements. In discussing core values for sustainable development, Arthur Westing, an environmental consultant, said that "The cultural norms or core values for sustainable development are an amalgamation of core social values and core environmental values" (1996;218). By analyzing United Nations and other international agreements, Westing suggests that these core values include:

<u>Core Social Values</u>
* all humans are born free and equal in dignity and rights
* right to life, liberty and security of person
* right to participate in government to a standard of living adequate to health and well-being of the person and his/her family
* right to education (free, compulsory elementary education)

<u>Core Environmental Values</u>
* an environment of a quality that permits a life of dignity and well-being
* solemn responsibility to protect and improve the environment for present and future generations
* education on environmental matters to create enlightened opinion and responsible conduct
* in formulating long-term plans for economic development, due account shall be taken of the long-term capacity of natural systems
* nature shall be respected and its essential processes shall not be impaired

What kind of education will natural resource professionals need to be able to work effectively in a world undergoing a transition in core values, a transition wherein the value problems of natural resources management are becoming more and more closely related to the value problems of just relationships between persons, societies, and the land, even while recognizing that what is said is important, but what is done truly tells the story. A brief report on the SAF study as completed to date reveals some interesting things regarding forestry core values.

The SAF Study of "Core Values"

The major effort of the SAF Ethics Committee to gather data of SAF core values was at the 1997 Critical Issues Forum (IF). The CIF did not employ a high-powered research design, thus it has limitations. It was, for example, a self-selected sample of SAF members in three ways: first, those who came to the convention; second, those at the convention who chose to attend the CIF; and, third, in the case of what is reported here, those who chose to turn in an individual response form to a set of questions. Still, there were approximately 370 members involved in the roundtable discussions, and 276 of them handed in the personal form. The following set of results covers the first two questions of the individual response form[1].

Question 1. What attracted you to the profession?
Responses fell into three general categories:

1. *The land*: 66 respondents said it was their love of the land/forest/nature/environment that attracted them to forestry; 16 focused on their love of trees; and 35 used words such as "enjoy", "interest" and "appreciate" to describe their attraction to forestry. The single biggest response was the 96 who said that they wanted to work either in the forest, on the land, in nature or the environment. These closely related responses make it fair to say that over 200 respondents specifically noted their love of and desire to work in the forest as something that attracted them to forestry.

2. *The forestry profession*: 42 respondents noted that it was the chance to manage/ conserve/protect/take action on forests that attracted them to forestry, while 19 noted the diversity, multidisciplinary nature and the opportunity to provide multiple-uses inherent in forestry that gave it appeal. Twenty-two were attracted by the notion of working with renewable/sustainable resources. A variety of other items were noted, but significantly less frequently (e.g., uniqueness, service, aesthetics, God's creation, wildlife, etc.).

3. *Personal history*: In part, this category refers to "who" or "what" got the individuals interested in forestry. Twenty-nine named family, and another 24 named organizations (Scouts, FFA, 4H, etc.). Other than where family was involved (e.g., a "USFS brat"), only 7 noted that a forester had gotten them interested in forestry. Sixteen noted their rural upbringing, including farm and ranch, while 6 said they were attracted to forestry as a way to get off the farm or ranch (and 2 more "to get out of the city"). Twenty mentioned hunting, fishing, camping or hiking.

Question 2. What basic values do you think foresters share?
Like the responses to Question 1, and obviously closely related to them, the responses to Question 2 fell into three general categories:

1. *The land*: The single largest response (83) had to do with love of the land/forest/environment/ nature. Thirty-five listed respect for the land, and 19 talked of care or concern for the land. Respondents also believed that foresters share a land ethic (34), a conservation/wise use ethic (19), or a stewardship ethic (40) as expressions of this love of the land.

2. *The forestry profession*: The ethics above call for action, and based on this category of responses it seems fair to say the respondents see foresters as sharing a belief that they are active land managers (71) who seek to sustain/renew forested ecosystems and resources (57) in service to society (34) so that the resources can be utilized by humans (50). Foresters are seen doing this by taking a long-term view (38), and by basing their actions on sound science (39). Fifteen specifically noted their belief that foresters share the view that wood production is a valid use of forests, while 19 suggested that foresters believe that they are the ones who know best how to manage forests.

3. *Ethical principles*: Some respondents took a different approach to "basic values," listing a range of ethical principles they believe to be shared by foresters. Noting only those principles that received 5 or more responses, 31 respondents listed honesty, 14 integrity, 8 each for loyalty and responsibility, and 7 noted trust. Another 17 suggested that foresters shared a strong work ethic.

Discussion:

The fact that such ethical principles as integrity, honesty, justice, altruism, and freedom were mentioned only in modest numbers by SAF respondents may be taken as indicating that these are expected, givens. They transcend individuals and professions and form the foundation of right relationships among peoples. They form the basis for the largely anthropocentric codes of ethics of most natural resource professions. It becomes a case of bringing them to the attention of our students, giving students practice in wrestling with the gray areas of value debates, and serving as role models in our conduct.

The results of the SAF study confirm the idea that foresters are attracted to forestry by a **love of the forest and a strong desire to work in it**. As much as they love the beauty, the workings, and the wonder of forests, they also recognize that forests are capable of producing a variety of goods and services, and they are willing to accept the challenge of **manag-**

ing forests. They believe strongly in a **land ethic**, although that is expressed in a variety of ways, including ways much more pragmatic than environmentalists who, for example, see only destruction in a clearcut, not renewal. They seek to provide **service**, in the broadest sense, to society, and they do so with a **long-term view**. Despite their love of the forest, they tend to be very **utilitarian and/or anthropocentric**, with management focused on meeting the needs of humans. And their actions are held by them to be based on **sound science**. They highly value **professionalism**, shown in curious ways by some who insist that since foresters know best how to provide societies needs from forests, and should be left along in their scientific expertise to provide what they think society needs. Their valuing of professionalism is also indicated in another odd way, the longstanding concern with **image** and the belief that is we could just educate the public to our views, we would be much more highly regarded.

To summarize, foresters consistently say that they value the beauty, variety, resilience, and especially the usefulness of forests. They hold science, technology, and management in high regard, and wish to apply these in service to humanity, based on the principles of professionalism. They value the same things others do: healthy forests, clean air, pure water, biodiversity, sustainability , and future generations. But the definitions they may have of these, such as what is a healthy forest, and the means they choose to reach these ultimate values (clearcutting) may often be different from those who seem to share the same desired ends as those foresters hold. Trite, but once past the motherhood statement of values such as love, the devil is in the details. One respondent in the SAF study put it this way: Around our table there was "… little conflict on philosophy – perhaps on technical issues we would have disagreed" (1997).

What does this mean for the teaching of core values in natural resources professions?

Implications for Teaching:

Forestry and other natural resource professions have often been accused of being so specialized in our education, training, and experience that – despite our very real love of the forest – we tend to disengage our hearts as we fully engaged our brains (Cornett & Thomas, 195; Wellman & Tipple, 1990; Williams, 1997, 10). Practically speaking, this means we are equipped to recognize and deal with questions like:

- what are the ecological opportunities for and limits to human use of timber resources; in other words, how much can we reasonably expect to grow and how big can the harvest be?
- What are the comparative costs and benefits of various rotation ages and timber harvesting techniques?
- How much use of related resources (wildlife, water, range, recreation) can be sustained without severely limiting the timber resource?
- What are the yield and cost benefits that can be obtained through tree-breeding programs?

Questions such as these are framed in ecological and economic terms, so that the form of the question makes it likely to be answered in such terms. Each also has value dimensions that penetrate and impinge on the answers while also shaping the role foresters are to play. Thus the first step is to understand that none of us is value free and the second is to understand and challenge the values and ethical principles which form the basis of our answer and decisions. In practice this means that one must recognize that answers and decisions have value and ethical dimensions, and that these occur in varying levels of importance. It is not enough to give our students a tool – like the SAF Code of Ethics or that of The Wildlife Society – and turn them loose with it without any discussion of meaning or consequence, practice, or even of how to use it. We don't do so with our science or our technology, nor should we do it with the core values of our professions.

One thing that I do is tell my students that their professional education is a socializing process; a learning of what is expected, what is accepted, and what is considered out-of-bounds. I tell them that this isn't wrong, but they should recognize that it is happening and that it is challengeable. Because the core values of a profession are taught, explicitly or implicitly, throughout the curriculum, I suggest that the assumptions and the values behind what is being taught must be shared with the students, and allowed to be held up to scrutiny.

I'll close by suggesting some questions that need to be dealt with by our various professions and taught in our various curricula as a means of revealing and understanding core values.

Some Questions to Frame the Teaching of Core Values:

Is science the only way tot know the world?

Foresters faith in **science** as the basis of their profession seems right and unshakable. Yet, in society there is a reemergence of art, intuition, poetry, and experience as ways to know the world and to base decisions on. These can be viewed as emotional, even non-rational ways of knowing the world, or they can be seen as complementary to science and as the foundation of living in harmony with the environment. One might chidingly ask, how can foresters use the non-scientific love of the forest that attracted so many of them to forestry as a foundation for the science they learned only later.

What role should foresters play?

If we have the **professional** expertise to be able to provide the goods and services people need and want, does that expertise some how give us the right to tell them what they should need and want? On the other hand, have we generally left value judgments to politicians and administrators who had neither

the competence nor the motivation to make balanced judgments about the forest and society?

Professions and individual professionals choose the role they play, whether by conscious choice or by what the sociologist Bella calls "performing an assignment, " as happens when members of an organization turn responsibility for their perceptions and beliefs over to the system and become "functionaries" (1987; 362). I suggest we are still wrestling with whether the role of foresters is to be apolitical, value free technical specialists or engaged experts with a professional obligation to shape social and political processes and decisions.

What resource is the forester concerned with?

If forestry is the only profession with the interest, education, and experience to grow wood as a crop of the land, how can wood and fiber production not be the core of forestry management? But if forestry is concerned, as its name implies, with the forest resource, how can we escape being timberists even as we make timber first among equals?

Do we let our values cloud our thinking?

Are we, for example, locked into functionally structuring our resource agencies as we have done for years – state parks, state forests, state wildlife refuges, etc. – even as we take up ecosystem management or an ecosystem approach to management?

Who do foresters serve?

Service, putting the interest of others before self-interest, is a long-standing value of forestry. Typically, it has meant starting out with the landowner's objectives in mind, and then using sound science and economics to reach those objectives. Meeting society's needs and wants has also been part of the service equation, but it becomes more difficult in the face of multinational companies, global trade, and rapid communications and transportation. As we respond, for example to Re. James Leach (R-IA) who has introduced legislation to end logging on public lands, saying "if we are going to exhort other countries to preserve their forests, we ought to act to save our own" (1997), we should note that the "society" being served is an expanded, global one.

Who is responsible for harmful actions?

To paraphrase civil engineer Elizabeth Anne Taylor, the extent to which we are responsible for the uses of our science and technology has not been well examined (1997). Like the engineers she talked of and to, we *make things happen* and value the action nature of our **management** profession, but do we question who is responsible for the consequences of making it happen? Do we simply supply the demands of society, or is there a proper time to say something about consumerism, population, and trivial demand?

Do we welcome diversity of thought?

Forestry, and other natural resource professions, are marked by a wide range of philosophies and beliefs, often even when sharing the same scientific knowledge. Thank heaven, otherwise we would be possessed of an Orwellian *group think* where there is only one right way to think and to do, and professional growth would be made much more difficult. But, when we ask others for dialogue, whether through public participation or multidisciplinary workshops, do we do so to listen to and understand others, or is the hope that they will adopt our values and beliefs?

There are many other questions that could be framed within the context of forestry's core values, but these should give a brief flavor. Foresters and all natural resource professions are in a transition from single discipline technical specialists to engaged catalysts and facilitators of resource planning and management. We must teach the next generation of foresters to care about and consciously think about their own and other professions' values and ethics as much as we teach them about inventory technique, fire management, or silviculture.

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[1]There is no statistical analysis, only the number of responses are noted (individuals could list several things in answering both questions).

WRITING AND FISHERIES AND WILDLIFE MANAGEMENT: CROSS-DISCIPLINARY COLLABORATIONS

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ABSTRACT: Often students disassociate courses which are in their core university requirements – such as writing – from the courses they take for their major. Yet, increasing demands within resource management professions require graduates competent in writing and in using Internet technologies for research and publishing. Thus, there is the need for cross-disciplinary collaboration between the university units responsible for teaching writing and the units providing education for resource professionals. With this need in mind, a unique partnership was formed at Michigan State University between the Departments of Fisheries and Wildlife (FW) and American Thought and Language (ATL) – the unit charged with teaching a variety of content-based writing courses for new students. We worked together to enhance the design of FW 100 – An Introduction to FW and two sections of ATL 150; course content and readings focused on conservation history, and assignments developed writing skills. Additional learning activities enhanced Internet skills, provided outside-of-class experiential opportunities, and helped students develop critical thinking abilities. In-class assessments showed that most students noted how the assignments and approaches used engaged them in learning course content and the value of writing. Future plans are to continue this collaboration, with more students cross-enrolled in the two complementary courses. The anticipated benefits of this collaboration reach beyond those obtained by students. We have found creative ways in which to integrate writing and communications with FW education, while contributing to scholarly applications of writing across the curriculum (WAC) within natural resources fields.

INTRODUCTION

Enhancing student learning through writing, and teaching fundamental writing and critical thinking skills can be great challenges. Faculty in natural resource disciplines often feel ill-prepared to tackle such challenges, and may have learned general pedagogical theory and practice only through informal means. Yet, effectively teaching our students disciplinary conventions in writing and critical thinking are very important in resource management. We desire not only to develop graduates who are technically competent in working and communicating within their discipline, but we also wish to foster the broader education goals of preparing our students to think and participate in informed dialogue about their own writings and those of important scholars in resource conservation, such as Aldo Leopold, Rachel Carson, and many others.

These challenges have been thoroughly outlined in the scholarship of the Writing Across the Curriculum (WAC) effort to reform post-secondary education. Early work in this arena focused mainly on recasting the role of writing in the learning process; early adopters of this approach were faculty in humanities and colleges of arts and sciences, who began to use writing-as-learning strategies in courses in the 1970s and 1980s (Jones and Comprone 1993). Presently, however, the writing-to-learn methods are being integrated with research and discourse on the role of writing within specific disciplinary communities (Blank 1996, Jones and Comprone 1993).

This so-called "next stage of development in WAC" is functioning to "foster integration among the areas of program administration, pedagogy, and research…[and will] link faculty, graduate students, and discipline-specific" research and teaching across the curriculum (Jones and Comprone 1993: 63). Specifically, during this phase of scholarly thinking about WAC, of critical importance is increasing the emphasis on "dialogic interaction" between faculty in science disciplines and in writing, and creating collaborations designed to carry out or create new knowledge as well as to form new teaching strategies (Jones and Comprone 1993: 64). In short, cross-disciplinary collaboration is one answer to the challenge of better preparing students, through writing and thinking about writing, to function effectively as resource management professionals and as educated citizens of a complex world.

Rooted in this scholarship, we have pursued an unique cross-disciplinary collaboration between the Departments of Fisheries and Wildlife (FW) and American Thought and Language (ATL) at Michigan State University (MSU). The Department of ATL is the MSU unit charged with teaching the entry-level writing courses within the content areas of American literary, historical and cultural studies. Although at many universities, making the link between the writing/composition teaching units and the disciplinary units remains a challenge (Jones and Comprone 1993), this link at MSU is greatly enhanced by another, service-oriented unit which works closely with ATL – the Writing Center. At the Center, MSU students can engage with other students (writing consultants) in conversations and reflections about their own writing. In addition, the Writing Center is the primary group on campus that provides faculty support through developmental workshops on writing and teaching/learning about writing. The purpose of this paper, then, is to share with colleagues in resource management the story of our ATL-FW cross-disciplinary collaboration. This collaboration was designed to improve the first-year student's learning experience in writing and thinking about FW management history and current conservation and environmental issues.

STUDENTS' NEEDS IN ENTRY-LEVEL FISHERIES AND WILDLIFE WRITING INTENSIVE COURSES

Students in Fisheries and Wildlife (FW) at Michigan State University (MSU) arrive on campus with varied levels of preparation to pursue college level work in writing, and in their own discipline. Of the 100-110 new FW students each year, about one-third are freshmen, and the other two-thirds typically transfer into FW from community colleges, MSU or other colleges.

Most FW students are from Michigan. State education standards require course work in English/Language Arts throughout high school, yet their varied exposure leaves some students coping with a difficult transition between high school level writing, and the writing expectations at the college level. In research conducted through MSU's Writing Center, new college students have reported many differences between expectations for high school writing vs. college level writing. Undergraduates reported that, in comparison to the high school level five-paragraph essay (in which they filled in a standard format with other peoples' ideas), college writing assignments more often asked them to conduct original research, provide greater elaboration, and communicate complex ideas, issues and understanding (Thomas 1995).

Given these challenges in making the transition from high school to college, and given that students in natural resources disciplines today may have fewer FW-related field or outdoor experiences than their peers in previous student cohorts (Craven et al. 1996), students may have difficulties reading, interpreting, writing about, and critically reflecting on FW-related writings traditionally used in entry-level courses (such as Leopold's A Sand County Almanac). In a survey of new FW students, we found that although nearly all have read Thoreau, and many have read Theodore Roosevelt's writing, only about one-third have previously read Leopold; fewer than one-fifth have read Rachel Carson's or John Muir's works. And only a handful have read any novels by James Oliver Curwood – an early conservation leader in Michigan.

First year students at Michigan State University are required to take a one-semester, four-credit writing course to satisfy the first tier of the university's writing requirement. Students who have declared Fisheries and Wildlife (FW) as a major are also required to enroll in FW 100, Introduction to Fisheries and Wildlife (1 credit). This writing-intensive course introduces students to management principles and selected topics (e.g., conservation history), career opportunities, and resources at the university. In addition, FW 100 develops collegiality among incoming peers, even though it serves over 150 students.

Often students disassociate courses which are in their core university requirements – such as writing – from the courses they take for their major. Additionally, students in science-related fields may not be aware of how the writing they will do in their careers and disciplines compares and contrasts with writing types and conventions used in traditional English or composition classes. Showing students that there are strong linkages between the two types of courses is important because of the amount of writing required for biologists and managers. Students may be under the erroneous impression that as FW majors they will not be writing much at all in their major courses, or even in their careers.

THE INSTITUTIONAL ENVIRONMENT, THE FACULTY AND THE TEACHING COLLABORATION

Meeting the needs of incoming freshmen as they make the transition to college-level learning and living is an important initiative at MSU and on other campuses. Likewise other recent university initiatives in improving student access to computing technology and in enhancing active learning opportunities are re-shaping the academic institutional environment. Rather than looking at these university-wide efforts as barriers to our abilities to prepare technically competent FW professionals, we have viewed these as providing for new "teachable moments" – opportunities for creatively bringing relevant information to students in order to help them develop needed educational background. Furthermore, institutional change brings renewed support for collegial interactions across disciplines such as FW and ATL.

This collaboration developed through an evolutionary process. Charnley provided leadership for a College of Agriculture and Natural Resources (CANR) and ATL writing across the cur-

riculum partnership called PROJECT WRITE. This effort, between 1989 and 1992, directly affected more than 4,500 students in a wide range of courses in the CANR at Michigan State University. More than anything else, it demonstrated that faculty working in various disciplines can help design and incorporate effective writing assignments that improve the ways students learn in the class and, at the same time, enhance the teaching of the subject matter. (Charnley et al. 1993, Charnley et al. 1990). In addition, Dann has participated in a Lilly Endowment Teaching Fellows Program, and in The Faculty Writing Project at MSU. In both, she focused her own learning on the issues of more effectively using writing as a learning tool, especially in large courses such as FW 100. Her areas of scholarship are in research in human dimensions of fisheries and wildlife, including communications and education program design and evaluation. Charnley's scholarly field is history, with specializations in oral history and Michigan history. As an active sportsman, he has developed an interest in the history of hunting and fishing in Michigan, along with a scholarly expertise by studying novelists like Ernest Hemingway and James Oliver Curwood, authors with strong ties to Michigan who have written many works dealing with fisheries and wildlife themes.

In response to student needs, then, faculty in FW and ATL desired to establish a mechanism to link the two, freshmen-level writing courses. While maintaining the integrity of both courses, we coordinated readings and writing assignments. This collaboration was designed to enhance the course design and assignments for first-year fisheries and wildlife students and for students in the ATL course. The conservation issues raised in FW 100 echo and point to the ways in which American writers have written about them in literary and other cultural texts. Those issues are already reflected in the current scholarship in American historical and literary studies, and became highlighted in this collaboration. Being able to link the issues raised in the FW course to narratives and stories within the ATL course allows those issues to come alive in more complex ways. It also allows conversation about skills in oral and written communication necessary for success in FW careers.

GUIDELINES FOR WRITING AND LEARNING USED IN OUR COLLABORATIVE EFFORT

Several guidelines (adapted from WAC scholars and practitioners and from many other sources) provided the basis for our assignments in the two classes. Many of these guidelines are tenets we share directly with our learners as we discuss the role of written communications, both within the disciplines of FW and in cross-disciplinary dialogue:

- "Writing makes thoughts visible."—Dr. Raymond Smith, Indiana University
- "All writers make mistakes; good writers do everything they can to correct those mistakes."—Dr. Leonora Smith, Michigan State University
- "Use all the writer's tools available to improve your writing."—Dr. Jeff Charnley, Michigan State University
- Short writing assignments improve with each repetition.
- Revise often and revise carefully.
- Peer review and peer editing are essential to improve writing.
- Keep writings short, direct, and original.
- Paraphrase often and always analyze sources critically.
- Write something new in each assignment.
- Make every writing your best work.

As WAC scholars recommend, these important rhetorical guidelines should be integrated with current thinking about discipline-specific conventions – and this integration should become apparent to students, so that they can function effectively in understanding the complexities of communications. Although there is little scholarly work being done on FW-specific writing, there are some important considerations to which students need exposure (Gilligan 1995, Turner 1995).

COLLABORATION IN THE TWO COURSES

Our two courses highlighted in this collaboration bring these conversations about writing alive for students. We approached these guidelines in varied ways across the two courses.

ATL 150, "Writing: The Development of American Thought," through a 4-credit semester-long course, requires substantial writing based on extensive course readings. Students write three one page analyses of scholarly journals, three 5 to 6 page essays on course topical themes, and a final oral history paper as a culmination of a semester long research project. An additional focus in Charnley's sections is on Internet web publishing, and students publish on their MSU web pages samples of their writings from the class.

The readings chosen in the course, except for the required writing textbook, related in some way to conservation, wildlife issues or environmental themes as they have developed in American history.
Students read Roderick Nash's American Environmentalism: Readings in Conservation History, Iola Fuller's novel, The Loon Feather, Caroline Kirkland's A New Home, Who'll Follow?, Henry David Thoreau's Walden, and James Oliver Curwood's The Grizzly King. Using a related feature film

as a cultural text provided another writing assignment. Students viewed The Bear, the 1989 Tri-Star film's adaptation by director Jean Jacques Annaud and wrote an essay based on a comparison with Curwood's 1916 book.

Related directly to these readings, we developed two enrichment activities outside of class for students in both courses. In the first, we arranged a Saturday field trip to Curwood Castle, the writing studio of James Oliver Curwood, in nearby Owosso, Michigan. Students were able to tour the studio and learn more first-hand about this famous wildlife novelist and his writings. Students commented how much the field trip helped them understand the novel, Curwood's perspectives on hunting and wildlife, and the development of a conservation ethic in the early 20th century. Besides this, we arranged an evening presentation entitled, "Wildlife and Photography: A Transcendental Connection." We linked some interesting comments by Thoreau in his book, Walden, with a photo lecture by a nature photographer and asked students later to write some comments about their experience. One student wrote this:

"With bicycles flying, cars charging, and the streams of people all focused on their mission, I often lose sight of what is important. I flow with the crowds, walking in a trance from class to class without stopping to take the time to enjoy life. The presentation on the transcendental connection between nature and photography sent a message that should be heard by everyone. Thoreau stated that the universe is wider than our views of it. People tend to become so focused on one item they never broaden their horizons or opinions. With the quiet confidence that nature lovers have, [the photographer] takes us on a journey of tranquility. Amidst the busy life that college brings, he gives us an hour to escape to search our souls and clear our minds. Intricate details of a spider hidden in the sand make us realize often beauty can be found if you take the time to look."

Most students commented they expected the evening to be boring and dull, but they were pleasantly surprised and most indicated they even enjoyed it! Their subsequent writings were descriptive, thoughtful, imaginative, and thought provoking. What more could instructors ask of these beginning college students? These outside-of-class learning activities helped break down some of the student/teacher barriers that so often intrude in a modern mega-university setting where an individual freshman can get lost easily amid 45,000 other students.

In FW 100, an Introduction to Fisheries and Wildlife, three writing assignments help students work toward achieving course goals; these consisted of writing journal, preparing an abstract based on field observations, and preparing a cover letter and resume. These three writing "pieces" were assigned within the context of helping the student develop a Professional Portfolio; this provides students with direction, purpose and audience for the individual written works, and gives these short assignments an important career-related context. Furthermore, these assignments allow students great ownership in their own learning; they choose subjects of interest, get to spend time outdoors, make connections with self-selected natural areas (some of which are their newly-discovered favorite locations on this huge campus), and learn the rudiments of scientific observation and writing. All of these help the students make their writings "their best work."

More importantly, peer review and editing processes were built into the abstract assignment. Students exchanged an early draft with a partner in an in-class, interactive exercise called "The Fish Bowl," (a teaching strategy encouraged by MSU's Writing Center). Through student-generated questions during the Fish Bowl, we discussed the most common writing mistakes and how to correct them. Then, students use peer comments to revise their work. Students turn in the final abstract as well as the rough drafts, with students' own markings and those of their peers. Student-to-student (peer-to-peer) collegial conversation about their first-ever abstract brings alive the point that these interactions about peers' writings are valued in the FW management community (and this activity makes a huge class in a large lecture hall much more interesting and dynamic than a stale lecture!)

Several very short, in-class learning experiences also relate to FW 100 students the role of writing in resource management. A 1-minute writing exercise asks students to write about their pre-conceptions of the definition of FW management, and the factors influencing their interests in FW. Other participatory writing (or "investment writing") asks students to frame questions they have for guest speakers who are discussing varied career opportunities in FW and to frame questions to the instructor about course content. Answers to these questions are then woven into course lectures.

Opportunities to write via email and use Internet resources in research and writing are also important for today's FW professional. In a "Spartan Safari" assignment, students visit several campus resource offices to learn about references available to assist their studies, their library research, and their career development. Students are asked to "visit" several websites for FW agencies, then send an email message to the instructor highlighting their favorite website, something about their background, or comments about FW 100. Another short writing activity engaged the students in their reading of Leopold, and asked them to respond to Charnley's online story entitled "The Lure" (http://www.msu.edu/user/charnle2/lure.html), an assignment students in ATL 150 also wrote using email. We cite a couple of student comments about this assignment, as follows:

"I did read "The Lure" and thought that it was a really interesting piece. I really don't think it was about a lure, but rather the memories a lure can bring of past fishing trips, or any past

memories connected to those trips (like the author's grandfather). I thought it was a good piece over-all. In comparison to the "Alder Fork," the subject of memories comes up again. A fisherman has many memories and tales to tell of his adventures while fishing, and these are the most valuable things he takes home with him after he's done fishing."

"'The Lure' was a short story that involved someone looking way beyond something. In this case it was a fishing lure that meant a lot more to someone that just a lure. It was an artifact that when he looked at it brought memories and allowed him to reminisce about past experiences and people. This story really hit home for me. There are a lot of little things that I take for granted and don't really appreciate as much as I should. I thought it was really cool that something as simple as a lure can mean so much to someone. There is the same idea behind 'The Alder Fork' by Leopold. Instead of going out and trying to catch the biggest fish possible and not being happy without it, he enjoys the little things about being out in nature. He takes the time to stop and think about things and remember what they mean to him."

Not all the student comments were favorable. For example, one misanthrope wrote:

"This story is about this guy's memories about fishing with his family and how important those memories are instead of whether or not you catch a fish. I didn't much like the story. I thought it was cheezy and overdone. This story is just like Leopold; he tries to use all this astounding imagery and put all this feeling and such into everything, but it's so overdone that it's just annoying."

It was refreshing to see critical analysis in many student responses! Experience has shown that when these writing assignments are "short, direct and original," many students write often and elaborate on their thoughts! Another tremendous benefit is that faculty can glean valuable insight into students' thoughts, learning processes, stumbling points on important concepts or points made by speakers, and reactions to course format and content.

WHAT WE HAVE LEARNED, WHERE WE ARE HEADED, AND FURTHER RECOMMENDATIONS

In 1997 (fall semester), we had no students who were dually enrolled in both courses (as we had intended). Instead, there were 52 students in 2 sections of Charnley's ATL 150 course, one of whom had previously taken FW100; there were 158 students in Dann's FW 100. We attribute this to the difficulty of advising students during their summer orientation prior to their first enrollment; since this pilot collaboration was developed late in Spring 1997, few students or faculty advisors had received word of this new effort. This should be easy to remedy in the future. So, in this "experimental" year, we had the luxury of getting to know each other's views on writing, readings, and history of conservation and FW management. We discussed assignments, pedagogy, and content in periodic collegial meetings. We plan to do more!

Certainly, although as collaborators we had the challenge of advising students into dual enrollment in FW 100 and ATL 150, we experienced many benefits to this unique partnership. One benefit is in having non-FW majors exposed to scholarly thinking and writings in conservation history – with specific reference to individuals (such as Curwood) with Michigan roots.

Student course evaluations in ATL 150 were overwhelmingly positive. The numbers of readings and amount of writings assigned were substantial. Sample student comments (given on the required ATL student evaluation form) in response to the general question, "Did the course increase your understanding of American cultures, ideas, and experiences?," included the following written comments:

"Yes, I had never thought to link environment with the world of literature before; it was a refreshing experience."

"Yes, this course made me look at things such as wildlife, native Americans, pioneers, and farmers in a way that I wouldn't have before. I am more aware of the differences and similarities in different cultures."

Using another evaluation instrument, Dann and Charnley asked students in both FW 100 and ATL 150 to respond to this question: "In general, how did this course affect your overall learning about fisheries, wildlife, and important issues related to our natural resources?" Three of Charnley's students in ATL responded with:

"It made me more interested in the topic and made me want possibly to pursue a career in wildlife."

"I am a fisheries and wildlife major, and it helped a lot. It broadened my horizons. It really didn't get into nature issues, but it did talk a lot about nature which was very interesting and unique." [NB: This ATL 150 student had taken FW 100 in a previous semester.]

"This course affected me because I would not have had the opportunity to learn these things on my own. I am not particularly interested in FW, so in that respect I am glad that I at least got a chance to be exposed to it. It was an interesting experience."

In-class assessments of student engagement in learning indicate a growing awareness of the value of writing in the field of FW management and in their own careers. Students reported that writing helped them learn what will be expected of them.

Even more importantly, many FW 100 students reported that they were most engaged in learning when participating in the field journal or other writing assignments. Most students noted that the writing experiences were new, although several also noted that they had already done some of the discipline-specific writing (abstracts or resumes). FW 100 students had the following comments:

"I feel that the writing assignments were a good part of this course. I felt that they were applicable to FW coursework and to prepare for FW careers. The field journal was a great experience, to practice a different style of writing while enjoying the outdoors!"

"I gained quite a bit from these writing experiences. They were varied, especially the abstract. It was hard to write about something scientific like that, but it was also fun. I learned there is more to FW than just the animals and their habitat."

"These writings did affect my learning. The writings made me think in a whole new way. It is a lot different than just writing an essay. It was good for me to have that change and make myself think differently. In general, I gained a lot from the writing experiences. I will be able to tackle future writing assignments with a lot broader base and be able to incorporate different writing styles."

Although not all comments were as positive as the comments above, some of the critical comments suggested ways of improving the writing assignments in the future. (For example, one person remarked "I don't think the limited field experience and abstract can really be considered scientific. However I think it's a good idea to be approached…in a 3-credit course.")

How did FW 100 students react (in writing) to their readings? The highest proportion of students reported that Leopold's A Sand County Almanac, and Rachel Carson's Silent Spring were the most informative readings. Several students commented that they were previously unaware of the connection of Carson's writings to early research at MSU regarding the impact of pesticides on songbirds; one student wrote "I was fascinated that this all started here at MSU." Another said "I found MSU's involvement in the 1950s with the robin counts very informative and exciting….I had never really realized what implications pesticides could have." Some students specifically commented on other short articles about Michigan's conservation history (e.g., a magazine article about the passenger pigeon in Michigan). Regarding Leopold and overall learning in FW 100, students wrote these passages:

This "really showed me how differently people looked at wildlife management in the past…it also showed me how far we..have come in regulating wildlife. I think we are headed in the right direction."

"The most fascinating part of the book was the section on the land ethic and how we (the public) have to evolve ecologically or suffer the consequences."

"I learned that the history of conservation is as important as the future when making decisions on management now."

Another astutely noted that she learned from Leopold that "you have to live the work you do."

What lies ahead in this cross-disciplinary collaboration? In the future, we plan to work together to:

- Continue to build upon our cross-disciplinary model designed to help freshmen, and to integrate content and teaching strategies across FW 100 and ATL 150. Our model serves to personalize learning for students, and to expand their thinking, reading and writing abilities related to fisheries and wildlife subject matter—no matter the ultimate career choice of the student. Furthermore, our model provides first-year students the opportunity to integrate Internet research, reading, and publishing—critical technological skills which will be needed in the future by all professionals.
- Advise more students to cross-enroll in FW 100 and ATL 150, and continue to provide joint experiential enrichment activities (e.g., field trips, guest presentations) outside of classes.
- Redesign FW 100 as a 3-credit course offered both fall and spring semesters. This will enable us to intertwine FW 100 more thoroughly with ATL 150. FW 100 students and faculty will now be able to use a discussion section (with only about 25 students) to explore readings in greater depth.

Future cross-disciplinary collaboration will have many long-term benefits. The cross-disciplinary dialogue we have begun should help advance the scholarship of teaching in FW, of teaching in conservation history, and of the writing across the curriculum (WAC) effort within natural resources education. In this spirit, we look forward to future collaborations, and to learning from our students!

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PRINCIPLES OF WILDLIFE CONSERVATION—TESTING DISTANCE DELIVERY METHODOLOGIES

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ABSTRACT: In conjunction with faculty at Oregon State University, we developed a distance education course in two phases. During Phase I, conducted Spring of 1996, we used Oregon ED-NET (a simulcast satellite education system) to reach 143 students at 14 sites in Oregon. In the second phase, we offered the course nation-wide in a video format Spring term 1997 and enrolled 92 students at 13 sites. We will offer the video course again during Winter term 1998 following an expanded marketing plan. Our objectives in this paper are to present (1) course design and production information; (2) our experiences with satellite and video teaching; and (3) present information regarding student perceptions and satisfaction with the two distance delivery methods. In Phase I we used notebooks, computer discussion groups, two-way audio, and toll-free phone access to assist students in comprehending the materials. Lectures used computer-graphic screen shows, slides, and locally produced video segments. Based on regular evaluations assessing student learning and satisfaction, we redesigned and professionally produced the course for video distribution in Phase II. Evaluations indicate a high level of satisfaction with the course, but student interaction was minimal. We discuss pros and cons for offering similar courses using these technologies, and present future plans for course enhancement.

INTRODUCTION

Fish and wildlife have increasingly become important elements, if not foci of critical environmental and natural resources issues (Kellert 1987). Ultimately, this is because wild animals are not only highly-valued in their own right, but also because they appeal to the general public (Kellert 1980). Fish and wildlife are vivid, and often aesthetically attractive, symbols of the environmental values the public desires. That fish and wildlife also can be indicators of ecological health helps elevate their prominence as factors in natural resource decision-making (Orr 1991). The prominent role of the spotted owl (*Strix occidentalis*) in debates about management of forest resources in the Pacific Northwest is exemplary. Public policies, such as the Endangered Species Act and sequential conservation titles of the Farm Bill, have elevated the social and economic significance of fish and wildlife. Thus it becomes critical that a broad range of people understand the relationships among wildlife resources, their habitats, and socio-economic factors.

Opportunities to systematically learn about wildlife, fish, ecological processes, and principles of natural resource conservation remain limited. Nature programming on television is likely the principle educational medium for many populations. For example, the most common means of participation in "wildlife-related recreation" in Missouri was viewing nature programs on television; 80% of the residents did so (Witter 1992). There is a substantial need and demand for wildlife and conservation education at the undergraduate level. In 1987, 95 colleges and universities offered wildlife curricula, and 76 of these reported an undergraduate enrollment of 5,997 students (Hodgdon 1990). Although a recent survey has not been conducted, advisers at many institutions report substantial increases in undergraduate enrollment since 1987. At Oregon State University, for example, our undergraduate enrollment in fisheries and wildlife has increased 90% from 140 students in 1987 to 266 in 1997. The majority of members of The Wildlife Society (72.6%) indicate that additional training is needed at the undergraduate level by people entering the profession (Brown *et al*. 1994). Furthermore, Stauber (1993) has argued that traditional market agricultural programs will likely fail if conservation and environmental issues are not fully incorporated within them.

Interest in distance education on university campuses has increased at the same time as demand for fish and wildlife education. Colleges and universities have generally viewed distance education as a means of expanding their clientele base, and improving service to clients by offering courses to students off-campus and in asynchronous modes. We

attempted to meet both demands by developing a distance education course on wildlife conservation. In October 1995, the Department of Fisheries and Wildlife at Oregon State University received a $56,000 grant from the US Department of Agriculture's (USDA) Higher Education Challenge Grants Program to develop a distance education course entitled Principles of Wildlife Conservation (FW 251). Under the grant, FW 251 was offered throughout Oregon as a simulcast satellite course Spring quarter 1996, and then developed as a video course for nation-wide distribution during the Spring of 1997 and again in Winter 1998. The goal of this paper is to describe the course and to relay what we learned about distance education in the process of teaching it. Our objectives are to present (1) course design and production information; (2) our experiences with satellite and video teaching; and (3) present information regarding student perceptions and satisfaction with the two distance delivery methods.

COURSE FORMAT

The 10-week course included three 50-minute periods per week, and was comprised of 28 50-minute lecture periods, and two 50-minute exams. The course was roughly divided into four parts: (1) social and political aspects of wildlife conservation and management, (2) challenges to management of biodiversity, (3) population management, and (4) ecosystem management. Social and political aspects of wildlife conservation examined public attitudes and perceptions regarding wildlife, wildlife values, bioethics, and national and international laws conserving wildlife and natural resources. Part two, challenges to management of biodiversity, examined the components of biodiversity and the causes of declines in biodiversity including habitat destruction and fragmentation, introduction of exotic organisms, diseases, and over exploitation. Part three, population management, provided a primer on population processes and regulation, and explored single species management programs including threatened and endangered species, hunting, and animal damage management. Part four, ecosystem management, introduced concepts of landscape ecology, and show how they can be applied to wildlife conservation including design and management of protected areas, and integrating wildlife into management of other natural resources.

Modes of Instruction and Format

The course employed several modes of instruction and used various formats in presenting course content. The basic mode of instruction was a 50-minute lecture incorporating several presentation formats. During Spring 1996, the lectures were broadcast live via satellite over Oregon's Ed-Net 1 system. During Winter and Spring of 1997, lectures were video-taped in a studio and duplicated for video delivery during Spring 1997. Each set of videos contained 14 tapes with two lectures per tape. During Spring 1997 and Winter 1998, the course could also be viewed on the educational cable TV channel of five Oregon metropolitan areas.

Fourteen instructors from OSU, Eastern University, U.S. Forest Service, and Oregon Department of Fish and Wildlife prepared course materials and delivered lectures. Approximately 50% of all lectures were accompanied by computer-graphic slides interspersed with color photo slides, graphics, and key points, definitions, and concepts in a bullet format. Approximately 50% of the remaining lectures employed high-quality overheads and slide presentations. Video feature articles and short segments were used in approximately 30% of the lectures. We used an internet bulletin board as a means of further discussing lecture content.

The video format of the course enabled us to modify our presentation of the course on-campus during Spring 1997. On-campus instructors delivered nine lectures live and the remainder were viewed on videotape. Videotapes were available for loan on campus in two locations (the OSU library's reserve reading room and the Department of Fisheries and Wildlife office). On-campus students could view live lectures when scheduled, or they could view the lecture on tape or cable TV. Thus, the video format gave both the students and instructor additional flexibility. On campus we used one class period each week as a discussion period and required the students to view the regularly scheduled lecture at another time. During the discussion periods, we addressed questions concerning previous lectures and discussed current events related to the course.

Course Materials

Materials for the course included two optional texts (Shaw 1985, Primack 1993) and a course notebook (Edge and Davis-Born 1997). The course notebook complemented the lectures and supplement the texts. The notebook contained a proposed lecture and exam schedule, course information, and lecture notes including graphs and figures with ample room for students to take additional notes. A section after each lecture contained discussion questions and recommended readings. The course notebook was developed as a website and can be viewed at http://osu.orst.edu/instruct/fw251/.

Testing, Grades and Evaluations

Tests for the course included one mid-term and one final exam. Each test included 50–75 multiple-choice questions, and were computer-scored using scantron forms. Exams were mailed to off-campus facilitators one week prior to the on-campus exam date. Off-campus facilitators were encouraged to synchronize exam dates with the on-campus class as much as possible. The final for the 1997 class was scheduled for Friday of exam week with final grades due the following Tuesday. Facilitators were encouraged to test early, or express mail or fax exams in order to meet the deadline for posting grades. Grades were based on a normal distribution. Each

exam packet also included an evaluation, which assessed students' perceptions of each lecture, ease and method of getting help, and an overall class evaluation.

Assistance for Students and Site Facilitators

We offered a range of services to meet the needs of students and site facilitators, including a course manager (CM), a teaching assistant (TA), a 1-800 phone line, and an internet discussion group. A full-time CM was in charge of logistical coordination with off-campus sites, distribution of handout materials, tests and evaluations, and was available during office hours via the 1-800 number to answer questions regarding course logistics. Our CM also developed marketing materials for the next year's presentation of the course. Our TA was available during office hours each day to answer questions from students regarding course content and graded the exams. In addition, the TA assisted in production of graphics and slides. Questions concerning course content were addressed to the TA via either the 1-800 number or an internet discussion group.

COURSE EVALUATION

Enrollment and Test Scores

A total of 143 and 92 students enrolled in FW 251 during Spring quarters of 1996 and 1997, respectively (Table 1). We anticipate an enrollment of at least 155 Winter term 1998. During each year, we enrolled students at community colleges, high schools, and extension offices. Enrollment figures represented a substantial increase in the average quarterly enrollment for this course since 1990 (= 57). During 1996, the course was taught at 13 sites off-campus; 2 of these sites (9 students) enrolled students for community college credit, rather than OSU credit. During 1997, the course was taught a 12 sites off-campus, including a high school in Greece; all students in 1997 enrolled for OSU credit. In 1997 the course videos were also used to supplement lectures for a similar course at the University of Montana and a natural resources course at Riverside High School in Portland, Oregon. For the Winter 1998 offering, ten high schools have committed to enrolling students and additional schools are interested in supplementing their current offerings. High school participation has increased substantially this year, and likely represents the greatest potential increase in student numbers. We attribute much of this increase in participation to our marketing plan focused on recruiting high schools.

Students enrolled in FW 251 differed by major between years and for on- and off-campus populations. Wildlife and fisheries majors composed 32% and 65% of the on-campus enrollment during 1996 and 1997, respectively. Off-campus, majors accounted for 12% and 16% of the enrollment during 1996 and 1997, respectively. All high school students each year had undeclared majors, but four of 38 freshmen entering the Department of Fisheries and Wildlife in the fall of 1997 had taken the course in high school (12.5% of all high school students that have taken the course).

Knowledge scores, based on final grades, suggest that on- and off-campus populations and high school versus non-high school students performed equally in 1996; however, high school students did not preform as well as non-high school students in 1997. During 1996, the mean final score for on-campus students (=68.2, SE = 1.4, n = 58) did not differ (t-test, P = 0.064) from off-campus students (= 64.7, SE = 1.2, n = 69), and high school students (= 73.3, SE = 4.7, n = 3) performed as well as non-high school students (= 66.1, SE = 0.9, n = 124; t-test, P = 0.24). In 1997, high school students preformed well, but not as well as non-high school students (= 71.2, SE = 2.4, n = 19 vs. = 79.3, SE = 1.2, n = 59; t-test, P = 0.0015), but on-campus and off-campus populations (= 79.0, SE = 1.3, n = 43 vs. = 75.3, SE = 1.9, n = 35; t-test, P = 0.11) performed equally.

Table 1. Number of students enrolled in Principles of Wildlife Conservation by type of site, student and year.

Sites/Enrollment	Sp 96	Sp 97	W 98[a]
Total enrollment	143	92	155
On-Campus enrollment	62	51	81
Off-Campus enrollment	81	41	74
Number of off-campus sites	13	12	12
Number of non-OSU colleges/univ.	5	4	2
Number of high schools	5	5	10
Extension offices	3	3	0
Number of high school students	7	25	21

[a]Final off-campus enrollment figures were not available at time of manuscript submission. Numbers represent minimum estimates based on discussion with off-campus facilitators.

Classroom Interaction

Classroom interaction was the most difficult aspect of the course (Diebel *et al*. 1998). Although we did not collect data on interactions during the satellite broadcasts in 1996, interactions rarely exceed five questions, answers, or comments per lecture, and many lectures had no interactions at all. The majority of interactions were instructor-initiated (Howard *et al*. 1996); very few were student-initiated. After the first exam in 1996, we began holding the satellite-link open for 5–10 minutes after the formal lecture period to provide for additional opportunities for students to ask questions. This format increased interaction some, but not substantially. Most interaction with students occurred during the lectures and the majority of the discussion was generated from the live class at OSU. During the video presentation of the course on-campus in 1997, most interactions occurred during live lectures, after the tape was played, or during the regularly scheduled discussions sessions.

Students did not make wide use of the either the internet or the 1-800 phone number for asking questions. Although, >75% of students both on- and off-campus has access to the internet, only 12 and 6 students subscribed to the list-server, and a total of 7 and 4 questions were posed via this source during 1996 and 1997, respectively. Less than 25 questions were received over the 1-800 phone line each year; most calls were between facilitators and the course manager regarding logistical matters. Despite this lack of interaction, evaluations indicate that the majority of students felt that they had adequate access to instructors or the TA. During 1996, 88% of on-campus and 81% of off-campus students felt they had sufficient opportunity to ask questions. During 1997, 95% and 82% of the on- and off-campus students, respectively, felt they had sufficient opportunity to ask questions.

Evaluations

We evaluated the course twice during the quarter, seeking input on each lecture, where and how students viewed the course, and demographics (gender, major/nonmajor, etc.). Modal responses for most lectures were 4 or 5 on a satisfaction scale of 1–5 (5 = high), and were <3 for one lecture in 1996 and two in 1997. These scores are consistent with scores obtained in most live offerings within the department. All lectures were retaped for the 1997 video phase, and the two lectures with poor ratings in 1997 were revised and retaped for 1998 video distribution. Review of written comments indicated some dissatisfaction with the number of instructors because of: (1) variation in style and quality of presentations, (2) variation in quality of course notebook content, and (3) students' inability to develop a pattern of note-taking consistent with instructor presentation style. Modal responses to questions regarding overall satisfaction with the course, including usefulness, and interest were mostly 4 (Figure 1). Written comments suggested dissatisfaction with the multiple-choice exam format for assigning grades because the questions failed to test students on their ability to integrate the fundamental principles of the course and were perceived as being trivial in nature. Many students commented on the flexibility in scheduling that the video course offered while others stated that they vastly preferred live lectures to a video. Three students stated that they would not have been able to take the course if not for the flexibility of viewing the video when convenient.

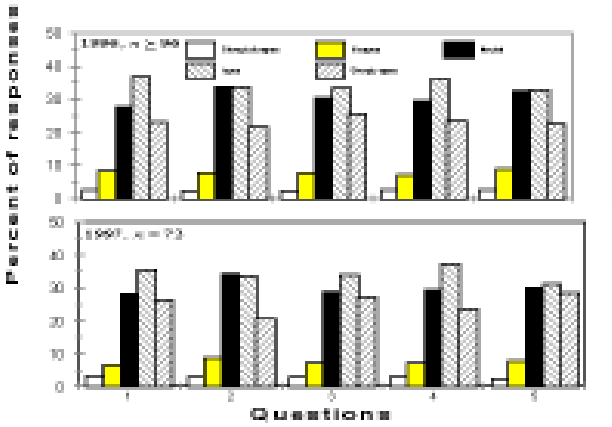

Figure 1. Percent of responses to five questions regarding overall distance delivery of Principles of Wildlife Conservation during 1996 and 1997. Question 1: As a result of this class, I have learned usefull information. Question 2: This course increased my interest in the topic. Question 3: I knew what was expected of me in this course. Question 4: Overall, wnough time was spent on each topic. Question 5: I would recommend this course to other students

Cost Estimates and Fee Structure

Total estimated direct cost for producing the satellite version of the course was $34,900 including CM, TAs (2 terms), copyright fees, printing and mailing, and satellite downlink and uplink fees. Estimated direct costs for producing the video version of the course in 1997 was $28,873, which included CM, TAs (2 terms), printing and mailing, tape duplication, and marketing. Cost estimates do not include instructors' time or technical support provided by OSU's Communication Media Center, which may double the cost of offering the course. We invested approximately $4,000 in marketing the 1998 course during 1997. Furthermore, a substantial amount of the instructor's and CM's time both years was related to marketing. The total direct cost for the two years was $63,780, which is equivalent to $174 per student-credit-hour for off-campus students. The OSU business office estimates that a typical lower division course taught on campus costs $224 per student-credit-hour (Robert Duringer, OSU Business Affairs). Thus, our course was comparable in costs to similar courses taught on campus. Our grant from USDA paid for $39,221 of our direct costs; the departments of Fisheries and Wildlife and Communication Media Center made substantial commitments to production of the course. Once marketing of the course is assumed by other OSU departments, we believe we can offer the course off-campus with minor instructor commitment and a TA to coordinate off-campus facilitation, testing and evaluation, and database management (< $5,000/ term).

Our grant from USDA also allowed us to highly subsidize tuition for off-campus students during the first two years of the course. We set tuition the first year at $150, and during 1997 we charged $200. During 1997, all off-campus students were required to make arrangements to view the tapes with our assistance. Options included local cable TV if available, or purchasing a set of tapes for $225. High schools purchased these tapes for students and we loaned tapes to most other sites. However, our 1997 brochures implied that students would have to purchase the tapes, which likely reduced interest in the course. For the Winter 1998 term, tuition for high school students was set at $225 via an arrangement with OSU's High School Outreach Program (HSOP) and $315 for other off-campus students. Furthermore, HSOP made a one-time offer to purchase tapes for all high schools enrolling one or more students. During 1998 we also began a program of renting sets of tapes for $35 plus a deposit of $190.

DISCUSSION

Overall, we were pleased with the enrollment and student response to both the satellite and video presentations of our course. Student satisfaction was high in spite of reduced classroom interaction and the number of instructors (Diebel *et al*. 1998). Many students expressed appreciation for access to a course that they would otherwise be unable to take any other way. Distance students performed as well as on-campus students, which is consistent with numerous studies of distance learners (Garrison and Shade 1990, Evans and Nation 1992, Bell and Tight 1993). High school students that took the class generally did well in the course, suggesting that offering advanced college credit provides an excellent fast-start opportunity for these students, and that the subject matter is appropriate for high school audiences. Furthermore, our enrollment of four freshmen during fall 1997 who had already taken our course suggests that the course might increase our undergraduate enrollment (a double-edged sword during difficult fiscal periods).

Our experience with both satellite and video technologies suggest that both methodologies have strengths and weakness, and are probably appropriate for different types of classes. Both approaches will require a substantial commitment by the instructor(s), requiring from three to six times the amount of effort to develop and conduct compared to an on-campus offering. In our minds, satellite delivery is most appropriate for special one-time offerings, professional courses, or for courses where interaction with distance audiences is important. Although interaction during our satellite delivery was minimal, we did little to foster it at the beginning of the course. Early exercises such as everyone in the class introducing themselves, reinforced by regular instructor-initiated questions and discussions could decrease students' fear of the technology (Diebel *et al*. 1998), and could substantially increase classroom interaction. Another solution for lack of classroom interaction is the use of separate discussion periods led by the off-campus facilitator. This strategy is currently being used by some off-campus sites. Satellite courses are expensive to produce and maintain. Satellite fees and communications costs for our course were almost $10,000, and do not represent market prices because Oregon Ed-Net subsidizes these costs. If the course was placed on a cost-recovery basis, tuition or technology fees would have to be relatively expensive, a situation that is probably most appropriate for professional-degree courses. For example, Oregon Health Sciences University offers a state-wide nursing program via satellite. Scheduling of a satellite course may also offer challenges unless it is done well in advance. Calling your up-link provider the term before you offer the course and requesting the 10:00–11:00, Monday-Wednesday-Friday slot is likely to result in a disappointing response. A final challenge to satellite delivery is the inevitable technology breakdowns. During our satellite delivery, we only had one instance where we were unable to uplink our broadcast for a 10-minute period, and three cases where a receive site had equipment problems, requiring us to mail a tape of the broadcast. However, we have heard some horror stories of daily problems with receive sites and frequent uplink site problems. Instructors must maintain a high degree of flexibility to be able to adapt to these challenges.

Producing the course in a video format provided us the opportunity of reaching a distance audience at a reduced cost, while decreasing scheduling problems. One-time production costs for the video course was relatively high, but now that the course has been produced, it is likely to generate income to the Department of Fisheries and Wildlife. Most importantly, our video course reduces scheduling conflicts with distance learners. Students can view the tapes at their leisure as long as they are prepared to take the exams at approximately the same date that we administer them to other sites. Furthermore, we can now offer the course totally asynchronously. For example, three high schools will expand the course into a full spring semester during 1998, rather than completing the course within the 10-week OSU quarter. Alternatively, students could compress the time needed and take the course during spring break.

A video course does offer some challenges. We encountered some resistance to the purchase price for the tapes, but believe that our rental program may reduce that problem and result in an increased enrollment in future years. A video course will require regular updating. Although our course was designed to be as timeless as possible (a principle is a principle) it is likely that one or more lectures will need to be updated annually. For example, we have two lectures on endangered species, which will need to be revised as soon as Congress reauthorizes and changes the Endangered Species Act. Revising tapes also requires a tracking database so that owners of tapes can be notified about updates. Finally, the video format presents challenges to lecture design and presentation. Our TV-oriented society has grown to expect high quality

production from something they view on the TV. Our lectures that were predominately "talking heads" consistently received the poorest evaluations. Fortunately, most natural resources subjects are visually attractive (i.e., students love to see pictures of animals and habitats). Furthermore, state and federal natural resources agencies usually have large video libraries, and footage for enhancing lectures can be obtained at low costs. All that is needed is the time required to solicit, view and select the appropriate roll-ins.

A major difficulty we encountered was marketing the class. Without an effective marketing system, you can produce an exceptional course that should have wide appeal and end up with just a few students. When we began our effort, the Office of Continuing Higher Education at OSU was the department that advertized distance education courses and enrolled off-campus students. However, their program had largely been designed to offer continuing education opportunities on campus; off-campus advertizing was minimal. Over 90% of the students we enrolled in our class the first two years were a direct result of the marketing we conducted from within the Department of Fisheries and Wildlife. We are convinced that there is a much larger market for this course, both nationwide and within Oregon. Within Oregon, all high school students are required to obtain a Certificate of Advanced Mastery (CAM) in one of eight subject areas. Most rural high schools in Oregon will offer the Natural Resources Systems CAM. Because the course meets many of the proficiency standards for the Natural Resources Systems CAM, we believe there is a potential market of up to 500 high school students participating in the course; many of these students would enroll for OSU credit and would later matriculate at OSU. OSU HSOP is beginning to develop an effective marketing system (we taught them many of our tricks), which should reduce our marketing requirements in the future. Every state in the country has at least one university offering undergraduate degrees in fisheries and wildlife, and with few exceptions all require a similar course in their curricula. OSU is one of two universities offering this course for distance learners. The University of Kentucky is the only other university that offers a similar course, and currently they only offer it to high school students.

Future Course Enhancements

We continue to revise and enhance our video course and have three major changes planned for the near future. In addition to lectures that are revised because of content changes, we plan to retape a few lectures each year and further enhance the visual attractiveness of the course with additional field footage. We have received a second grant from USDA to develop an interactive website to support our video lectures. Our objectives for the grant are to (1) develop a self-guided, interactive website to reach and motivate large audiences efficiently; and (2) identify effective components of distance education and distribute our findings to natural resources and agricultural sciences educators nation-wide. An interactive module will supplement each lecture topic and will include hyper-linked text and graphical demonstrations of principles and concepts. Each module also will include a quiz covering the subject that will give students immediate feedback on their answers (e.g., "Correct," or "B is incorrect because . . ."). Finally, all modules will contain a built-in evaluation so that we can receive feedback from the student as they finish the exercise. After this site is developed we will need to evaluate the access of potential students. Although a majority of students have internet access (Diebel *et al*. 1998), there is still the potential of outstripping the student's technological resources, such as graphic software and modem capabilities. Beginning in the summer of 1998, we will offer an in-service training course to high school teachers who are interested in the course. Our in-service training will cover course logistics including website navigation, course content, and offer ideas for field exercises that teachers can use to supplement the course. Finally, we have asked The Wildlife Society to provide us with a peer-review of our course. To our knowledge, this would be the first peer-reviewed course in natural resources curricula. We hope to obtain professional suggestions for improving the course and a peer review may enhance our nationwide marketing efforts.

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THE INTERDISCIPLINARY NATURAL RESOURCE AND ENVIRONMENTAL POLICY PROGRAM AT UTAH STATE UNIVERSITY

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ABSTRACT: The Natural Resource and Environmental Policy Program at Utah State University (USU) is an interdisciplinary, graduate, educational program that has been developed since the fall of 1991. The program administers and awards a graduate certificate, sponsors invited speakers, oversees student policy presentations, and facilitates interdisciplinary collaboration. The program has earned broad, campus-wide support and participation. All eight colleges at USU supported approval of the certificate program in 1994. At present, sixteen academic units are represented on its Faculty Advisory Committee, which oversees and makes decisions about the program. Fifty graduate students from fourteen academic units have pursued the Interdisciplinary Certificate in Natural Resource and Environmental Policy, eight students have received the certificate, and sixty-three faculty representing twenty academic units are affiliated with the program. The graduate certificate program appears to be enhancing students' employment options in applied resource management and coordination roles. This paper reviews program development efforts, describes the program, analyzes some of the challenges and opportunities that have confronted program developers, and offers a preliminary assessment of outcomes.

INTRODUCTION

The process of developing the Natural Resource and Environmental Policy Program at Utah State University (USU) has been an exciting endeavor and has produced several significant accomplishments over the past six years. Those accomplishments include establishing a growing interdisciplinary graduate certificate program, facilitating interdisciplinary education at USU, and bringing interesting and provocative outside speakers to campus to lecture about and discuss a variety of current policy issues with members of the USU and local communities. The program development process has also included some significant challenges that tend to be common to interdisciplinary programs attempting to cross the politically entrenched departmental structures typical at most universities. The form that this program has taken can best be understood in light of the institutional opportunities and constraints that it faced at the time of its development.

DEVELOPMENT EFFORTS

Background

Utah State University, the land-grant institution for Utah, has had long-standing natural resource and environmental emphases in various academic programs, for instance in natural resource disciplines (Forest Resources, Fisheries and Wildlife, Rangeland Resources), in some of the social and behavioral science disciplines (Sociology, Economics, Political Science, History), and in several professional program areas (Environmental Engineering, Landscape Architecture and Environmental Planning). Within this context, there was much interest and a fair amount of informal cross-disciplinary interactions in terms of research, graduate student committees, and student selection of courses outside of their departments. Thus, some people became interested in creating a structure that would encourage and facilitate such cross-disciplinary exposure and collaboration.

Original efforts to develop a natural resource and environmental policy program such as the one described in this paper were initiated at Utah State University in the early 1980s. An ad hoc committee of faculty from several natural resource and social science programs began to meet to consider the issue. In March 1985, several people involved in and knowledgeable about natural resource and environmental policy were invited to Utah State University for consultation on the potentials for and possible nature of such a program. These people were: Robert Nelson, Office of Policy Analysis, United States Department of the Interior; Gary Shute, Senior Public Affairs Research Analyst with Standard Oil of Indiana; Jack Peterson, Executive Director and Chief Economist of Idaho Mining Association; Steven Kellert, Associate Professor of Forestry and Environmental Studies at Yale University; and, George Coggins, Tyler Professor of Law at the University of Kansas. Despite these consultants' concurrence on the need and potentials for a natural resource and environmental policy program at Utah State University, efforts to establish one did not come to fruition at that time.

Efforts to establish a natural resource and environmental policy program were renewed in the fall of 1991 with responsibilities for overseeing such an effort assigned to a new faculty hire (Joanna Endter-Wada) whose tenure-track position resided in the Department of Forest Resources within the College of Natural Resources. One of the first activities pursued by the program was sponsorship of a seminar series featuring invited speakers. These invited speakers included academicians, federal and state resource agency personnel, and members of natural resource and environmental organizations. A steering committee for the new program met with these invited speakers during their campus visits to discuss Utah State University's efforts to establish this program. These consultations were encouraging and helpful to program development efforts.

Need Assessment

External constituencies provided one important source of need assessment for the new program. Heads of natural resource agencies, owners of environmental consulting firms, and members of non-profit organizations expressed the need for resource professionals with broader backgrounds than the sets of technical skills that natural resource programs had emphasized in the past. They recognized the fact that many of the problems confronting natural resource and environmental managers are social, as well as technical, in nature. Public involvement in decision-making, equity concerns, and conflict management were becoming critical issues for them. Resource professionals were increasingly being challenged to design management strategies and public policies which maximize human well-being, environmental quality, and ecological integrity. The Natural Resource and Environmental Policy Program was designed, in part, to better prepare resource professionals to meet the public policy challenges of developing innovative, creative and feasible approaches for addressing these issues.

The other important source of need assessment came from students themselves. Some USU graduate students had, on their own, put together more diverse and interdisciplinary programs of course work designed to gain a broader perspective on natural resource issues than they found available within their own departments. In addition, faced with a tight job market, graduating students were having a harder time finding desired professional employment. Students were eager for any educational advantages they could obtain that would put them in a more employable position. Thus, other rationales behind the program were to have students develop familiarity with both disciplinary and interdisciplinary concepts and principles of the social, natural, and physical science approaches to natural resource policy and to engage students in educational activities and thesis projects designed to apply this training to current policy and management issues. We hoped that by providing students with a more comprehensive educational framework for understanding complex natural resource and environmental concerns and with the critical thinking and analytical skills needed to address these issues, we would enhance their employment opportunities.

Based upon feedback from external constituencies and students, the program undertook a formal survey of other natural resource and environmental policy programs around the country to determine how they were structured, how they were funded, who they recruited, and how successful they were. We used this information to assess if there was a market for a such program at USU and to see if we could find some models that best fit our own set of institutional constraints. We determined that a graduate certificate program seemed to be the best alternative, where graduate students would still obtain a needed disciplinary degree but in addition have the opportunity to broaden their training through pursuit of an interdisciplinary certificate. There were no such graduate certificate programs in Utah at the time. Certificate programs similar to the one we have developed existed at the University of Colorado and at the University of New Mexico, but the former program had a law emphasis while the latter focused more on economics and public administration. The program that has been developed at Utah State University is unique regionally and nationally in terms of its interdisciplinary breadth and capitalizes on Utah State University's strengths in the social science aspects of natural resource and environmental policy.

Program Building Process

The Natural Resource and Environmental Policy Program has evolved through a series of efforts undertaken over the past six years. The first year involved program conceptualization and establishment and initiation of the program's seminar series. Program conceptualization and establishment activities

included discussing visions for the program with students, faculty, and administrators, conducting the formal needs assessment which included soliciting information on similar programs at other universities, making campus presentations about ideas for the program, establishing an informal steering committee of interested faculty, preparing and submitting proposals, hiring office staff, and negotiating arrangements for a budget, office space, and equipment. The program's seminar series was initiated with a set of speakers who addressed the theme, "Policy Analysis or Advocacy," which focused on the role of natural resource professionals in the policy process. The seminar series provided campus-wide visibility for the program and promoted interaction among faculty and students from different colleges at USU.

During the second year, development efforts were focused on program development and design and on coordinating the College of Natural Resources' annual Natural Resources Week Symposium, which draws from a national audience. The program development and design activities included further networking with USU administrators, faculty, and students, developing consensus on vision for the program and a mission statement, analyzing similar programs around the country (which included phone conferences with key individuals involved in their development), designing a curriculum for the graduate certificate program, and exploring foundation, government, and private funding opportunities. The Natural Resources Week Symposium, which was entitled "Conflicts in Natural Resources Management: Integrating Social and Ecological Concerns," was planned by faculty members from the Natural Resource and Environmental Policy Program. The symposium was very successful (in terms of attendance and audience evaluation) and established the precedent of enabling graduate and undergraduate students to attend the symposium for course credit in order to become better informed about current natural resource policy and management issues. In addition, the program continued to sponsor its own invited speaker seminar series and established permanent offices in the newly constructed Quinney Natural Resources Library addition to the College of Natural Resources.

The third year was characterized by program approval and institutionalization as two significant milestones were reached. The first milestone was that the Policy Program obtained university and state approval for the Interdisciplinary Graduate Certificate Program in Natural Resource and Environmental Policy. This involved securing institutional support from participating departments, colleges, and decision-making entities, including the Dean's Council, Graduate Council, Educational Policies Committee, Faculty Senate, Graduate Dean, Provost, President, and USU Board of Trustees. State approval for the certificate program involved responding to comments from other institutions of higher education in the state and seeking final approval from the Utah Board of Regents, which was achieved in May 1994. The second milestone was that the program obtained more permanent, institutional funding from the College of Natural Resources and the College of Humanities, Arts, and Social Sciences. Other development activities during year three included formalizing a Faculty Advisory Committee with representatives from academic units involved in fostering the program and continuing sponsorship of the invited speaker seminar series.

Efforts in the fourth year of the program focused on implementing the Interdisciplinary Graduate Certificate Program, developing the new courses designed for students in the program, and coordinating the speaker series which students began attending for credit toward the certificate. Implementing the certificate program involved program advertizing, student recruitment, student advising, conducting formal meetings of the faculty advisory committee, establishing office procedures to ensure the program was well monitored, and setting up files on students, affiliated faculty, and program courses. The new courses developed specifically for students enrolled in the program consisted of a cornerstone course, the invited speaker seminar series, and a student policy presentation seminar series. Administrative activities continued, such as operating the office, responding to inquiries about the program, preparing budget proposals and funding requests, and representing the program at various university functions.

For the fifth and sixth years, development efforts focused on refining the details of program administration and planning for the future. Monitoring and improving courses and program administration were achieved through soliciting and incorporating suggestions from enrolled students and affiliated faculty. Procedural guidelines for awarding the graduate certificate were established as students began to complete the program and receive certificates. The program is currently occupied with the transition from quarters to semesters being undertaken at Utah State University, hoping to be strengthened by impending changes in the curriculum offered by participating departments and programs. In the near future, the program will begin overseeing the awarding of student cash prizes for student research and papers focusing on examples of agency use of science in policy-making. These awards will be issued in cooperation with several federal land management agencies. The Policy Program is also devising a five-year plan for further growth and development that will be made possible by new funding to be provided by a private foundation commencing in July 1998. Finding creative ways to intensify the level of interdisciplinary interaction between faculty and students at USU and to increase the relevance of both natural and social sciences to public policy and decision-making are additional longer term goals of the Natural Resource and Environmental Policy Program.

PROGRAM DESCRIPTION

Program Goals and Objectives

The mission and goals of the Natural Resource and Environmental Policy Program are: 1) to foster integration of knowledge from the social and natural sciences and its application to policy issues through interdisciplinary education and research; 2) to stimulate the search for innovative, creative, feasible solutions to challenges involved in developing natural resource/environmental policies and management strategies; 3) to analyze ways of facilitating public involvement in decision-making and of managing conflicts over natural resources and environmental issues; and, 4) to provide service to policy makers, natural resource managers, and public constituencies through applied research, analysis, and information transfers.

Interdisciplinary Representation

All eight colleges at USU supported the formation of the Natural Resource and Environmental Policy Program. Sixteen academic units are represented on the Policy Program Advisory Committee. The sixty-three affiliated faculty come from twenty different academic units and the fifty students in the program represent fourteen different degree granting programs. The following list illustrates the program's cross-disciplinary breadth, where participation on the Faculty Advisory Committee (FAC) and formal membership by affiliated faculty (AF) and students (S) are indicated after the various units.

- College of Agriculture
  - Agricultural Systems Technology and Education Dept. [FAC, AF, S]
  - Plant, Soils and Biometeorology Dept. [AF, S]
- College of Business
  - Business Administration Dept. [FAC, AF]
  - Economics Dept. [FAC, AF]
  - Management and Human Resources Dept. [FAC, AF]
- College of Education
  - Health, Physical Education and Recreation Dept. [AF]
- College of Engineering
  - Biological and Irrigation Engineering Dept. [AF, S]
  - Civil and Environmental Engineering Dept. [FAC, AF, S]
- College of Family Life
  - Human Environments Dept. [AF]
- College of Humanities, Arts, and Social Sciences
  - American Studies Program [S]
  - History Dept. [FAC, AF, S]
  - Landscape Architecture and Environmental Planning Dept. [FAC, AF, S]
  - Political Science Dept. [FAC, AF]
  - Sociology, Social Work, and Anthropology Dept. [FAC, AF, S]
- College of Natural Resources
  - Fisheries and Wildlife Dept. [FAC, AF, S]
  - Forest Resources Dept. [FAC, AF, S]
  - Geography and Earth Resources Dept. [FAC, AF, S]
  - Rangeland Resources Dept. [FAC, AF, S]
  - Watershed Science Unit [FAC, AF, S]
- College of Science
  - Biology Dept. [FAC, AF]
  - Toxicology Program [S]
- University Libraries [FAC, AF]

Graduate Certificate Program

The main activity presently of the Natural Resource and Environmental Policy Program is administering the Interdisciplinary Graduate Certificate in Natural Resource and Environmental Policy. The certificate program is a unique interdisciplinary program that is supplementary to disciplinary degree programs, and trains students for careers in government, education, consulting, and conservation. A student who completes this program receives a certificate in Natural Resource and Environmental Policy, and notification of this certificate appears on the student's transcript.

The certificate program recruits from students accepted into thesis-requiring master and doctoral degree programs at Utah State University who satisfy the program prerequisites of having undergraduate or other experience in natural, physical, and social sciences and/or demonstrated understanding of general ecological principles, earth processes, and social systems. A sub-committee of the Policy Program Advisory Committee reviews graduate student requests for admission to the program.

Students must complete several course requirements in order to obtain the certificate. First, an integrative cornerstone seminar offered each year as a team-taught course is normally taken in the student's first year. Second, students are expected to take at least four courses from a list of twenty policy core courses offered by several departments to gain perspective on different disciplinary approaches to natural resource policy. Students are required to take graduate course work in other departments as only one of these courses can be from the student's home department. Finally, students must participate in two other integrative activities. They must attend the invited speaker seminar series for credit (one year of attendance for master students; two years of attendance for PhD students). In their last year of graduate school, certificate candidates must make a public presentation on the policy dimensions of their thesis or dissertation as part of the student seminar series, for which they receive one credit. Administrative requirements include having a faculty member affiliated with the Policy Program on students' graduate committee and completing various forms to receive the certificate.

Invited Speaker Seminar Series

The Policy Program sponsors a seminar series that features about nine invited speakers each year (three per quarter). Speakers are generally recommended by students and faculty and the Policy Program often cooperates with departments to co-sponsor speakers. The seminar series has included diverse speakers from venues such as government, conservation groups, academia, and non-profit organizations. These speakers have addressed local, national, and international natural resource and environmental policy issues. The seminar series is widely advertised and serves not only affiliates of the Policy Program but members of the USU campus community and the broader local community in which the university is located.

Program Administration

The Interdisciplinary Graduate Certificate Program is overseen and administered by the Natural Resource and Environmental Policy Program Faculty Advisory Committee, which consists of representatives from the sixteen academic units participating in the program. The Faculty Advisory Committee members make decisions concerning program policies and student admissions, review and coordinate the courses included in the program, and advise certificate students from their respective departments.

Program management and record keeping is handled by the director and staff of the Natural Resource and Environmental Policy Program. The program director is an associate professor in the Department of Forest Resources. One-third of her nine-month appointment is allocated to the Policy Program. The program's staff consists of one half-time staff assistant and a part-time student worker.

Several academic units at Utah State University have provided funding and support for the program over the past six years. The Department of Forest Resources has provided the director's salary and some administrative support. The College of Natural Resources has provided the staff assistant's salary, one-half of the program's $8,000 annual operating budget, and office space. The College of Humanities, Arts, and Social Sciences has provided the other half of the program's annual operating budget. In addition to funding, these units have provided the critical political support that was necessary to develop the program.

CHALLENGES AND OPPORTUNITIES

Program Formation Context

The Natural Resource and Environmental Policy Program faced several challenges and opportunities during the formation process. Efforts in the mid-1980s to initiate the program were stifled by lack of support from several key administrators who placed more emphasis on disciplinary expertise than interdisciplinary collaborations and who were in positions to prevent the program from moving forward at that time. Changes in some administrative positions and the hiring of some key administrators who were much more receptive to such initiatives led to the revitalization of program development efforts in 1991.

The USU context in the early 1990s presented other challenges for program development. The most important constraint was the competition for resources by departments and programs already in place. Limited state funding had led Utah State University to rely heavily on external funding sources, principally research contracts and grants, and the College of Natural Resources, along with several other colleges, had become highly leveraged. Department heads had become dependent upon salary and overhead return money that their faculty brought in from outside sources and were protective of their positions as cost centers for research projects. In this context, the politics of university decision-making made it highly unlikely that proposals for new cost-center programs would be supported. Key decisions were made during the first year by university administrators, one of which was that the Policy Program would emphasize curriculum development and would not become a research unit and seek cost center status.

At the same time, limited state funding and leveraging had increased pressures on faculty to compete for extramural funding, which limited their availability to offer additional classes or create new ones in support of the Policy Program. Faculty members' past efforts in support of interdisciplinary programs had oftentimes been unrecognized, unrewarded, or opposed by department heads whose priorities were on ensuring faculty loyalty to meet departmental needs first. However, Policy Program resources were limited. The program was allocated a small amount of seed money. It had no faculty positions except one-third of the director's nine-month appointment, and insufficient funds to offer compensation to faculty to develop or teach courses designed specifically for the Policy Program. The program initially shared a secretary with two other interdisciplinary programs, had a half-time professional staff person, and had limited office space. Resource reallocation was nearly impossible given the political power of department heads and their desire to protect existing departmental budgets and space allocations. As a result, efforts to develop the program's curriculum were of necessity oriented toward primary reliance on existing courses offered in the participating departments.

Another factor that influenced the form that the Natural Resource and Environmental Policy Program took was the fact that two other interdisciplinary programs already existed within the College of Natural Resources, the Ecology Center and the Watershed Sciences Unit. The directors of those programs had previously had battles with department heads and college administrators over issues typically raised by

programs that attempt to cross major institutional boundaries, such as funding, space allocation, faculty loyalty and time commitments, receipt of credit and provision of services for interdisciplinary program students, appropriate evaluation and recognition of interdisciplinary contributions by faculty, and administrative discretion. The result was that college administrators and department heads did not want to see a program that looked like either of the existing interdisciplinary programs, but instead wanted a program that would be less threatening to the current situation.

Interestingly, the two existing interdisciplinary programs differed quite substantially from one another and from the eventual form that the Policy Program took. The differences are best explained in terms of the timing and politics of when they were initiated. The Ecology Center is over thirty years old and has the advantage of a large annual line item allocation from the state legislature originally secured when state funding for higher education was more readily available. It is able it to support a twelve-month half-time director, a full-time professional assistant to the director, and a full-time executive secretary. The Ecology Center also pays portions of faculty salaries and in return prescribes courses those faculty will teach in support of its graduate educational program. The Ecology Center has cost center status which enables it to secure overhead return on research projects it administers. Graduate students in the Ecology Program receive degrees from their respective departments but with an ecology emphasis based upon course work approved by an Ecology Center steering committee (e.g. students can earn degrees in Forest Ecology, Fisheries Ecology, etc.).

The Watershed Science Unit was developed about twenty years ago and is unique in being the only non-departmental degree granting program at Utah State University. Students can earn B.S., M.S., and PhD degrees in Watershed Science. The program was originally developed and continues to survive based upon the commitment of a core group of natural resources faculty to understanding and teaching how water moves through natural landscapes (which differentiates it from engineering) and why it is important in the diverse ecosystems of the arid West. The program operates with minimal financial and staff resources. It depends upon faculty to negotiate with their department heads to allocate portions of their teaching loads to support the program and upon someone to direct it for minimal compensation.

Since neither of the interdisciplinary programs at Utah State University provided a model that was possible to emulate in the early 1990s, we looked to other universities for ideas. The certificate programs from the University of New Mexico and the University of Colorado provided interesting examples of program structures that appeared to be financially and politically feasible. The program could be built, for the most part, upon existing courses that were selected, approved, and packaged for their relevance to the program's goals, thus reducing costs and conflicts over commitment of faculty time. A certificate program was less threatening to existing departments because it recruited from students already admitted into their programs and it enhanced the educational opportunities available to their students.

One additional constraint which probably delayed design and approval of the certificate program by about one year was debate that occurred during the 1992-1993 academic year over whether the university should transition to a semester system. A new university president, who was determined to instigate the change at the behest of the Board of Regents, eventually chose to defer a decision on the matter, in part due to strong faculty opposition. During this time, faculty were reluctant to put much effort into shaping educational programs that might soon be irrelevant if a semester conversion resulted in wholesale curriculum revisions. Ironically, a transition to semesters was later mandated state-wide by the Board of Regents without discussion and is scheduled to be implemented during the 1998-1998 academic year. Because this occurred well after the Policy Program implemented its certificate program, the transition poses little risk to the program's survival, although it does pose new challenges as well as opportunities for modifying the content offered in some courses.

Given these contextual challenges, what opportunities account for the program's success? The most significant factor has to do with the visions of faculty members, their recognition of important changes occurring in the field of natural resource management, and their collective commitment to interdisciplinary education and to making this program a reality. Their program building efforts were shaped by feedback from students and external constituencies, who affirmed that this was a valuable pursuit. In addition, the support of the deans from Natural Resources and from Humanities, Arts, and Social Sciences and of several department heads (particularly from Forest Resources and Sociology) helped with the institutional politics. The program also benefitted from the fact that a new Quinney Natural Resources Library attached to the College of Natural Resources building was dedicated in fall 1992 and the Policy Program was allocated some office space in this new building.

Institutional Concerns

Part of the program building process involved securing support and approval from several USU decision-making bodies, including the Dean's Council, Graduate Council, Educational Policies Committee, Faculty Senate, Graduate Dean, Provost, President, and USU Board of Trustees. A formal program proposal had to address various institutional concerns. The proposal included four sections: 1) the request which stated the justification of need and an indication of whether similar programs were offered elsewhere in the state or region; 2) an indication of institutional readiness which included an explanation of the program's relation to USU's overall mission and goals, how the program would be

administered, the impact of the program on other programs at USU, faculty and staff needs, and, requirements for new facilities, equipment, and library or learning resources; 3) a description of the curriculum, projected enrollments, and involvement of external consultants in developing the proposed program; and, 4) estimated costs and projected budgets for the first five years.

State approval for the certificate program from the Utah Board of Regents involved having other institutions of higher education in the state review and comment on the proposed program and then responding to their comments. The only real opposition to the program came from another state-supported university, which had no program that was in direct competition with the Policy Program but which was making plans for future development in this general area. That university's comments were addressed and the program was approved.

Curriculum Issues

One of the impacts of the Graduate Certificate Program on existing programs has been to increase student diversity and enrollments in some graduate courses, particularly those identified as core courses for the certificate. The core courses consist of one course from Agricultural Systems Technology and Education, one course from Civil and Environmental Engineering, two courses from Economics, two courses from Forest Resources, two courses from Fisheries and Wildlife, two courses from Geography and Earth Resources, two courses from History, one course from Landscape Architecture and Environmental Planning, two courses from Political Science, one course from Recreation Resources, one course from Rangeland Resources, two courses from Sociology, and one course from Watershed Science. The Advisory Committee has provisions for including new core courses as appropriate ones become available. All of the professors who teach courses identified for inclusion in the certificate program agreed to have their courses listed as part of the program. These professors are committed to interdisciplinary education. However, the challenges and benefits of having students from various disciplinary backgrounds in their graduate courses have become more apparent over time.

The increased enrollment in certificate courses has changed the nature of some formerly small graduate seminars, but has generally been manageable and welcome in most instances. Some graduate courses that risked cancellation from lack of sufficient enrollment or were only taught sporadically given limited departmental student demand have been stabilized and are offered more regularly.

The greatest challenge for professors has been to meet the disciplinary needs of departmental students as well as the interdisciplinary needs of graduate students from other departments who may not be very well prepared for advanced course work in another department. Graduate students sometimes struggle in advanced courses outside their own discipline. Although the program has tried to address this issue by having students meet some cross-disciplinary prerequisites, some problems persist. The most obvious benefits of the increased course diversity are student enlightenment that comes from exposure to different viewpoints, challenges to disciplinary assumptions and mind sets (which hones critical thinking), lively debates, and comradery with students that program participants might not otherwise meet. The challenges and opportunities are really two sides of the same coin. Students and faculty do occasionally struggle with the need to learn and communicate outside of their accustomed disciplinary niches, but they are also enriched in the process.

The cornerstone course for the Policy Program has been an attempt to deal with disciplinary diversity during the first year of students' courses of study. The major objectives of this course are: 1) to introduce students to different disciplinary perspectives for understanding and analyzing natural resource and environmental policies and decision-making processes; 2) to help students understand the role of science in policy-making; and, 3) to challenge students to evaluate and integrate information about a common resource management or environmental policy issue that tends to give rise to competing and often contentious perspectives. This is achieved by focusing on a highly visible and controversial current natural resource policy issue, having a team of faculty affiliated with the Policy Program participate in the course, and giving students opportunities to meet with people directly involved in the issue (via forums or guest speakers, attendance at public hearings, field trips, etc.). The cornerstone course presents a unique opportunity for students to assess available data, follow news coverage of an issue, and have discussions with representatives of different viewpoints.

ASSESSMENT OF OUTCOMES

The success of the Natural Resource and Environmental Policy Program can be assessed by various outcomes. Program growth and development as marked by milestones mentioned previously are one indication of the program's success. The program has gained increased university recognition and stature for its educational contributions through the certificate program and its visible seminar series that serves the entire campus community. The program has had a positive effect on departmental programs' abilities to recruit highly qualified faculty and graduate students as they perceive additional benefits from being involved in the program.

The program is fulfilling its main objective of facilitating interdisciplinary graduate education. Student enrollment has grown to fifty students in the almost four years since the graduate certificate was approved. Graduate students appear to be satisfied with the program, as indicated by opinions expressed in exit interviews and in advising sessions with the

director. For some students with broad interests that do not fit neatly within departmental structures, the Policy Program is perceived to be their main academic unit of affiliation and has given them an enhanced identity. From experiences of the eight students who have received the certificate (two PhD students and six master students), the program appears to be positioning them for more applied resource management and coordination roles. Of the two PhD students, one is working as an agricultural economist for the Economic Research Service of the USDA in Washington D.C. through the Presidential Management Intern Program, while the other is working as a coordinator of conservation and rural community development programs for the Natural Resource Conservation Service in Colorado. Of the six master students, one is working as an environmental analyst for a private consulting firm in Utah, one is a program associate for forestry extension at Utah State University, one is a county extension agent in Montana, one is a Natural Resource Conservation Service agent in Missouri, one (recently completed) is volunteering for an environmental agency while seeking more permanent employment, and the last one has just completed and is on the job market.

Finally, the program is involved in numerous forms of outreach and extension through its seminar series and through the individual activities of various affiliated faculty members. The program has been of direct service to state policy makers through the role that the director played in 1996-1997 chairing a state-wide legislative task force on forestry issues. Many faculty affiliated with the program are involved in outreach teaching roles through short courses that address the training needs of resource management agencies. In addition, faculty and students are involved in focused research efforts that are conducted on behalf of or in cooperation with federal and state resource and environmental agencies.

SUMMARY

The Interdisciplinary Natural Resource and Environmental Policy Program at Utah State University has been developed since 1991, although efforts to establish such a program date back to the mid-1980s. The program's goals are to foster interdisciplinary collaboration toward addressing a variety of natural resource and environmental challenges in order to better train the next generation of resource management professionals and to be of service to policy makers, natural resource agencies and professionals, and public constituencies. Input from external constituencies and from USU graduate students, as well as a formal assessment of similar programs in the United States, established demand and need for such a program.

Program development efforts included formulating a common vision and mission statement, networking with faculty and administrators, negotiating over access to resources (office space, staff, operating funds), finding innovative ways to work within the existing university political and resource allocation structure, designing a curriculum, seeking institutional and state approval, and implementing and administering the certificate program. Current program activities involve administering a graduate certificate program and sponsoring an invited speaker seminar series. The program has gained wide cross-disciplinary and institutional support.

The major challenges to program development had to do with the political and institutional context at the time it was developed, which was characterized by limited resources, institutional leveraging, increased pressures on faculty, the existence of other interdisciplinary programs that threatened departmental structures, and uncertainty over whether USU would transition from a quarter to a semester system. Several opportunities account for the program's success, given the challenges it faced: faculty commitment to a common interdisciplinary vision, recognition of important changes occurring in natural resource fields, the support of several key deans and department heads, and allocation of some space, faculty and staff time, and money to initiate the program.

The program has had several impacts on USU. It has increased the enrollment and diversity in some graduate courses, which present challenges as well as opportunities for faculty and students. The program has aided in new faculty and student recruitment and increased satisfaction among some graduate students not comfortable within departmental confines. The program has grown, gained recognition, increased employment opportunities for graduate students, and been of service to outside constituencies.

Some continuing challenges confront the program. The program must contend with departures or shifts in role assignments of key faculty. Programmatic reorientation in some departments can occur. Institutional pressures, particularly regarding growth in undergraduate enrollment, can have impacts on the allocation of resources to graduate education.

The program is seeking ways of extending educational opportunities for students in the future. Being a better source of information as well as funding are primary goals. Enhancing graduate student opportunities to participate in field trips, professional meetings, and internships, as well as helping students find policy-related professional employment, are directions for future development.

NEW IDEAS FOR TEACHING NATURAL RESOURCE MANAGEMENT: FROM THE LONG-TERM REALITIES OF NATIONAL FOREST MANAGEMENT

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ABSTRACT: Research and study of 90 years of managing multiple uses on national forests has revealed three new ideas or understandings about the nature of forest management (Fedkiw 1997a).

The first idea is a new definition that describes the task of forest management and the role of forest managers. The second emphasizes the critical, continuous role of the learning experience that accompanies resource management and its relationship to both the adaptive and holistic ecological approaches to resource management. The third establishes that forest management has been on a pathway toward a holistic ecological approach from the beginning of American forestry. It also describes how forest management advanced, and continues to advance, incrementally and adaptively on that pathway in response to intensifying and diversifying uses and services; improving experience, technology, and science; changing markets and social preferences, and Nature's unexpected responses to use and management and her own random vagaries.

These ideas have a large potential for improving the knowledge, teaching, communication, and progress of forest management in the classroom, in the field, and with the general public and its interest groups. To be effective, however, these ideas must be communicated, discussed, debated, researched, tested, refined, and written about, not only among resource professionals, but also with students, interest groups, stakeholders, landowners, policymakers, and the public-at-large. New ideas tend to roll off like water off a duck's back unless they are communicated, discussed, and debated; highlighted in their newness; packaged in a familiar context, and presented in a user/audience friendly way with graphic images (Perry 1993).

INTRODUCTION

My learning experience in studying and writing about 90-years of managing multiple uses on national forests has revealed a range of new ideas and understandings about the long-term nature of forest management particularly, and resource management generally (Fedkiw 1997a). The new ideas have three focal points:

--- A functional rather than a technical definition of forest management,

--- The important learning experience accompanying the management, and

--- The movement of forest management along a pathway toward a fully holistic ecosystem approach.

These ideas are new primarily in their explicitness. They were largely implicit in the past management of national forests and other forest properties. Foresters just did not articulate them explicitly. They are poorly documented in the natural resource literature because long-term, on-the-ground shifts in resource use and management are poorly researched and difficult to observe or grasp---even from one's own long-term experience---without a systematic study approach. These new understandings emerged largely from the inductive and historical methodology of my study and three questions:

---Who used the national forests: what for, and why?

---How were the uses implemented and managed? And then,

---What happened in response to the management and the evolving science, technology, markets, and public values?

The study examined national forest management use-by-use, year-by-year, decade-after-decade for 90 years. My framing of these ideas was also shaped by the modern emphasis on the ecological approach to resource management.

THE NEW IDEAS

The New Definition

The idea for a new definition for forest management emerged early in my study as I began to explore the evolution of national forest uses, their implementation, and the consequences use-by-use, year-by-year. That methodology quickly revealed a practical understanding of the purposes of national forest

management: **fitting and maintaining multiple uses and services into ecosystems according to their capability to support them, compatibly with other uses on the same or adjacent lands, and in ways that assured the permanence of the uses, the resources, and their benefits for future generations**. This definition forthrightly describes the task of forest management and the role of forest managers; not only for students and resource professionals but also for users and the general public. Landowner/user objectives are reflected in the emphasis on uses and services.

This definition contrasts strikingly with the current "official" and largely academic, abstract definition: "the practical application of scientific, economic and social principles to the administration and working of a forest estate for specified objectives" or "that branch of forestry concerned (a) with the over-all administrative, economic, legal and social aspects, and (b) with the essentially scientific and technical aspects especially silviculture, protection and regulation" (Ford-Robertson 1971).

The methodology which led to this new definition also clearly reveals that management is driven by use and service demands whether they be commercial, recreational, environmental, societal, aesthetic, psychological, or spiritual.It likewise reveals that use and management come incrementally use-by-use, area-by-area, year-by-year and that the user not only has an interest in the use, but also in the management, for the use must be located where it is accessible as well as suitable and effective for the user's purposes.

This new operational definition appears to be universal, since it can be readily extended or adapted to apply to natural resources management generally or to its individual components such as wildlife or range management. It can even be extended to ecosystem management, and become the framework or a first principle in formulating a theory for ecosystem management. It can also be a useful framework in teaching forest and natural resources management.

We often talk about the need for better communications with the American people about forest management. A new definition that conveys a clear understanding of the task of forest management and the role of resource managers in fitting uses into forest ecosystems could be a big help in addressing this agenda.

A vivid operational definition could also enlighten and perhaps ameliorate the unending confrontation and debate about the "proper" use and management of our public and private forests. The debate is primarily about the optimum levels and combinations of uses of our forests and, only secondarily, about the technical aspects of resource management. When the debate mixes uses and their allocation on the land with management practices, i.e., ends with means, it confuses the issue and adds to the difficulty of its resolution. For example, concerns expressed by some individuals and groups over timber salvaging often are based on objectives for retaining those areas for future wilderness designation. The salvage management practice may be entirely appropriate and consistent with approved national forest management plans and guidelines.

The American people obviously have not come to an agreement about this issue of proper levels and combinations of uses and environmental services, particularly for national forests and generally for the Nation's forests. A meaningful definition of the task of forest management and the role of resource managers would help clarify the debate by focusing it on use, and policymaking on uses and ends rather than on management. It is not the technical capabilities of professional resource managers that is so much in question as the proper levels and combinations of uses and services for both public and private lands, and who determines them.

The role of the resource manager in determining uses is largely limited to their location on the land and matters of technical feasibility. Where there are differences among the public and users about the proper use of forest lands, managers often have difficulty finding a satisfactory resolution without compromises among the public interests and users. Appeals and court suits are often involved. The dominant role of the resource manager, of course, is in determining and applying the appropriate management practices to implement the uses compatibly with each other and assure the permanence of the resources and their supporting ecosystem.

The Learning Experience

Over time, the learning experience is a critical, but often unrecognized, aspect of managing forests. This idea emerged primarily from examining how the use and management of national forests evolved over time, use-by-use, year-by-year, decade-after-decade. It was the study's long-term perspective that revealed the dynamics of forest use and management---how the uses increased and diversified; how public interests and preferences changed; how management knowledge, technology, and science continually evolved, and how Nature often responded unexpectedly to management and from time to time introduced her own largely unpredictable events. This evolving aspect of public land management often made managerial judgment, reinforced by practical experience, equally and sometimes more important than the underlying science.

Ordinarily the long-term dynamics of forest use and management are difficult for managers with day-to-day problems to comprehend, because the long-term dynamics cannot be seen or observed. They can only be remembered or recalled from long-term on-site experience and observation. These are important axioms for teaching and practicing forest and resource management. An understanding of the long-term dynamics of forest use and management and the underlying causal factors is difficult to acquire or cultivate without a deliberate systematic approach for doing so. Often the documentation is inadequate and the formal research is even less adequate. An

even greater problem is the lack of general understanding about the need and importance of such information. Let me cite some examples of important early and modern learning experiences.

In the early decades of national forest management, it was widely accepted that predator control would contribute to the build up of game populations. In later decades, when game populations became a problem to their own food supply and to forest conditions, both national forest and state game managers introduced various practices including the direct reduction of some game herds and hunting options that would reduce and keep game populations within the limits of their habitat capacity and food supply. Predator control for game management was largely abandoned.

For several decades it was thought that good timber management constituted good game management. It increased food supplies, edge effects, and desirable cover for wildlife. In the 1960's, however, elk hunters and biologists throughout the Rocky Mountain area became concerned about the behavior of favorite herds and began to question the impacts of timber harvesting and road construction designs and practices on elk. The Forest Service and several partners undertook 15 years of research on the influence of timber management and harvesting and road construction on elk. This research uncovered needed changes in management in favor of more desirable elk behavior. An understanding of the importance of wildlife interactions over the large landscape scale emerged from this research and is now institutionalized into the ecological approach for managing multiple uses on national forests.

The science of even-aged management and clearcutting to regenerate desirable shade intolerant tree species was well-established and widely practiced on national forests through the 1950's and most of the 1960's. Beginning in the late 1960's, however, other considerations relating to diverse and changing user interests and values led to major reductions in clearcutting and substitution of other methods of regeneration harvest.

A more recent management adaptation is the need to modify national forest management strategy and practices for both wildfire control and timber growth and harvest purposes to reduce forest fuel accumulations. In this case, the successful implementation of public policy to control wildfires on national forests over many decades created a new management challenge. Forest areas once subject to frequent, low intensity, natural or human-set fires were particularly affected by this build-up of forest fuels and the related risk of conflagration fires.

Much of the debate and confrontation national forest managers are now experiencing over the proper use and management of national forests is likewise a learning experience, not only for the managers but also for the users, stakeholders, policymakers, and the American public generally. The enactment of environmental legislation called for public involvement which expanded the sources of input for the learning experience. New legislation introduced many new environmental standards and requirements which necessitated widespread management adaptations. The Endangered Species Act is a special case in point. It required management adaptations that would protect and improve habitats to restore viable populations for listed endangered or threatened species. This became an especially complex challenge where such species' ranges encompassed multiple ownerships and jurisdictions. The Clean Air and Clean Water Acts likewise called for many adaptations. Thus, "learning to do it better" became a common demand of the modern learning experience.

Today, the management emphasis is on adaptive management, but the learning experience is implicit. The adaptive management practice is the response to, and the last step, in each learning experience. It also provides the setting for the next learning experience. The modern emphasis on monitoring epitomizes the importance and need for continuous learning. It provides data and information for the learning experience and, if properly planned, the framework for collecting and interpreting the data. It is the information tool for the learning experience. However, we need to keep in mind that resources for gathering statistical data are limited and will never be enough to even begin to cover every acre and management action. Resource managers will need to rely on the tools that were so important to the early forest managers when science and statistically gathered data were almost nonexistent: keen observation and perceptive interpretation. These skills can help determine where it will be necessary and cost-effective to collect statistical data. Another important tool may be long tenures for resident managers of forested properties to improve the quality of their observations and perceptions over time, economize data collection, and strengthen its interpretation.

The adoption of the holistic ecological approach to resource management increases demands on the learning experience since it expands the variables and the resource interactions that forest managers need to consider as well as the spatial and time dimensions of those considerations. Forest management is---and always has been and will be---a challenging and fascinating art in which the artist is never done learning (Hanna et al 1978).

More explicit emphasis in forestry education and communication on the unending learning component of forest management can produce more perceptive resource managers and more effective management. Deepening the understanding of the uncertainties associated with forest and ecosystem management can also provide a more humble and constructive framework for collaborative stewardship versus the endless debate and confrontation about what constitutes the "proper" use and management of renewable natural resources.

The Pathway Toward a Fully Holistic Approach to Management

National forest management has always been on the pathway toward a fully holistic ecological approach to resource management---or ecosystem management as it is often called (see Addendum: The National Forest Pathway). This idea and understanding has been implicit in national forest management particularly, and all professionally planned forest management generally, from the very beginning of forestry in America by virtue of the concern and emphasis of professionally-trained foresters on sustaining wood flows and assuring waterflows. That emphasis clearly meant maintaining soil productivity, protecting watersheds, and regenerating forests. Though not fully holistic in scope, these are ecosystem-wide considerations and principles for protecting and sustaining ecosystem functions and components. They were epitomized a hundred years ago in the Organic Act of 1897 which provided the original policy direction for managing national forests---called Forest Reserves before 1907. The Act declared that the purposes of the Reserves were to secure "favorable conditions of waterflow and to furnish a continuous supply of timber for the citizens of the United States." It also provided for the "permanence" of the forests by directing that they be protected from destruction and improved. "Permanence" in 1897 carried much the same connotation or meaning as the usage of the term "sustainability" does today. These primary concerns and principles put national forest management on the pathway toward a fully holistic ecological approach to management. Because they were sound underlying principles of forest management generally, they also guided the progress of forest management on other lands and ownerships where professional foresters were employed. In recent years, the environmental movement and the emergence of explicit concerns for ecosystem sustainability have accelerated the movement of forest management along that pathway.

The Ecosystem Approach. However uneven or slow it may have been, historically, forest and resource management evolved incrementally and adaptively toward the holistic ecological approach as the intensity and diversity of resource use grew and our science and experiental knowledge improved. The environmental movement and the modern emphasis on ecological principles and ecosystem sustainability are now accelerating forest and resource management along that pathway. Further progress on that pathway, however, will come, much as it has in the past, incrementally and adaptively. It is impossible to achieve fully holistic management of forests and natural resources in one great leap since uses grow and change incrementally use-by-use, site-by-site, year-by-year, decade-after-decade.

Also, the scientific knowledge about the limits of ecosystem adaptability to uses and the interactive relationships among ecosystem units and their multitude of variables is incomplete, though progress is being made in many areas. We still do not have a generally acceptable management theory or practical guidelines for applying a fully holistic ecological approach. Such a theory and guidelines will need to integrate the holism of ecology with the democratic freedoms, open economy, and societal preferences of the American public. That is a particularly difficult challenge. We do not yet have the institutional framework or governance, other than the concepts and processes of public participation and collective stewardship, for managing resource use and decisionmaking among the wide diversity of stakeholders and across the multiple ownerships and jurisdictions that constitute ecosystems.

Nature will continue to surprise us with her responses to management and with her random events. Technology will also change with time and both public preferences and markets for natural resource uses and services will continue to be dynamic in the longer-term. The science of what we know or think we know about ecology and ecosystems will also change and improve. For all these reasons, and others, the ecological approach to forest and resource management will continue to be incremental and adaptive as it has been in the past with the traditional approach to land and resource management.

What **is** new is that managers are beginning to expand the framework within which they make management decisions for implementing and maintaining the uses and services of the forests and their resources. That framework includes a longer time horizon, a wider geographic scope, more environmental variables and species components of ecosystems, and wider-scale interactions among ecosystem units in addition to public participation of stakeholders and collaborative stewardship with multiple ownerships and jurisdictions. Much of our traditional forest and resource science and experiental management knowledge will remain relevant, but some will need to be adapted to the new ecological dimensions. Management decisionmaking is now more complex and challenging. Uncertainty and judgment continue to be important components of the decision process. Experts in the functional resource areas such as wildlife, water, timber, and others will increasingly need to work collaboratively and even-handedly with resource managers in the interdisciplinary mode.

CONCLUSION

It is now time to put together and make explicit the philosophical framework within which we are working to manage forest uses and resources. That framework will define where we are, where we have been, and where we are headed. It will be applicable to forest management particularly, and generally to all resource management, and have a large potential for improving the knowledge, communication, and progress of resource management in the classroom, in the field, and with the general public and its interest groups. In addition, the framework will provide a starting point for elaborating a practical theory for applied resource use and management based on the ecological approach, public participation, and collaborative stewardship. If we do not do this for ourselves,

then who will do this for us? Will we continue to strive to do our work in an anomalous setting?

The parts of that philosophical framework are all there. We need only to identify them and put them together into a meaningful framework. The three new ideas elaborated for teaching natural resource management have a strong catalytic value for shaping that philosophical framework:

- The operational definition of forest resource management with its focus on fitting uses with each other within the capabilities of ecosystems, and sustaining ecosystem functions and basic structure,

- The never ending role of the learning experience and its explicit recognition that no one of us nor all of us collectively know it all, with its corollary: the need for monitoring, continuing research for better knowledge, and the adaptive management approach.

- The fact that resource management has always been on a pathway toward theholistic ecological goal and has advanced incrementally and adaptively on that path as resource use increased and experience, technology, and science improved. The ecological goal cannot be achieved in one great leap.

The framework should also provide for proper sequencing of discussion, dialogue, and debate of ends (or more practically, uses, services, and objectives) versus means (or management practices). The ends, as used here, include all human utilities whether they are material, recreational, aesthetic, social, spiritual, or a mixture. Management is driven by uses, services, and objectives. They, together with resource conditions and ecosystem capabilities, are the principal determinants of the appropriate management practices. In long-term planning the focus is specifically on ends and their potential allocation on the land, and only generally on means. In short-term planning, such as for projects, the ends are known and the planning emphasis is on their actual location on the land and the appropriate management practices. Where there are public issues about existing management on the ground or planned management, the challenge reflects both ends and means and these need to be sorted out for a coherent dialogue and to avoid defensive managerial responses since the roles of professional managers are different between ends and means.

Thus, the framework ultimately needs to differentiate between the role of the professional manager and that of the public, the landowner, or the user not only in determining the uses, services, and objectives but also in deciding upon the appropriate management practices. In our open, democratic society the role of the public and its interest groups is dominant in establishing uses, services, and objectives, particularly for public lands. On private lands, the role of the public is also important but circumscribed by private property and landowner rights. This is a difficult and challenging time for professional resource managers on public lands. It is partly due to the focus of modern legislation on environmental objectives as well as management standards and direction on public lands and on opening up public land management to public participation, appeals, and adjudication. Some of this influence has spilled over to private lands. Much of it is OK. But it is the lack of agreement among the American public about what constitutes the proper use of forest lands and resources that adds most significantly to the difficulties managers are experiencing in deciding their appropriate management. This is a difficult nexus to unscramble in a viable manner, for the dominant role of the public in determining use is highly political while that of the professional managers is primarily technical, mainly locating uses within ecosystem capabilities and determining and applying the appropriate management practices.

Elaboration of the philosophical framework surrounding this nexus and the management that resource managers are striving to provide will enlighten the role of resource managers and strengthen their responses and contributions for resolving the challenges of that nexus. Hopefully, it will also provide enlightenment to the American public for more effective communication and collaboration in advancing the use and management of the Nation's natural resources.

These ideas, however, will not be effective in elevating the modern understanding of resource management and the role of resource managers unless we communicate, discuss, debate, research, test, and refine them and write about them---not only amongst ourselves as resource professionals but also with students, stakeholders, landowners, policymakers, and the public-at-large; in classrooms, in the field, and in the public arena, including the media. As expressed by technical editor-writer Carol R. Perry, in Corvallis, OR, "...new ideas tend to roll off like water off a duck's back" unless they are repeatedly communicated, discussed and debated; highlighted in their "newness", and presented to users and audiences in friendly packages with familiar contexts and graphic images (Perry 1993).

ADDENDUM

The National Forest Pathway. On national forests the first "Use Books", as the early guidelines for use and management were called, emphatically directed forest managers to take care where soil-disturbing practices were applied---especially timber harvests---to assure that watersheds and waterflows would be adequately protected. Over the years resource managers provided such protection by coordinating use and management activities with national forest soil and water resource experts. Such coordination became increasingly complex and challenging as all uses increased rapidly after World War II. There were management failures as well as natural and wildfire damages to watersheds, but most have been rehabilitated consistent with the Organic Act direction to protect and im-

prove the forests, so that watersheds and their waterflows have seldom become national or regional issues or problems. Although ecosystems were altered considerably through timber harvests and management in favor of younger and more vigorously growing forests, forest cover and soil productivity as well as watersheds and waterflows, major aspects of ecosystems, have been generally well-maintained and protected. Timber sales and harvests, however, have been greatly reduced from the average annual level of 11 billion board feet achieved in the 1960's and continued through the 1970's and 1980's. Currently national forest timber sales and harvests are reduced to 3 to 4 billion board feet a year, about the same as those at the end of World War II. Net timber growth on the other hand is now 3.3 billion cubic feet (equivalent to about 16 billion board feet) compared to 2.1 billion cubic feet in 1952 (Powell et al. 1993). The reduction in timber harvests largely reflects the national forest management response to public values, interest group demands and court decisions for the protection of endangered species, particularly the spotted owl and certain anadromous fish species in the western states.

In the early decades, range grazing was the most widespread use on national forests. Forest managers gave priority to rehabilitating the rangelands which had been badly damaged by severe droughts and overgrazing at the end of the 19th and beginning of the 20th Century. By 1936, national forest rangelands were greatly improved compared to the conditions on private rangelands and the unmanaged, open grazing lands on the Public Domain. Today, only 15 percent of the national forest grazing lands are in unsatisfactory condition (Fedkiw 1997a, Gardner 1991, U.S. Senate 1936).

Under the Weeks Act of 1911, as amended, the National Forest System acquired over 25 million acres of primarily heavily cutover woodlands and abandoned croplands in the East. National forest management focused on their rehabilitation and reforestation to restore healthy forests, protect watersheds, and add to timber supply. This effort clearly had ecosystem dimensions. Most of the restoration and rehabilitation has been accomplished. But, a great deal more was also done to restore wildlife and fishery habitats and to provide a wide diversity of recreation opportunities.

Big game populations were at their lowest levels on the lands of the national forests at the turn of the century. Under national forest management, all big game species have generally increased in response to improvements in State game laws and management and to restocking and habitat improvements provided by national forest managers. Hunting visitor days rose from 2 million in 1947 to 19 million in 1996. In response to changing public values, especially the emergence of the endangered species legislation, national forest wildlife and fisheries management has increasingly focused its attention on nongame species and become more strongly integrated with management for other multiple uses, especially the management for market commodities (Fedkiw 1997b).

Fish populations and habitats, in general, including riparian areas are poorer than they were in the early decades. Much of the decline in fish populations is attributable to factors such as reservoir construction, both offshore and instream commercial and sporting harvests, diseases, agriculture and irrigation, and other land management on lands largely downstream from national forests. National forest management has generally sought to protect and improve fish habitats and in recent years has adopted a new focus for restoring riparian areas and habitats. National forest angler visitor day use rose from a little more than 2 million visitor days in 1947 to nearly 18 million in 1996 (Fedkiw 1997b).

Aggregate recreation use, including fishing and hunting, rose from about 15 million visitor days in 1947 to 160 million in 1965 and 341 million in 1996, much more rapidly than population growth. Visitor use diversified as much as it intensified. National forest managers were continually challenged to provide recreation visitors with safe, sanitary facilities and adequate services that were compatible with other national forest uses and the sustainability of the forest resources. The national forest concept of wilderness use emerged in the 1920's and by 1941 the Forest Service had designated 2.5 million acres and targeted a total of 15 million acres for such designation. Today there are 35 million acres of designated National Forest Wilderness---18 percent of all national forest lands.

As national forest uses rapidly intensified and diversified after World War II, national forest management became increasingly complex and challenging and called for more science, better technology, and more effective integration of uses and their management. Shifting public preferences in the 1960's and 1970's from commodity production to amenity uses, intensified these challenges and accelerated the process for strengthening management direction. The enactment of NFMA (the National Forest Management Act of 1976) and its implementing regulations were a major outcome of those challenges and public pressures. Later, in 1992, the Forest Service adopted an ecological approach to managing multiple uses with emphasis on the principles emerging from ecological science, for as yet---and still today---there was no widely accepted theory or practical guidelines for "ecosystem management" itself.

The concepts and principles of ecological science were not new to the Forest Service and its national forest managers. They began to establish Research Natural Areas (RNA's) in the 1920's to document baseline data on individual ecosystem units and forest types which could be used to evaluate the effects of national forest use and management on ecosystem processes and components. (Other Federal and state land management agencies subsequently followed suit). The RNA concept emerged with the Ecological Society of America in 1917 to protect habitats of rare plants and animals. To that end, the Society set up a work group that ultimately became The Nature Conservancy---a long-time cooperator with the Forest Service. In the 1970's, the establishment of RNA's acceler-

ated in response to the growing environmental concerns and pressures. Today, national forests have more than 300 RNA's totaling more than 300,000 acres.

The ecological aspects of national forest management gained further emphasis in 1970, when Chief Edward Cliff gave this message to regional foresters and station directors:

> I am convinced that with an ecosystem approach to multiple use management our forests and rangelands can contribute to a better living for present and future generations...(USDA Forest Service 1970)

This was followed by the establishment of an ecosystem management training program at Colorado State University where the Forest Service co-sponsored an Ecosystem Management Short Course with the Range Science Department. When the University first offered the course in 1968, it became the first University-level course in ecosystem management per se. By the early 1980's, nearly 1,000 national forest managers and staff from the ranger district to the Chief participated in it. Many of its graduates also participated in the national forest land and resource management planning training programs that were established to help implement the National Forest Management Act of 1976. These graduates served as a bridge for linking ecosystem management principles with national forest planning and management (Fedkiw 1997a).

In 1992, the Forest Service formally adopted an ecosystem approach to managing national forests. Chief F. Dale Robertson announced it this way:

> An ecological approach will be used to achieve the multiple use management of the national forests and grasslands. It means we must blend the needs of people and environmental values in such a way that national forests and grasslands represent diverse, healthy, productive, and sustainable ecosystems (USDA Forest Service 1994).

In 1993, the Chief's Office asked national forest managers to begin using the National Hierarchical Framework for Ecological Units to provide a consistent basis for collecting data on resource conditions, and for estimating ecosystem productivity, probable responses to management practices, and interaction effects among ecosystem units for land management planning. This framework was initially developed by the Forest Service's Robert G. Bailey in the 1970's. It was improved through the years so that when the Forest Service leadership needed it, it was ready for application (Fedkiw 1997a).

More recently, the Forest Service introduced the "collaborative stewardship" approach which seeks consensual guidance and approval from stakeholders and other natural resource interests for national forest management decisions within the broad ecological perspective. This approach is based on inventorying ecosystem conditions on national forests and surrounding ownerships and jurisdictions, mutually sharing this information with stakeholders and other interests, and discussing national forest use and management objectives in the context of resource conditions, objectives, and management on other ownerships and jurisdictions as well as national forests.

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STUDENT TEAM PROJECTS AND NATURAL RESOURCES EDUCATION: ARE WE ACHIEVING EDUCATIONAL OBJECTIVES?

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ABSTRACT: As college instructors have recognized the benefits provided by cooperative and active learning, many have shifted from their traditional teaching style, dominated by lectures, to a new style where students work together and learn from each other as well as from the instructor. One strategy commonly used to implement cooperative learning in the classroom is to require students to work in teams to complete a class project. This strategy is particularly attractive to natural resources educators because natural resource issues are generally complex and interdisciplinary providing a natural setting for teaching concepts regarding natural resources ecology and management using student team projects. Further, natural resources agencies are seeking to employ individuals who have the skills to work in interdisciplinary teams to address current problems. Thus, assigning projects to student teams in natural resources classes can serve several important purposes: it can aid student mastery of the subject matter by creating a cooperative learning environment; it can provide a hands-on, problem solving context for student learning; and it can provide students with the necessary skills and experience to work effectively in teams as professionals. Although using student team projects has many potential benefits, the effectiveness of this approach as a teaching tool can vary greatly. We reflect on our experiences with using the team approach in three different courses: Fishery Management, designed for junior and senior level students; Natural Resources Decisions, a capstone course designed for seniors in the School of Forest Resources; and Watershed Management Planning, a graduate level course. As a result of our collective experiences in these three courses, we propose that investing a relatively small amount of class time to introduce students to the concept of a team and how teams work can increase the effectiveness of teaching by using student team projects.

INTRODUCTION

The process of natural resource management is becoming increasingly multidisciplinary as natural resource agencies move towards "ecosystem management" in an attempt to manage natural resources in relation to their physical, chemical, biological, and social environments (Barinaga 1996, ESA 1995, USGAO 1994). For example, the U.S. Environmental Protection Agency (EPA) is promoting a watershed approach to address water quality problems. EPA describes the watershed approach as a coordinating framework that integrates a wide range of environmental objectives with objectives for economic stability and other social and cultural goals (USEPA 1996). Another example of the multidisciplinary nature of current natural resource management issues is found in fisheries management. Fisheries managers working at federal and state natural resource agencies are commonly asked to predict the economic and cultural effects of changing fishing regulations as well as to predict the effect of these changes on the fish population (Krueger and Decker 1993). In forest resources management, the relatively new concepts of timber product green certification requires foresters to evaluate sociological as well as biological impacts of harvest decisions (Shissler 1997).

Because it is unlikely that every individual can be sufficiently trained in all required areas, a team approach is being advocated for decision making regarding the management of natural resources (Krueger and Decker 1993, Harville 1985). As a result, natural resource management agencies are seeking individuals who not only have an educational background in natural resource management, but who can also work effectively as members of interdisciplinary teams. A survey of fishery managers working for the US Forest Service revealed that "getting along with people" and "being a good team member" were the two top attitudes identified as necessary for success within the agency (Kennedy 1986). A recent report of the Interagency Ecosystem Management Task Force (IEMTF), created by the federal government to implement a recommendation of Vice-President Gore's National Performance Review, noted that the U. S. Forest Service and other federal agencies are focusing on training top leadership in techniques for collaborative, interagency planning to carry out the ecosystem management approach

(IEMTF 1995). State agencies are also relying on a team approach to address current natural resources management issues. For example, a Wisconsin Department of Natural Resources report to its managers asserted, "Managers working in integrated teams will form the foundation for the way we 'do' ecosystem management" (WDNR 1995).

Natural resources educators have been challenged to achieve several goals in undergraduate education including teaching students content (i.e., natural resources ecology), process (i.e., the process of establishing management plans and options), and effective teamwork. Many have acknowledged the benefits of cooperative and active learning and have tried to shift their teaching style from one dominated by traditional lectures that emphasize content to one that motivates students to learn cooperatively and experientially in order to emphasize content, process, and teamwork. Cooperative learning is defined as the use of small groups in instructional settings where students work together to maximize their own learning as well as each other's learning (Johnson et al. 1991a, b). Extensive research has shown that students who work in effective cooperative learning groups tend to learn more, better understand what they are learning, have better retention of learned material, and feel better about themselves, their classmates, and their peers than students who are engaged in individualistic or competitive learning situations (Johnson et al. 1991a, b). Experiential learning can be defined as providing the students with the opportunity to experience their learning as opposed to simply telling them what they are to learn (Eitington 1996). Whereas traditional lectures emphasize content, experiential learning emphasizes both content and process. Studies comparing the learning retention of students engaged in experiential learning situations versus students exposed to the same material in a lecture setting found that students who learn experientially retain 70 - 90% of the material presented while students who learn through lectures only retain 10 - 20% of the material (Eitington 1996). Thus, using cooperative and experiential learning strategies to teach natural resources management is attractive not only because student learning and retention is enhanced, but also because skills for working effectively in teams are learned.

One way to implement cooperative and experiential learning strategies in the natural resources education classroom is to assign "real world" projects, such as developing a management plan, to student teams. The approach of using student teams to work through the process of developing management plans for natural resources can serve several important purposes: it can aid student mastery of the subject matter by creating a cooperative learning environment; it can provide a hands-on, problem solving context for student learning; and it can provide students with the necessary skills and experience to work effectively in teams as professionals. Although using student team projects has many potential benefits, the effectiveness of this approach as a teaching tool can vary greatly. According to Johnson et al. (1991a, b), in order for student groups to be truly cooperative, the following five basic elements must exist. First, positive interdependence is present when students believe that they are linked with their team members in a way that no individual can succeed unless all of the group members succeed. Second, face-to-face promotive interaction is present when students not only teach each other, but also encourage each other's learning efforts. Third, individual accountability/personal responsibility requires that the instructor assess the performance of each individual student and provide feedback to the individual and the group. Fourth, collaborative skills including leadership, decision-making, and communication are necessary for team functioning and have to be taught. Finally, group processing requires the group to assess how well they are achieving their goals and how to maintain effective working relationships between group members.

We reflect on our experiences with using the team approach in three different courses offered at the School of Forest Resources, Pennsylvania State University: Fishery Management, designed for junior and senior level students; Natural Resources Decisions, a capstone course designed for seniors in the School of Forest Resources; and Watershed Management Planning, a graduate level course. As a result of our collective experiences in these three courses, we propose that investing a relatively small amount of class time to introducing students to the concept of a team and how teams work and to structuring and evaluating teams can increase the effectiveness of teaching by using student team projects.

EXPERIENCES WITH TEAMS IN NATURAL RESOURCES COURSES

Fishery Management (WFS 463)

Fishery Management is a course designed to introduce students to the process of fisheries management and to survey major methods of management involving people, fish populations, and habitat. It is taught as a part of the Wildlife and Fisheries Science curriculum at Penn State University, but students from other majors, including Biology, Geoscience, and Environmental Resources Management, also enroll in the course. Approximately 25 juniors and seniors take the course each spring. The format of the course includes two 50-minute lectures a week and one three-hour laboratory/recitation session.

One of the primary educational objectives of the course is to provide the students with experience in developing and communicating a fisheries management plan. In essence, students should leave the course with knowledge of both the content of a fisheries management plan and the process required to develop such a plan. As the process of fisheries management is becoming increasingly multidisciplinary and a team approach is being advocated for decision making regarding the management of fisheries (Taylor et al. 1995, Krueger and Decker 1993, Harville 1985), the course uses a

team approach to simulate the work environment that most of our students will encounter once they graduate. Thus, to achieve the objective of providing students with experience in developing and communicating a fishery management plan, students are assigned to work in teams to develop a written management plan for a particular Pennsylvania fishery as well as a presentation regarding their plan.

During the lecture portion of the course, students are introduced to the process and techniques used to manage fisheries. In the beginning of the semester, several lectures are dedicated to outlining the steps necessary to successfully implement a fishery management plan. In the laboratory, students gain familiarity with the process through several small group exercises that allow them to practice going through the steps of developing a management plan. Lectures and laboratory exercises during the rest of the semester focus on different fishery management techniques that can be used to achieve the goals of a fishery management plan. About one-third of the way into the semester, the students are assigned to develop the fishery management plan for a particular Pennsylvania fishery following the steps outlined in class. To complete this assignment, students are randomly assigned to teams of four to five students. They are expected to work together to produce a written management plan (with all of the required background literature review) and to produce an oral presentation based on their plan. Most of the work of preparing the assignment is expected to take place outside of the classroom, although at least two laboratory sessions are dedicated for work on team projects.

Grading for the group project is based on the team's written report and oral presentation. Each individual is expected to contribute to the team's report and presentation, but only one grade is assigned to the entire team. Individual grades for the team project do vary as 10 percent of the total score is based on peer evaluation of each member's performance on the project. Each individual turns in a "grade" for each team member, including themselves. The team project constitutes a substantial percentage (approximately 33 percent) of each student's final grade in the course. The rest of each individual's grade is determined by individual performance on exams and short assignments.

The team approach to teach students the process of developing and content needed in a fisheries management plan has worked with varying success. In a few cases, students have truly formed collaborative, inter-dependent teams that functioned very well and produced fishery management plans that were well developed and thoughtful. In the cases where teams worked effectively together, their bond spilled over into other aspects of the class. In many cases, successful teams not only worked on their specific assignment together, but also studied for exams and discussed other assignments together. This interaction generally led to improved performance of all team members in all aspects of the class (demonstrated by improved scores on exams and assignments in the latter portion of the course as compared to the beginning). Further, peer evaluations were very positive, focusing on people's strengths and what new insight they were able to contribute to the project. In these few cases, the essence of cooperative learning as described by Johnson et al. (1991 a, b) was achieved, and the students learned both process and content.

In some cases, student teams have failed to deliver an acceptable management plan in either written or oral format. In general, these were teams where strong personality conflicts caused students to not work together effectively and none of Johnson et al.'s (1991 a, b) criteria for cooperative groups was achieved. These "teams" usually put something together in a rush just to get the assignment completed; many times the product is the result of the efforts of one or two people in the group. Needless to say, the peer evaluations from groups at this extreme are generally very negative focussing on the faults of all team members. Students in this category also express resentment at being forced into working in a group and feel that they could have done much better in the course if they would have worked individually.

In this class, however, most teams have fallen somewhere in between the two extremes. Most teams get together, assign different parts of the project to different individuals, but do not work together again until the end when all of the different parts need to be integrated. In this case, the individuals function as a group, but few if any of the characteristics of a cooperative group (Johnson et al. 1991a, b) are achieved. The written report and oral presentation are often disjointed as they consist of several individual parts loosely put together.

In general, most students leave fisheries management with knowledge of the content that is necessary to build a management plan. However, except in the few cases where teams do work cooperatively, most students gain little insight into the process involved in formulating a management plan. Failure of these teams to work cooperatively relates to several things: 1) the way teams are structured (randomly), 2) lack of instruction regarding the role of teams in natural resource management and as to how teams should function, 3) lack of milestones or progress checks during the project (i.e., the students do not hand in any interim products), and 4) student concerns regarding grading. Suggestions for addressing these problems are made in the "Suggestions for the Future" section.

Natural Resource Decisions (FOR 497E)

Originally designed as the capstone for a new program in the School of Forest Resources that never developed, Natural Resources Decisions (NRD) continues into its fifth year as a general elective for seniors in the School and across the university. The largest enrollment to date is 25 students. Through the use of two major projects, NRD allows students to use previous coursework and life experiences to develop appropriate resources and solutions. More importantly, the

projects demand that students collaborate as they develop their solutions.

The projects chosen for the course represent two extremes. The first, the development of a forest resource management plan for a large private ownership, represents a relatively well-defined project with specific owner described objectives. The second, most often a large multi-faceted public policy question, is a project with diverse clientele, controversial issues, inadequate information, and requiring a solution that is best crafted through a group process.

In the past, instructors have deliberately minimized their involvement allowing students to discover their individual strengths and the need to work collaboratively. To accomplish this, the instructors seldom present formal lectures. Rather, they lead students through discussion to identify project elements, such as the parts of a management plan, identifying landowner objectives, developing questions for conducting a landowner interview. As students identify tasks in preparation for developing the plan, they naturally begin to work in teams that use their individual strengths.

The landowner parcels examined in the first class project, the development of a forest management plan, have been as small as two hundred acres and as large as a thousand. We invite the landowner to present their objectives to the class. Through question-and-answer with the landowner, the students discover information about the property and the extent of the project. The syllabus clearly shows two three-hour visits to the property for collecting necessary data. Although we encourage students to work together, they most often fail to realize that this is a class project. Only when faced with data collection, under apparently impossible conditions, do they raise the prospect of doing a class plan.

This project culminates with a class presentation of their plan to the landowners. During a dress rehearsal, students work to meld their comments into a coherent report. Most often we find significant development at this stage as the students realize that they have to work together to ensure that each individual is prepared and can do well in order to make the entire group look good in front of the landowner; a professional spirit develops. Through this experience, the students begin to build the necessary characteristic of positive interdependence described by Johnson et al. (1991a, b). The presentation also seems to cement the students' commitment to the written document. They now have pride in what they are doing and are going to share.

The second project is more difficult. The issue is large, and the students need to rapidly develop an in-depth understanding of various perspectives, define information needs, and craft various strategies for addressing the problem. As a result of their experience during the first project, the students have some appreciation of the need to effectively work together to develop their response. The scope of the issue changes each year. In the past, the class has addressed issues such as the implementation of the state forest strategic plan on the district level, developing cooperative strategies for the Bureau of Forestry and the Game Commission to implement ecosystem management across ownership boundaries, and crafting an education program on white-tailed deer that would persuade hunters to permit herd reduction. As was the case in the first project, students develop their own niches in helping bring the project to fruition.

To lend reality to the project, we have had the state forester and his staff, a Game Commission section chief, outdoor writers and game commissioners present perspectives and ideas to the class. Having these professionals participate in the class early in the project emphasizes the importance of the issue and motivates the class to develop viable and creative responses. These same resource people return to the class at the end of the semester to hear and receive the class' final report.

A single class plan raises issues related to grading, sharing the load, and completing the project that begin to dominate class discussion. The class does develop a strong commitment to developing a useful project report that they can present to the landowner. The pressure to perform varies from student to student, some choosing an easier path than others. Often, conflict, either subtle or overt develops, providing an opportunity for the instructors to introduce conflict resolution skills and processes for team collaboration. In the second project, the students clearly understand what is expected of them. They pull together more readily, perhaps, even taking laggards to task achieving more positive interdependence.

There are opportunities for students to share knowledge with the class enhancing Johnson et al.'s (1991a, b) face to face promotive interaction. Enrollment from Wildlife and Fisheries Science majors normally dominate the class. Originally, the instructors anticipated a more equal split across majors, allowing students to share information and experiences that other team members may not have. This has not happened as frequently as hoped. From time to time, one or two students, frequently those from outside the School's programs can and do offer information useful to the class. These interactions may vary from impromptu presentations and to more formal interchanges.

The instructors encourage students to participate in class discussions, sharing ideas and information. About half way through the course, the instructors conduct an evaluation of each student's progress. One focus of this assessment is the student's participation in class. Students who dominate discussion as well as those who are too reticent are encouraged to examine their participation. Another part of this evaluation is a reflection, from the instructor's perspective, on how we perceive the individual is participating in the project. We encourage the students to discuss our perceptions and comments with us at a time convenient to them.

On the occasion of this teacher to student evaluation, we ask for a reciprocal evaluation. Our plan is unannounced and the class is asked at the beginning of the period to develop an oral presentation to the instructors by the end of the class period. This evaluation encourages students to develop their arguments and presentation skills. We have found this useful in both improving the course and in cementing class relationships. After this evaluation the students are more open, willing to express themselves to us and each other.

While students struggle with a seeming lack of guidance early in the course, they ultimately develop an appreciation for the approach as they understand that the course design permits them to experience "real life" projects and situations. Students frequently comment on the value of the course. Several returning students have said that lessons learned in NRD have helped them become more effective members of professional team projects. Instructor and student evaluations for the course are in general high. These scores coupled with student comments suggest that the course is useful and appreciated.

Special Project in Watershed Management Planning (FOR/ LARCH 597A)

Watershed Management Planning was an experimental course taught by four Penn State faculty in the Fall semester of 1996. The inspiration for the course was the anticipated visit of an international team of professionals in watershed management to the Spring Creek watershed, as part of an International Countryside Stewardship Exchange (Exchange). The Exchange was a week-long event organized by a local non-profit community organization and designed to have the international team of professionals learn about the watershed, the issues facing it, and to provide the community with recommendations. Because the Exchange was scheduled for the third week in September, it created an ideal opportunity to build a course focussed on watershed management planning.

The four faculty who designed and taught the course were themselves an interdisciplinary group -- a watershed planner, a fisheries biologist, and a forest hydrologist from the School of Forest Resources, and a landscape architect from the Department of Landscape Architecture. We recruited eighteen graduate students from a variety of disciplines, including Wildlife and Fisheries Science, Forest Resources, Soils, Agricultural and Biological Engineering, Environmental Pollution Control, Biology, and Ecology.

The goal for the course was to have graduate students learn about the complex process of watershed management planning and gain practical experience by developing a plan for the Spring Creek watershed (Ferreri et al. 1997). The specific educational objective was to produce students who could enumerate the key elements of a watershed management plan, identify and use appropriate data for assessing watersheds, translate issues identified into a management strategy, and work effectively in team situations.

The class met formally twice a week, once for about one hour and once for two to three hours. These class periods were used for lectures on technical topics related to watershed management and for group discussions. The students were expected to work independently and in groups outside of class. The role of the instructors was to provide guidance, information, and constructive feedback to the students as they developed their watershed management plans. The students spent the first few weeks of the semester learning about watershed management planning and the characteristics of the Spring Creek watershed in preparation for the Exchange. They participated in many activities during the Exchange. After the initial five weeks of the course, at the end of the Exchange week, the students were organized into teams of six to eight members each. The students were directed to work in interdisciplinary teams to develop the Exchange team recommendations into a watershed management plan for the Spring Creek watershed.

The course instructors asked the students to identify their skills and areas of expertise and interest and then assigned each student to one of three teams. From the information provided by the students, the instructors attempted to create heterogeneous teams with a range of expertise and skills, expecting that students would choose to divide up the teams' work by discipline or interest. In an effort to increase the diversity of each team, the instructors also divided up the five women in the class, with two teams each assigned two women, and one team assigned one woman.

This course was successful in achieving most of its educational objectives. It provided students with a framework for watershed management planning and a practical and personalized experience applying this knowledge. The final oral presentations and written reports of the students demonstrated that the teams were able to integrate the physical, biological, social, and economic components of the watershed into a management plan.

Grades were based on both individual and team performance, with team grades constituting the largest portion of a student's final course grade. The team score for the final oral presentation made up 25 percent of the grade; the team score for the written final report made up another 40 percent. In addition to instructor evaluations, each student was given the opportunity to evaluate the performance of the other members of his/her team in terms of their contribution to the team's final product. The peer evaluation made up 20 percent of a student's grade on the group project.

Achieving the proper balance between group and individual grades proved to be a difficult issue, and the students were very concerned about their individual grades. Although the instructors established their grading protocol at the beginning

of the course, most of the grading was based on the final products, and in practice it proved difficult to determine individual contributions to the team products. In the peer evaluations, many team members were unwilling to distinguish among their teammates, except for two students who were clearly considered by their teammates to have underperformed. Student evaluations of the course indicated that the evaluation process was a primary source of concern in this course.

Either because of, or in addition to the concern about grading, several students expressed discontent with the process of working on teams. It is not clear whether the watershed management planning course achieved its objective of working effectively in teams, at least for a few members of the class. The students were able to function in groups well enough to complete their group products. However, it is not clear how many of the elements for successful cooperative learning (Johnson et al. 1991a, b) were present except individual accountability for contributions toward the final team products. It is also not clear whether students developed the skills necessary to work effectively in groups in the future. In fact, for some students the class experience may have negatively affected their attitudes toward team work.

In addition to the grading issue, the instructors for this course concluded that our assumption that we could create successful teams simply by achieving a heterogeneous mix of skills, expertise, and interests was flawed. The separation of the minority of women into even smaller minorities within the groups was a problem for some of the women. Personality and work style conflicts also created serious friction in at least one team.

SUGGESTIONS FOR THE FUTURE

Using cooperative learning techniques in the natural resources management classroom has the potential to not only enhance student learning, but also has the added advantage of simulating real work conditions encountered by graduates in natural resource management agencies. Our success using team projects in classes to teach content and process has varied. In some cases, we have fallen into the trap described by Johnson et al. (1991b) who points out that simply placing students into groups does not necessarily lead to a cooperative learning environment. In many cases, we have failed to see Johnson et al.'s (1991a, b) five attributes of cooperative groups within our teams. We suggest that paying more close attention to the way teams are structured, providing instruction regarding the role of teams in natural resource management and how teams should function, actively checking progress of teams throughout the project, and addressing student concerns about grading should help us create truly cooperative learning teams in the future.

Structuring Groups With Potential to Succeed

Our experience with our three natural resource classes at Penn State University has led us to conclude that one of the issues we needed to pay more attention to in future courses is how to structure teams that have the potential to be successful. Research has shown that grouping people with complementary learning styles can enhance group performance (Miller et al. 1994). Miller et al. (1994) suggest that assessing student's potential learning styles and personality can be accomplished with a tool such as the Myers-Briggs Type Inventory. A Myers-Briggs Type Inventory would provide the instructor with the information necessary to structure groups that were comprised of individuals with complementary learning styles. However, this approach to structuring teams may be overly complicated for the novice instructor and may consume more class time than instructors are willing to spend.

In our experience, some of our less successful groups seemed to spend most of their time struggling with group logistics where even finding an appropriate time to meet was difficult for them. Yamane (1996) suggests that getting some minimal information from students at the beginning of the course can help structure groups in a way that addresses the logistics problems. In his introductory sociology course, Yamane (1996) begins by having students provide him with their work schedule, class schedule, and areas of sociological interest. He uses this information to form project teams that reflect the students' schedules and interests. We propose going one step further in gathering information from the students. Because we often deal with interdisciplinary teams in the natural resources management classroom, we suggest getting information regarding a student's background knowledge and experience in addition to their schedule and interest information. A simple one page questionnaire could be devised where the students provide their schedules, interests, and then rank their experience with several different skills that are related to the project being assigned. For example, for a watershed management project, students might be asked to rank the knowledge and experience with areas such as water chemistry analysis, macroinvertebrate collection, macroinvertebrate identification, fish identification, GIS, spreadsheets, word processing, and presentation graphics. A simple scale could be used to allow students to rate their knowledge within a subject area; for example, 0 could mean "no experience", ½ could mean "limited experience" or "have observed it once", and 1 could mean "very experienced" or "very comfortable with topic." The instructor could use such information to form groups that not only had compatible schedules, but also had complementary skills. This type of team structuring would promote positive interdependence as each group member would be an "expert" in some area and would be expected to use that expertise to help the team achieve their goal. In classes with students from a wide variety of disciplines and with various kinds of expertise, it might be helpful to create opportunities for students to educate each

other through the preparation of mini-lectures, white papers, or other exercises.

Provide Instruction About Teams

One of the common problems we faced in our three classes was getting students to feel comfortable working in teams. In many cases, students complained that they could be much more effective and efficient at completing the project if they could just work by themselves. In addition, many students expressed a feeling that working in groups to solve problems was simply an academic exercise and that they would never be asked to work in a group setting once they entered the work force. We attribute these types of comments to two things: 1) we often lack student "buy-in" into the idea that using teams to solve problems in natural resources is not only a good way to approach natural resource management, but is also the current approach used by natural resources agencies, and 2) students generally lack the collaborative skills necessary to make their team function effectively.

A simple discussion exercise during one class period may help to increase the students' confidence in the necessity for and the effectiveness of a team approach to natural resources management. Prior to the class period, students could be assigned readings on some pertinent natural resource issue (e.g., Pacific salmon issues in the Northwest for Fishery Management; the Chesapeake Bay nutrient reduction strategy for Watershed Management Planning; and Pennsylvania State Bureau of Forestry ecosystem management principles for Natural Resource Decisions). During the class period, students could be asked to discuss the disciplines needed to address the problem and how best to approach designing a management plan. By the end of the discussion, students should have a pretty good idea that a team made up of members with different backgrounds would be the best way to approach these complex natural resource problems. A short presentation regarding the use of teams in management agencies and additional readings (such as Kennedy (1986)) would increase the students' confidence in the team approach as a viable and timely way of approaching natural resources decisions. Role plays or games where teams are asked to solve problems unrelated to their academic disciplines may help demonstrate the value of teamwork. Several commercially available team survival simulations are used primarily in business organizational training, but may be successfully transferred to the classroom (e.g. *Desert Survival* by Human Synergistics Inc.). These team survival games consistently show that group performance is higher than the individual performance of any single member under the same survival scenario. They may help convince students that a team approach produces higher-order solutions to problems than an individual approach.

Johnson et al. (1991b) point out that most undergraduate students are products of competitive academic settings where individuals are rewarded for exceptional performance. As such, many students lack the collaborative skills needed to make a team work effectively. Collaborative skills, such as leadership, decision-making, communication, and conflict-management, need to be taught just as purposely as other academic skills (Johnson et al. 1991a, b). The instructor should introduce some basic ground rules for working in teams that the class could discuss. Some of these ground rules might include: schedule weekly meetings, value the diversity of team members, keep positive team dynamics, decide by consensus, everyone participates, and keep records of meetings (Mears 1994). Yamane (1996) suggests that to facilitate group dynamics, groups should assign each member a specific role. In his four person groups, four roles are defined and assigned: discussion leader, keeps the group on task by developing a meeting agenda; meeting recorder, keeps notes from each meeting with particular attention to work assignments and distributes these notes to all team members; meeting coordinator, identifies possible meeting times and locations based on member's schedules; and intermediary, meets with the instructor on a regular basis to report on the team's progress. For long-term projects, these roles could be rotated around the group so that each member has the opportunity to experience more than one group role. We believe that investing a lecture or two of valuable class time to help students discover the collaborative skills and ground rules needed for teams to work effectively will facilitate the building of truly cooperative teams by helping students identify (if not gain) the skills needed to achieve face-to-face promotive interaction and collaborative skills.

Actively Track Team Progress

Another trend we found in reviewing how we are currently using team projects in our classes is that we have rarely monitored group processing. Group processing involves a group discussion of how well the group is achieving its goals and maintaining effective working relationships among team members (Johnson et al. 1991a,b). Most of the monitoring we have done in our classes has been very informal, usually in the form of a class discussion about how the projects are going in general, or in response to students who express their concern about the progress teams are making or the direction that teams are taking. Yamane (1996) suggests that instructors should actively track the progress of each group throughout the duration of the project by setting up meetings with each group at the time each project milestone is reached. This type of active discussion between instructor and student team would help to facilitate group processing. During these meetings, instructors could not only discuss progress toward the final product with the group, but could also discuss how well the team is working together. As such, we suggest that team projects be assigned in a manner that allows teams to make progress toward the final product by reaching certain milestones. Meetings between the instructor and the student team could be held in conjunction with each part of the assignment being submitted. This approach, in conjunction

with using Yamane's (1996) intermediary, should enhance group processing.

Grading and Evaluation

Because of the anxiety that many students have about grades, this is perhaps the most difficult issue that instructors have to contend with in team-based courses. Good students fear their grades being lowered because of poor performance of other members of the group, and they often feel that they work harder than others to pull the group along. On the other hand, the poorer students may feel little incentive to work hard if their group is doing well without their full involvement. One approach may be to assign every student an "A" grade at the beginning of the course and to take points away from individual students throughout the semester based on instructor and peer evaluations of group processing and individual performance. Another approach may be to use a detailed numerical rating system such as that used by Professor Christopher Uhl at Penn State. Uhl has used a complicated numerical peer evaluation system for group projects in his undergraduate biology class, which subdivides the project into categories which are weighted and multiplied by individual and group peer grades. Another alternative may be to encourage the use of performance contracts among the group members which are as specific as possible about the group's expectations of quality, quantity, and interdependence from each member. While this approach would approximate a professional work environment, some teams could spend most of their time trying to agree on expectations. Our experience in the three natural resources courses we have taught suggests that group grading should not be left until the final product is completed, but include intermediate points for evaluation of individual and group progress throughout the course. This should reduce the anxiety level for most students and provide intermediate feedback for the group to positively encourage better performance from its members.

SUMMARY AND CONCLUSIONS

Our collective experience with three natural resource management classes at Penn State University has convinced us that assigning team projects can help achieve several educational objectives. Research has shown that creating an environment of cooperative learning will enhance student retention of material learned in a class. As such, using a team project in a natural resources management class can help students learn management concepts and strategies more effectively than using a traditional lecture approach. Experiential learning, where students learn by doing, has been shown to enhance learning and retention of process related information. Because natural resources management is a continuously evolving process, it is important for students to learn the process of management. Thus, assigning student teams to develop natural resource management plans in a team setting facilitates their learning by providing a cooperative learning environment and an experiential learning situation. However, in order for cooperative learning to be effective, teams must be truly cooperative as defined by Johnson et al. (1991a, b). Cooperative teams exhibit five characteristics including positive interdependence, face-to-face promotive interaction, individual accountability/personal responsibility, collaborative skills, and group processing (Johnson et al. 1991a, b). Our experience has shown that it is not enough to simply place students in groups to make them cooperative teams. In contrast, to create truly cooperative teams, the instructor must pay close attention to the way teams are structured, provide some instruction as to why a team approach is important and how teams should work, actively check on the progress of the group throughout the project duration, and address student concerns about grading. We suggest that investing a small amount of our valuable class time to ensure that students believe in and understand the team approach will enhance our success with using team projects in the future.

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ASSESSING A FORESTRY EDUCATION: THE NORTHERN ARIZONA UNIVERSITY EXPERIENCE

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ABSTRACT: In an attempt to provide students with a strong generalist education, the faculty at Northern Arizona University's School of Forestry has presented its undergraduate forestry education in a unique, integrated, team-taught approach for over 20 years. Over this same period of time, higher education has experienced profound changes. Within the discipline, the technical knowledge expected of undergraduates has expanded greatly. Simultaneously the demand for accountability in higher education has increased. Students, parents, state legislators, governing boards, and taxpayers alike have questioned the importance, relevance, and value of higher education. The so-called "student-as-consumer" model in higher education is but one manifestation of this increased demand for accountability. A fundamental question arises: How well does the forestry program at NAU prepare students educationally as foresters?

Assessing student academic achievement with respect to educational outcomes provides one way of answering this question. Such a process can help determine how well students master a set of defined skills, knowledges, and competencies. Such an approach requires a defined set of desired educational outcomes.

The faculty at the NAU School of Forestry have been engaged in this process for over three years. Although not complete, we have begun to identify both desired educational outcomes and means for assessing their achievement. This effort has involved a variety of approaches, including a comprehensive survey of School of Forestry alumni. This work reports on the results of this latest effort, the alumni survey.

INTRODUCTION

The operational environment for higher education has experienced profound changes recently. Both student populations and demographics have changed, with a smaller proportion of "traditional students" in a four-year degree completion cycle coming to universities directly from high school graduation. Students have different expectations about the value of higher education. Such changing expectations include both the content of higher education and the form of delivery.

Coupled with changing expectations about the higher education process, is an increasing complexity and volatility of employment. The massive mergers, acquisitions, and downsizings in the private sector during the 1980s and 1990s have fundamentally altered employment relationships. Public sector employment, especially in natural resource agencies at the Federal level, has experienced similar downsizing changes. Such changes have placed a premium on individuals with marketable skills, while the increasing rate of technological change results in the rapid obsolescence of such skills.

Higher educational institutions, and their governing boards, have altered their outlooks and operations in response to these changes in expectations, employment relationships, and technological volatility. For example, the growing interest in post-tenure review may be viewed as a response demanding greater accountability on the part of faculty members. Some colleges and universities have increased the flexibility of degree programs, especially in terms of delivery venue (*e.g.*, web and web-based courses, the growth in distance education, and the move toward the "virtual university") in response to the demands of students. In addition, accreditation bodies have put increased emphasis on assessing student academic achievement as part of the accreditation criteria for member institutions.

Assessing student academic achievement focuses on a set of three key educational issues:

1. What are the core knowledges, skills, and attitudes that students should have upon graduation, or "What should students know and know how to do"?

2. How can educational systems best help students acquire these knowledges, skills, and attitudes, or "How do we best help students learn what we think they need to learn?", and

3. How can educators and educational institutions assess the efficacy of educational systems, or "How do we determine if students know what we as educators think they should learn?"

Faculty in the School of Forestry at Northern Arizona University have internally begun answering question one for its professional forestry curriculum (Fox *et al*. 1996a,b). This paper reports on the latest assessment activity in the School (an alumni survey) and describes on-going and planned assessment activities.

ALUMNI SURVEY

Faculty had a belief supported by anecdotal data that the integrated, generalist curriculum of the School well- prepared students to move into forestry and related natural resources careers. More specifically, faculty believed that although perhaps not receiving the depth in certain areas that other forestry programs provide, NAU forestry graduates received a breadth of information, along with synthesis and integrative skills, that serve as effective trade-offs for any lack of depth. Such content breadth, along with synthesis and integrative skills, would allow them to succeed in land management careers over the longer term. As the faculty identified core knowledges and competencies, a logical next step was to determine from the graduates of the forestry program the knowledges, skills, and attitudes that best served them in their careers. A formal survey was seen as the best way to acquire the desired assessment data. Specifically, the survey had the following five objectives:

1. To assess whether the skills, knowledges, and attitudes acquired by graduates of the forestry program prepared them for their first professional position after graduation;

2. To assess whether the skills, knowledges, and attitudes acquired by graduates of the forestry program prepared them for their current professional position;

3. To assess the overall quality of instruction, advising, and career counseling in the forestry program;

4. To determine the demographic profile of NAU forestry graduates, including employment; and

5. To determine the overall satisfaction of graduates with the integrated forestry program.

Methods

Beginning in 1996, the administrative leadership of the School identified the need and desire to survey forestry alumni. Over the course of approximately six months a survey instrument was generated, working closely with the Social Research Laboratory (SLR) in the College of Social and Behavioral Sciences at Northern Arizona University. An initial decision was made to involve the SLR because of its expertise and a desire to remove the School's faculty and administrative leadership from direct participation in the survey. This would help create a climate of anonymity for respondents with the hope of generating more direct and honest responses. The survey instrument allowed and encouraged comments from respondents on any aspect of the survey and the forestry program.

In the Spring of 1997 the survey was sent to 1,098 School of Forestry graduates, from an alumni mailing list generated by the School. A reminder postcard was sent out one week after the first mailing. Approximately one month after the first mailing, a second survey packet was sent out to all those alumni that had not yet returned their surveys. Seventy-two questionnaire packets were returned as undeliverable. A total of 400 questionnaires were returned. This response rate of 39% was judged acceptable by the SRL for such a survey.

The Social Research Laboratory compiled and tabulated all responses, including the verbatim comments. The final report was delivered to the Chair of the School of Forestry in September 1997. In addition to providing the mailing list and administrative time working with the Social Research Laboratory in design of the survey, this survey cost approximately $6,000.

Results

Demographically, some 82% of the alumni respondents identified themselves as male, and 90% identified themselves as "white." Of those responding, 56% went on to pursue graduate or other undergraduate education after their forestry degree, with 48% of these studying forestry and another 23% in business.

First post-graduation employment was overwhelmingly in the general area of forestry (79%), but this value dropped to 59% for the current positions. Of the positions in forestry, the majority of the first positions were with government agencies (65%), with this value dropping to 57% for current positions. Private sector employment totaled 26% for first positions, and comprised 24% of current positions. Alumni currently hold positions in a wide range of organizations including federal, state, provincial, tribal, county, and municipal governments, school districts, non-governmental organizations, forestry and wood products firms, and consulting firms. Specific current career pursuits outside the general area of forestry included law, medicine, education, the clergy, ski industry, real estate, and state and municipal recreation.

Overall, forestry alumni returning the survey felt that they received high quality instruction, with 93% rating the quality of the instruction as "good" or "excellent" (Table 1). Although still high, the ratings for the quality of academic advising were below those for instructional quality (Table 1). In the area of career counseling, alumni ratings dropped considerably, with only 35% of the respondents feeling they received good or excellent assistance in this area (Table 1).

Table 1. Alumni rating of the quality of instruction, advising, and career counseling (percent of respondents)

Rating	Instruction	Academic advising	Career counseling
Excellent	45	23	11
Good	48	37	24
Fair	7	26	33
Poor	1	8	18
Never met w/ advisor	na	6	11
No opinion	--	1	4

As part of the survey, we were interested in determining how well the forestry program developed certain skills the faculty felt were important for students to have. Overall, responding alumni thought that the program did best in developing writing, critical thinking, problem solving, quantitative, job preparation, and forestry field skills (Table 2). The development of managerial, analytical modeling, oral communication, and creative thinking skills received lower ratings (Table 2).

Table 2. Alumni rating of the forestry program in developing selected skills and abilities (percent of respondents)

Rating	Writing	Oral comm.	Critical thinking	Creative thinking	Problem solving	Quantitative skills
A great deal	26	10	22	15	23	17
Considerably	40	36	45	40	48	51
Somewhat	24	37	28	32	25	24
Very little	7	14	4	9	3	5
Not at all	2	3	1	3	1	2
No opinion	—	1	1	1	1	2

Table 2 continued. Alumni rating of the forestry program in developing selected skills and abilities (percent of respondents)

Rating	Managerial skills	Analytical modeling skills	Forestry field skills	Preparation for further study	Job prep. skills
A great deal	10	8	53	22	33
Considerably	27	32	35	42	35
Somewhat	33	32	9	22	19
Very little	19	16	2	4	7
Not at all	10	7	1	1	2
No opinion	1	5	1	9	4

We next asked alumni about the value of certain skills and abilities to both their first post-graduation and current positions. Forestry field skills overwhelmingly topped the list of the most valuable skills for the first post-graduation position (Table 3), but also ranked second as the least valuable skill (Table 4).

In relation to skills and abilities needed by alumni in their current position, writing skills topped the list (Table 5), moving up one notch from its ranking in the first post-graduation position (Table 3). Verbatim responses for the "Other" category (Table 5) for the most valuable skill included "ability to learn new skills", "confidence," "forest hydrology", and "persistence". Forestry field skills ranked as the least valuable skill for alumni in their current position (Table 6).

Table 3. Most useful skills, knowledges, and abilities developed in the forestry program for first post-graduation employment (top 5 responses, percent of respondents)

Skill/knowledge/ability	Percentage
Forestry field skills	32
Writing skills	16
Other	14
Silviculture	9
Analytical	8
Communication	8
Problem solving	8

Table 4. Least useful skills, knowledges, and abilities developed in the forestry program for first post-graduation employment (top 5 responses, percent of respondents)

Skill/knowledge/ability	Percentage
Range management	13
Forestry field skills	11
Wood technology	11
Other	9
Analytical modeling	8
Recreation	8

Table 5. Most useful skills, knowledges, and abilities developed in the forestry program for current employment (top 5 responses, percent of respondents)

Skill/knowledge/ability	Percentage
Writing	23
Other	20
Problem solving	9
Analytical	8
Communication	8

Table 6. Least useful skills, knowledges, and abilities developed in the forestry program for current employment (top 5 responses, percent of respondents)

Skill/knowledge/ability	Percentage
Forestry field skills	16
Range management	12
Wood technology	9
Recreation	8
Analytical modeling	6

The survey also asked alumni to identify the skills and abilities needed in their careers that the forestry program did not provide. Although the rankings differed somewhat between first and current position needs, the top five responses had a high degree of overlap, with five of the skills sets appearing on both lists. Computer and human resources/personnel/supervisory and law/policy/legislation skills ranked very high for both first position (Table 7) and current position (Table 8) needs. The "Other" entry for untaught skills and abilities for the first position (Table 7) included such verbatim responses as "tree planting skills", "safety", "technical how-to information", "orientation toward detail", and "ability to assimilate different ideas".

Table 7. Skills and abilities not taught in the forestry program but needed in first post-graduation position (top 5 responses, percent of respondents)

Skill/knowledge/ability	Percentage
Other	16
Personnel management/ human resources/supervisory	15
Computer skills	11
Other forestry courses	10
Fire management	9
Law/policy/legislation/NEPA	9
Other non-forestry courses	9

Table 8. Skills and abilities not taught in the forestry program but needed in current position (top 5 responses, percent of respondents)

Skill/knowledge/ability	Percentage
Computer skills	20
Other non-forestry courses	18
Personnel management/ human resources/supervisory	10
Law/policy/legislation/NEPA	9
Other forestry courses	9

Overall, over 70% of the alumni felt that the forestry program provided a good or excellent preparation for their first post-graduation position (Table 9). This dropped to 65% for their current position (Table 9).

Table 9. Rating of overall effectiveness of the forestry program in developing the necessary skills for the first post-graduation and current employment position (percent of respondents)

Rating	First position	Current position
Excellent	22	17
Good	51	48
Fair	19	21
Poor	5	9
No opinion	4	6

Comparing themselves to graduates of other programs 62% of the responding alumni felt that they were better prepared by the integrated program than graduates of other forestry programs for a forestry career, with only 8% feeling they were not as well prepared.

Discussion

Given that the 39% return rate represents an unbiased sample of NAU forestry alumni, what do these survey results tell us? Overall on the positive side, it appears that alumni feel that they received a good education. For those experiencing the integrated curriculum, most felt that this approach has served them well in their careers, although somewhat more so for first positions as opposed to current positions. And alumni believe that the program did a good job of developing certain key skills that faculty have identified as important (namely writing, critical thinking, problem solving, quantitative, job

preparation, and forestry field skills). On the negative side, alumni feel that the forestry program could be improved in the area of career counseling and in developing other key skills, such as oral communication, managerial skills, and creative thinking. Verbatim responses provided a wide range of opinions about the program. Many alumni comments supported the program and the education received. These positive comments came from alumni that had and had not continued their careers in forestry. However, many were highly critical of the program and employment opportunities for forestry graduates.

In terms of specific skills, one of the most interesting results was the responses about forestry field skills. The response that field skills are not useful for current position performance is not surprising, given the general move away from field work that often occurs with career advancement. Also not surprising is the response that field skills were highly valuable for many alumni as they entered their first post-graduation position. But that 11% of the respondents felt that forestry field skills were not important for first position performance is surprising, and perhaps reflects the diversity of employment that graduates obtain. The high amount of overlap between the set of skills felt valuable for first and current employment (writing, problem solving, analytical, and communication skills were common to both rankings, albeit in different orders) seems to indicate that the forestry program has done a good job, at least in part, of identifying key core skills for both short-term and long-term career benefits. Unfortunately, the alumni respondents believe the program could be improved in some of these areas, notably oral communication, analytical modeling, and managerial skills.

The forestry program did not provide some skills that alumni feel would have been beneficial for first and current positions. The commonality of these skill sets (personnel management/human resources/supervisory, law/policy/legislation/NEPA, computer skills, other courses, both forestry and non-forestry), especially taken with some of the verbatim responses, provides important evidence for the faculty to investigate and further analyze. Of perhaps equal importance is the alumni perceptions about those subject areas least useful in either first or current positions. Such information should provide the faculty and administrative leadership with the impetus for further revision and refinement of the program's offerings.

The drop in forestry and forestry-related employment from first to current position, coupled with the overall rating of career counseling and many of the verbatim responses, identifies an important element of the professional program beyond the usual academic issues of academic content, skill sets, and delivery methods: employment of graduates. This issue is being addressed by the School, as discussed in the next section.

In summary, this survey provides evidence that will assist faculty and leadership in the School to identify desired changes in the professional program. Much of the evidence from this survey, especially with regard to general skills sets desired for forestry careers, supports many of the conclusions already reached by faculty and leadership. And as noted previously, the survey also yielded some surprising results.

CONCLUSIONS AND ACTION ITEMS

This survey has provided one set of assessment data to use in the evaluation of the professional forestry program at Northern Arizona University. On the positive side, alumni generally feel that they received a good education at NAU. Both alumni and faculty agree on many of the skills that are important for career success. But the diversity of responses should cause some deep reflection. The general question that arises is how to best incorporate the information from this survey to improve the program. Specific questions that need to be asked, and answered include:

* How best to achieve these mutually desired educational outcomes?
* Should the program be restructured to add those subject areas that alumni find valuable that are not offered?
* Should the program be restructured to delete those subject areas that alumni found of least value?
* Should the program provide greater career counseling, and if so, how?

With respect to this last question, even before completion of the survey the faculty recognized the need to provide more assistance to students in the area of career counseling. Looking holistically at student needs over time, the faculty agreed to reprogram funding available for a faculty line position into a staff support position with the triple objectives of recruitment, retention, and placement. The faculty felt that these three elements are inextricably linked. The School's new coordinator of Recruitment, Retention, and Placement joined the staff in November 1997. Part of his initial assignment will be to help develop close contacts and working relationships with the University's Career Services (placement) office to help formalize, strengthen, and expand the employment contacts available to students in the School.

The faculty has also greatly strengthened the development of computer skills in the past few years. We also plan to ask the SRL to revisit the survey data to categorize computer skills-related responses by graduation year group in an attempt to get a better picture of how the changes in computer development have impacted alumni.

And the faculty has embarked on a major writing-across-the-curriculum effort to strengthen the written communication skills of forestry graduates (see Souder 1998).

Survey results such as presented here must be used in the context of triangulation or converging evidence. Based on the findings here, a case could potentially be made to strengthen

or reduce the offerings of just about any particular subject area offered. As a faculty, we need to carefully review these findings, adding them to at least three other assessment mechanisms: On-going faculty-led assessments of program structure and content; course and program evaluations from current students; and surveys from employers. All these efforts require time, energy, and financial resources. Given the rapidly changing higher education and employment environments, time may be the most scarce of these requirements, especially given the needs for program delivery and the pattern of the academic calendar (*e.g.,* nine month contracts for many faculty) that greatly reduce the amount of time available for faculty to work on curriculum reform. But failure to undertake such activities courts disaster to the extent that current practices no longer fit student and greater societal needs.

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A GRAPHICAL SURFACE-VEGETATION-ATMOSPHERE TRANSFER (SVAT) MODEL AS A PEDAGOGICAL AND RESEARCH TOOL

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ABSTRACT: This paper considers, by example, the use of a Surface-Atmosphere-Vegetation-Transfer (SVAT), Atmospheric Boundary Layer (ABL) model designed as a pedagogical tool. The goal of the computer software and the approach is to improve the efficiency and effectiveness of communicating often complex and mathematical based disciplines (e.g., micrometeorology, land surface processes) to the non-specialist interested in studying problems involving interactions between vegetation and the atmosphere and, in the nature of interactions rather than a description of the components. Topics are addressed within a Socratic framework using a scenario system based approach: As an example of this, the interactions between a vegetation canopy and a carbon dioxide rich (2 times ambient CO_2) atmosphere, are presented. This will illustrate such nonlinear interactions between the physical components and in system behavior that would not be intuitively obvious to the student or, would be to complicated to be insightful. This type of approach is another careful, critical way of thinking fostered by interactions with a computer model. The student instead of taking things apart, is looking at them as wholes and is encouraged to make new and important distinctions.

INTRODUCTION

The power of computer software tools to engage learners in intrinsically motivating, experimental learning may be their greatest potential. However, computer programs cannot anticipate every need that a user might have and so, some form of collaborative support is essential. Pedagogical models embody such ideas as two or more learners working together to provide cognitive and affective support or, have a learner work with written scenarios that coach the learner to a level of understanding. Embedded within such a process in the idea of higher order learning to encourage the student to

Frame and resolve problems
Exhibit intellectual curiosity
Strive for life-long learning

In the scenario context, we further pose partnerships (between individuals and computers) for problem-solving, teams for project-based learning, structured controversy, peer teaching and review. This has far reaching implications as it eschews individual differences (e.g., prior knowledge, tolerance for ambiguity, culture, gender, age, etc.) that might prevent effective learning. Moreover, instructors' roles are radically shifted from the traditional norms – the instructors become mentors, coaches, and co-learners. Faculty are challenged to shift from being a "sages on the stage" to "guides on the side." They facilitate learning, not deliver information, they support collaboration, not foster false competition and they assess development rather than test.

What follows is an example of what we term the scenario approach. The example scenario is a final one in a series which comprises a course in Land Surface Processes. In the course we use a SVAT (Soil-Vegetation-Atmosphere-Transfer) computer model as a cognitive tool to help build a systematic understanding of what are complex interactions in a system – the land / atmosphere. We are interested in the nature of interactions rather than a description of its components. To gain an initial understanding of the resultant behavior of a system we avoid confusing details and concentrate on the resultant effects. The course is designed to prove useful to the non-specialist and, more precisely, to those who are interested in studying problems involving interactions between the vegetation and the atmosphere.

Teaching and learning are difficult, but the scenario approach, coupled to a cognitive tool such as a SVAT, can help us overcome the problems of learning complicated systems that are intrinsically inter-disciplinary. It uses the computer as a medium of intellectual curiosity rather than as some might argue, a wasteland for mindless entertainment.

AN EXAMPLE SVAT SIMULATION—CARBON DIOXIDE FLUXES

Preamble

Plants live by taking in carbon dioxide (CO_2) and converting the carbon to its own substance (assimilation). The net carbon gain manifests itself (virtually by definition) as an increase in the biomass, which consists of roots, stem, leaves, flowers, etc. Carbon dioxide enters the plants through the stomates and so, the rate of biomass increase is closely dependent on the stomatal resistance. Not surprisingly therefore, the economic value of a crop is closely tied to the level of transpiration, which also depends on the stomatal resistance. Since transpiration is not beneficial to the plant except to reduce the leaf temperature[4], we might expect plants to favor a maximization of carbon dioxide intake in relation to transpiration. Thus, plants benefit most by keeping the stomates open, regardless of the transpiration, as long as sufficient water reserves are available to the roots. By now you must realize from previous simulations that decreasing soil water content does not necessarily reduce transpiration until the plant perceives itself to be in danger of water stress, although the stress signal does not depend uniquely on soil water content.

In these days of the runaway greenhouse effect scare, some researchers take heart that an increase in carbon dioxide concentration in the atmosphere will lead to an enhanced carbon dioxide uptake by the plants and so, to an increased biomass production. Experiments done in the greenhouse and in the field suggest that an increase in carbon dioxide concentration also causes the stomatal resistance to increase, with the net effect being a gain in biomass and a decrease in transpiration, thus doubly benefiting the plant. We can use our simulation model to explore this finding.

Our main purpose, however, is simply to examine the flux of carbon dioxide in a canopy (specifically the carbon dioxide assimilation rate *A*). If time permits we can test the idea that an increase in stomatal resistance associated with an increase in ambient carbon dioxide concentration leads to both an increase in the carbon dioxide assimilation rate and to a decrease in transpiration.

Calculating the carbon dioxide assimilation rate from the outside

Let us return to the idea that a flux of a substance moves down a gradient of potential across a resistance, the Ohm's law analog for diffusive fluxes. The source of carbon dioxide is in the atmosphere, let us say above the plant canopy, where the concentration of carbon dioxide gas (*C*) has a mean value of about 330 parts per million (of CO_2) by volume of air (ppmv), which is numerically equivalent to 330 microbars (ìb) or to 330 mol (CO_2) mol^{-1} (air) times 10^{-6} . We will refer to this ambient carbon dioxide concentration as (C_a). If the drop in carbon dioxide potential is$\triangle C$ and the resistance across that potential drop is *r*, the flux of carbon dioxide (FCO_2) is given by Equation.1a.

$$FCO_2 = \frac{\Delta C}{r} \qquad [1a]$$

If the plant is to ingest carbon molecules there must be a flux of CO_2 downward through the surface layer along decreasing concentration to the leaf surface (see Figure 8.1 from scenario 8 – Microclimate of the Plant Canopy). The appropriate resistances are approximately the same as that for water vapor, but with some adjustments for the differences in diffusivity of carbon dioxide in air. The turbulent resistance in the surface layer will be called . Once inside the canopy the molecules move through the interleaf air-spaces and across the surface boundary layer of the leaf, where the resistance is r_{ahc}. Ignoring the flux of carbon dioxide across the leaf surface (the cuticle), the carbon dioxide molecules then penetrate into the leaf via the stomates where they encounter an internal (or intercellular) carbon dioxide concentration C_i. . The stomatal resistance to carbon dioxide flux is r_{sc}. Accordingly, we can write a somewhat more elaborate version of Equation 1a in the form of Equation1b:

$$FCO_2 = \frac{[C_a - C_i]\rho_{CO_2} C_p}{r_{CO_2} + r_{ahc} + r_{sc}} = A \qquad [1b]$$

note that the density (pCO_2) of carbon dioxide gas (kg m^{-3} of CO_2) is necessary to make the units agree with the left hand side of the equation which has the units of kg (CO_2) m^{-2} s^{-1}.

Resistances for carbon dioxide flux are generally somewhat larger than those of water vapor because the molecular diffusivity of carbon dioxide in air is less than that of water vapor in air (possibly because the former is somewhat heavier (molecular weight 46) than water vapor (molecular weight 18)). However, the differences in resistances between carbon dioxide and water vapor in air are generally less than a factor of two (depending on what resistance one is talking about). Accordingly, let us agree for the sake of argument (since it alters no fundamental result) that the two sets of resistances, that for water vapor and that for carbon dioxide, are equal.

Imagine a flux of water vapor from the stomates into the surrounding interleaf air-spaces, as in Equation 7c from scenario 7 – Stomatal Resistance, and thence into the surface layer above the canopy through resistance r_v. Ignoring the parallel water vapor flux from the ground below the canopy, the flux of water vapor between the leaf and the atmospheric surface layer (in kg m^{-2} s^{-1}) is given by Eqn. 1c.

$$FH_2O = \frac{[e_s(T_1) - e_{af}]\rho C_P}{\gamma L_e (r_v + r_{ah} + r_s)} \qquad [1c]$$

Note that e_a here refers to the vapor pressure above the canopy, i.e., at some elevation where the carbon dioxide concentration is not immediately affected by transient perturbations in the canopy fluxes[5].

Now, if we equate the resistances and take a ratio of the two fluxes (dividing Equation 1b by Equation 1c to yield Equation 1d) we obtain a measure of the water use efficiency (WUE), which is the essentially the ratio of the carbon dioxide concentration gradient between the atmosphere above the plant canopy and that in the sub-stomatal cavities to the gradient in vapor pressure between the inside of the leaf and that in the surface layer above the canopy.

$$\frac{A}{T_r} = WUE = \frac{\rho_{CO_2}}{\gamma L_e}\left[\frac{C_a - C_i}{e_s(T_l) - e_{af}}\right] \qquad [1d]$$

$$\gamma = pC_p / 0.622 L_e$$

Note, however, that because of the 30-fold smaller concentration of carbon dioxide than water vapor in the atmosphere, the magnitude of the water fluxes will be much larger than those for CO_2. A typical value for FCO_2 at noon on a sunny summer day is 1 x10^{-6} kg m^{-2} s^{-1} or 20 micromoles per square meter per second. The sub-stomatal concentration C_i is known to be approximately constant under normal atmospheric and plant conditions. It is about 220 ppvm for C_3 plants, such as wheat, rice and potatoes, and 120 ppmv for C_4 plants, such as corn and sorghum. We will have more to say about this intriguing parameter later in these notes. Equation 1d show us that the primary control of water use efficiency is exerted by the vapor pressure deficit between that at the leaf surface and the that above the canopy.

Assuming that the latter is largely controlled by the atmosphere, the single most important variable in the WUE relationship is the vapor pressure in the leaf, which is to say that control rests with the leaf temperature. We might imagine that the plant is trying to maximize the WUE but, at the same time maximize its rate of carbon intake. Blum (1989) cites a formula relating plant yield (YE) to WUE, more specifically the product of WUE times the evapotrananspiration. He also cites another formula relating biomass creation to the ratio of transpiration to potential evapotranspiration, which is a little bit like the moisture availability you saw defined in an earlier scenario.

Calculating the carbon dioxide assimilation rate from the inside

Well beyond the scope of this course is the frightening terrain of pure plant physiology. Nevertheless, plant physiologists are also struggling with the modeling aspects of assimilation rates. One of the most well known of the current assimilation models is one constructed by Farquhar (1989); of feed-forward fame. The Farquhar model, which deals primarily with C_3 plants, attempts to describe the curve shown in Figure 1, which emerges from numerous experiments in which C_i is varied as a function of assimilation rate.

We see that A increases first rapidly and almost linearly with increasing C_i and then much more slowly beyond a bend in the curve which is actually not far from the characteristic value of C_i for the plant. Typically, C_3 plants tend to have a more gradual transition from rapidly increasing assimilation rate to slowly increasing assimilation rate than C_4 plants, as shown in Figure 1. The bend in the two curves occurs close to the present-day normal values for internal carbon dioxide concentrations.

The bend also represents a transition between two physiological states of the plant, one in which the photosynthesis is limited by the availability of an organic compound called Rubisco, which is involved in the reduction and oxidation in the C_3 pathway (low C_i), and the other in which photosynthesis is limited by the availability of photon flux (high C_i). Clearly, an increase in internal carbon dioxide concentration causes the assimilation rate to increase, although at a rapidly decreasing rate with increasing concentration. We will later touch on the importance of this decrease in assimilation rate with increasing carbon dioxide concentration.

The Farquhar model can be used to calculate C_i. When combined with another type of formulation, called The Ball-Berry model, which determines stomatal resistance as a function of the rate of photosynthesis, the photosynthesis can be calculated directly without having to specify either C_i or stomatal resistance because the latter can be calculated as a solution to the combined Ball-Berry / Farquhar equations. Of course, this combined formulation requires additional, and perhaps more exotic, parameters to obtain real numbers. Although further discussion of this approach lies beyond the scope of these notes, the model does offer an option for calculating photosynthesis and carbon dioxide fluxes directly by specifying the Ball-Berry model. We suggest that only the most serious plant scientists among you venture to call upon this option!

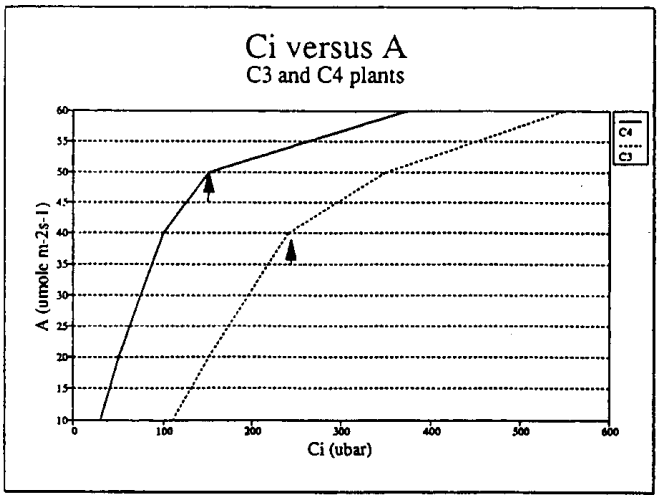

Figure 1 Schematic illustration of variation of assimilation rate versus internal CO_2 concentration for C_3 and C_4 plants. Arrows denote present day internal CO_2 concentrations.

Changes in assimilation rate and transpiration with increasing carbon dioxide concentration

Worst-case scenarios (not one of ours) suggests a doubling of ambient carbon dioxide concentration by the middle of the next century, from the present 330 ppmv to about 660 ppmv as the result of continue fossil fuel burning. This increase already comes on top of an increase from 280 ppmv from the middle of the last century. A first guess based on Equation 1b is that the doubling in C_a would cause the assimilation rate A to increase by a factor of about 4 for C_3 plants and about 2.5 for C_4 plants (assuming no change in the values for C_i). In fact, Cure and Acock (1986) examined all the published measurements they could find that were related to the response of plants to an increase of carbon dioxide. Their results show that the increase in assimilation rate is likely to be only about 40% for C_3 plants and about 25% for C_4 plants. Moreover, they show that plants grown under ambient concentrations of 660 ppmv or allowed to come into equilibrium with their new enriched CO_2environment show an even lower increase in assimilation rate, about 30% for C_3 plants and less than 10% for C_4 plants. These increases in assimilation rate translate into approximately equivalent percent increases in biomass production.

Laboratory measurements show that an increase in carbon dioxide concentration at the surface of the leaf induces an increase in stomatal resistance. A glance at Figure 1 shows that assimilation rate does not increase rapidly with an increase in internal carbon dioxide concentration beyond present-day concentrations. Experiments further show that while fluctuations in stomatal resistance and other local factors do not significantly affect internal carbon dioxide concentration, an increase in ambient carbon dioxide concentration moves the entire curves for both C_3 and C_4 plants, shown in Figure 1, toward the right. Despite this shift, the net effect is one of an increase

in assimilation rate even for C_4 plants (although the sharper transition at the bend in the curves followed by a nearly constant value of assimilation rate of the C_4 curve above the bend translates to a smaller gain in *A* for C_4 plants than for C_3 plants with an increase in C_a).

A further intriguing implication of Cure and Acock's (1986) data is that transpiration should decrease by about 20% as the result of carbon dioxide doubling! What Figure 1 shows clearly is that an increase of 20% in stomatal resistance is not sufficiently large to hold the assimilation rate to only a 40% increase; rather, both C_i and stomatal resistance must increase as ambient carbon dioxide concentration is increased. This increase, in stomatal resistance, seems to be associated with the leaf 's ability to sense an increase in carbon dioxide concentration at its surface.

Stated alternately, if one doubles the amount of food on the table (ambient carbon dioxide concentration), people will stuff their mouths more (internal carbon dioxide concentration), but they will not ingest twice as much food. Moreover, given some time to equilibrate, people may get sufficiently fed up (literally) that they will become more resistant to temptation and not ingest much more food than before, although it is certainly true that the more food available the more one eats (up to a point). Thus stomatal resistance increases in response to the plant's inability to assimilate all that is put on its plate, given the amount of available sunshine and nutrients for carrying out all its chemical reactions. (Speaking of resistance, anyone who has ever tried to feed an infant would know what happens when you try to increase the food intake rate by increasing the mass of goop on the end of a spoon! You do get more inside the infant, but a lot of resistance is put forth and a lot of goop ends up on the walls).

Simulations

The SVAT model calculates carbon dioxide flux and outputs it in units of kg m^{-2} s^{-1}. As with water vapor fluxes, the calculations refer to flux per unit sunlit leaf area, but the output is in terms of flux per unit horizontal surface area. The problem therefore, is to scale from a leaf to a canopy. One way of dealing with this is to calculate fluxes for each leaf or leaf strata. Another approach is to divide the leaf resistances by the leaf area index multiplied by a scaling factor called a 'shelter factor.' The reason why we divide by the leaf area index is that we must sum up all the individual leaf fluxes for one-sided transpiration. Were we to simply divide by LAI (equivalent to multiplying the transpiration fluxes by LAI) the resultant fluxes would generally be too large because the transpiring area would be overestimated, since many leaves are shaded by other leaves and thus have a larger stomatal resistance. Accordingly, we use an equation that reduces the leaf resistances by an amount that varies between about 1.0 for a fairly low leaf area index to about 2.0 for very large leaf area indices. Both the carbon dioxide and water vapor fluxes have been scaled in this way.

Simulation # 1.

Re-run the base case simulation, but this time examine the carbon dioxide fluxes and the water vapor fluxes together. Don't forget to use a large LAI in order to effectively suppress the evaporation component of the evapotranspiration. (We will output the transpiration in the same units to make it easier for you to compute a WUE ratio). Then run a simulation in which water stress manifests itself as a plateau in the evapotranspiration and note the changes in WUE, carbon dioxide fluxes and transpiration during the day and from the unstressed run. Use the field results of Figures 2 and 3 as a comparative platform from which to discuss the SVAT's results for transpiration and photosynthesis.

Simulation # 2.

Run the case with double root / stem hydraulic resistance again and examine the carbon dioxide fluxes, WUE and transpiration. Changes in the root / stem hydraulic resistance occur during the life of the plant. It probably decreases in the early stages of the plant's life and increases again with time as the plant matures and then senesces.

Simulation # 3.

Finally, and only if you have oodles of time to burn, check out the carbon dioxide doubling issue referred to by Cure and Acock (1986). First, increase the ambient carbon dioxide concentration to 660 ppmv. Note the increase in the fluxes of carbon dioxide from the base case and see if it is similar to the 30% increase indicated by the results of Cure and Acock. It isn't ! So then increase the minimum stomatal resistance by 30% and see if you reduce the carbon dioxide fluxes by 30%. You can't unless you also increase C_i which you can also do. So finally increase the internal CO_2 concentration until the assimilation rate is 30% above your reference case. To increase the stomatal resistance increase r_{smin} by the appropriate factor. Thus, if you wish to increase the stomatal resistance by factor of 2 simple double the minimum stomatal resistance. At this point, look at the decrease in transpiration from the base case. Does that value agree with the 20% decrease anticipated by the results of Cure and Acock ? If not, is the model full of baloney? Are Cure and Acock out to lunch ? Or is something up here that is a little more profound than scientific silliness ?

SUPPLEMENTARY FIGURES

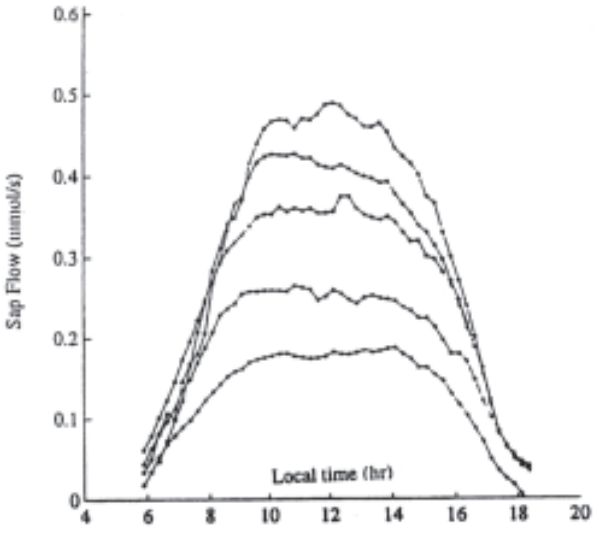

Figure 2 Diurnal evolution of sap flow measurements on selected days. The selected days are (by decreasing magnitude of sap flow): Julian days 246, 248, 251, & 255 near Avignon, France.

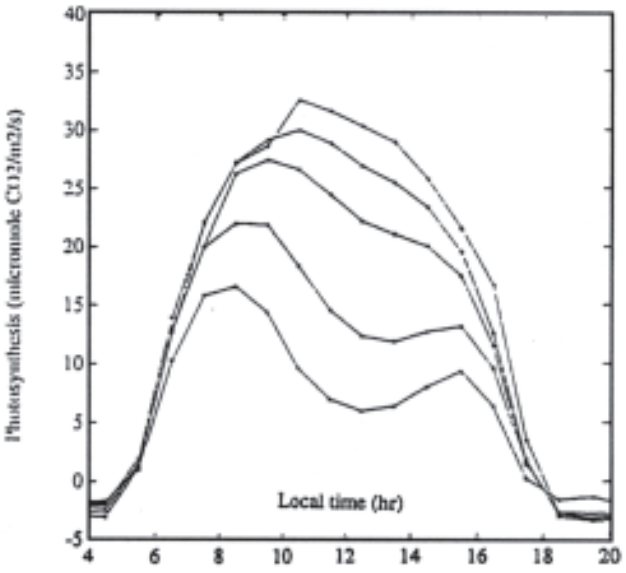

Figure 3 Diurnal evolution of photosynthesis in *u*moles-m^{-1}-s^{-1}. The selected days are identical to those in Figure 2.

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Cure, J. D. and B. Acock, 1986, Crop responses to carbon dioxide doubling: a literature survey, **Ag. and Forest Meteor**., 38, 127-145.

[4] Water transport from root to leaf is nevertheless critical in bringing nutrients and hormones to the plant factory. Transpiration is also necessary to maintain a reasonable leaf temperature, since photochemical processes tend to be more efficient at higher temperatures. Very high temperatures, however, will not force the plant to lose more water through the leaves but will tend to destroy cellular function.

[5] Plant scientists often prefer the units of micromoles per square meter per second. Fluxes in these units can be obtained by dividing those of kilograms per square meter per second by 44 and then multiplying the result by 10^9.

TRAINING FORESTERS FOR WOOD PROCUREMENT

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ABSTRACT: In the Southeastern United States the proportion of commercial forest land owned by non-industrial forest landowners is very high (75% in Alabama). Procurement of raw wood material from these private lands is a major activity of wood dealers and industrial forestry firms and is a major source of jobs for new forestry graduates. Few forestry curricula train students in the intricacies of procurement, however. This paper describes a course taught by the School of Forestry at Auburn University, ***Industrial Wood Procurement Practicum***, that introduces forestry students to the many facets involved in procuring raw material for an industrial firm.

Each spring, procurement foresters from industry are invited to participate in the *Practicum* as procurement managers of hypothetical forest products companies. Each hypothetical company is assigned a set of mills and product output. This in turn determines raw materials the company will be vying for on the open market. Each company's mills are situated across southern Alabama and located on a map. Fifteen forest stands are identified on the 5500-acre Solon Dixon Forestry Education Center, where the *Practicum* is held. A variety of stand types are chosen to provide a range of products and product mixes available for "purchase." Each stand is also located on a map of southern Alabama, scattered among the companies' mills. Road miles from each stand to each mill is given for computing hauling costs and evaluating potential competitors' interests. A prospectus is given for each stand, listing the general products and most recent diameter distribution available.

Students are assigned to the companies and become procurement foresters working for one of the procurement managers. The students, with their manager, determine which stands might provide suitable raw material for their mills at a competitive price. Prices can be negotiated among companies for transfer of products. Appropriate stands are inventoried and values are estimated taking logging, hauling, overhead, severance tax and other costs into account. Sealed bids are prepared and opened for each stand. One stand is sold as a negotiated tract by a fictitious landowner, who is typically given an unusual set of circumstances with which the students must cope.

Students and the industrial procurement foresters respond well to this scenario. Both feel it is a very worthwhile and "realistic" exercise. Important "lessons" will be discussed.

INTRODUCTION

As substantial percentage of all new jobs in the southeastern U.S. are in the area of wood procurement. Traditional forestry curricula in the South concentrate on aspects of managing the myriad of resources produced within and by the forest, but allocate little or no time on the area of procuring wood for industrial firms from private landowners. In Alabama, over 75% of the forestland is owned by non-industrial, private landowners. These forestland owners include farmers; individuals who inherited the land; professionals such as doctors, lawyers and teachers who purchased the land for recreational, investment or other reasons; land trusts managed by consultants or banks for income; insurance companies that purchased large parcels for investment; and others who own the land for a variety of reasons. The wood products produced on these lands are not pledged to a specific mill and are therefore available to be sold on the open market.

Wood procurement has often been equated with timber cruising. To buy wood, one simply cruises a tract of timber, places a dollar value on the products, makes on offer to the landowner, and begins cutting. Wood procurement today, however, requires a complex set of skills including competence in timber inventory techniques (increasingly utilizing GPS, GIS and data recorder technology), personal and industrial negotiation, legal and environmental regulations, financial and business management, people management, and strong interpersonal and written communication skills. A successful wood procurement forester is much more than a "timber cruiser." He or she must constantly deal with people from all walks of life; be able to manage independent road, logging and hauling contractors; operate within the constraints of corporate guidelines and governmental regulations; and handle large sums of money. The total value of wood delivered to mills in Alabama exceeds $13.2 billion per year. Procurement foresters commonly purchase tracts of timber valued greater than $500,000. Above all else, a procurement forester must deal

fairly with all sellers and clients and must maintain the highest level of integrity.

The School of Forestry at Auburn University has for more than fifteen years offered courses in Wood Procurement in order to prepare graduates for this important career. This paper describes an Industrial Wood Procurement Practicum that is designed to give students a near "real-world" experience in wood procurement. It involves a major commitment of time and effort by the forest industry in the state. It provides the students not only experience and a better understanding of the art and science of wood procurement, but also gives potential employers an "on-the-ground" interview of potential employees.

PURCHASING WOOD IN THE SOUTH

Most southern states are similar to Alabama, in that a large proportion of the forestland is owned by non-industrial private landowners. Many of these landowners have an interest in selling timber from their land. Some sell based on economic maturity, others during times of high stumpage values, and still others when income is needed for a family emergency, college tuition, or a new vehicle or other consumer item. The decrease in harvest levels on public lands, particularly in the western U.S., has resulted in substantial increases in stumpage values in the South. Many landowners that in the past had little or no interest in selling timber are actively seeking buyers.

Standing timber is often bought by a procurement forester or timber buyer negotiating one-on-one with the landowner for a fixed, lump-sum payment, or for specified prices per unit of wood (per ton or per cord, etc.). Many landowners, however, believe they can maximize their timber income by advertising the sale of their timber, with a specified date, time and place of the acceptance of sealed lump-sum bids. Ten years ago it would have been unusual for more than six or eight potential buyers to place bids for a tract of timber. It is not uncommon today to have more than twenty bidders for attractive tracts of timber.

Many corporations and mills employ procurement foresters whose job is to purchase wood suitable for their mills, contract with independent loggers and haulers to harvest and transport the products to the mills, and to sell products they do not need to other mills. Many organizations also encourage or require foresters to work with the landowner in regenerating the land and may even offer technical and financial assistance for regeneration efforts. In some organizations, foresters have responsibility for both procuring wood for company mills and for managing company-owned land. These foresters require a wide breadth of knowledge and skills.

A large portion of wood supplied to mills is provided through what is called the "dealer" system. Wood dealers are independent businesses that purchase timber on the open market, often bidding against the large corporations. They are not tied by contract to one mill, but may have "wood quotas" from several mills. The dealers, in turn, pay independent loggers and haulers to cut and haul wood they purchase to their wood yard. Some also purchase "gate wood" or wood purchased by a logger. This system provides independence among the timber suppliers and the mills. The dealer does not work for the mill, and the loggers do not work for the dealer. Each is an independent entity. This provides some "insulation" for the mills in terms of liability, but also helps insure the proper working of the free market system, since a single mill in an area cannot control the market price of wood. The laws of supply and demand are exemplified in such a situation.

THE INDUSTRIAL WOOD PROCUREMENT PRACTICUM

The following instructions are given to each student and industrial procurement forester:

Eight companies have been established, each with differing mills and wood requirements. Procurement foresters from industry will serve as procurement managers of each "company." Each student is "employed" by one of these companies. Each student's responsibility is to work with their procurement manager in evaluating available tracts of timber to determine which tracts could provide suitable raw material for your organization. You will determine an appropriate bid price on desirable tracts given specified mill requirements, market conditions and profit considerations. Employees (students) will work in the manner decided upon after consultation and discussion with their manager. *The manager, in addition to what is given in this handout, may give instructions and constraints*. **Instructions and specifications may be changed by agreement of all companies.**

You may cruise the tracts in any manner you wish, with approval of your procurement manager. Local weight tables **requiring dbh only** are provided for all pine and hardwood products. Utility poles will be cruised as "sawtimber", that is if a tree is determined to make a utility pole, its dbh will be estimated and weight determined. A premium price will be given for "pole sawtimber." You do not need to place poles in classes. After determining weights for each product, associated costs can be determined by multiplying each product weight by given cost factors. ***Product weights, harvesting costs, hauling costs, overhead costs, severance taxes, mill or woodyard delivered gate price and market price will be used to determine stumpage price for each product and a bid price for each tract (see example below).*** All companies must complete a 100% inventory, by product, of tract #14 (one acre). For this tract use the inventory processor to estimate weights

only, no dollar values. Product weights will be compared to assess variability of product calls among companies.

Bids are due on:
four tracts — 7:30 a.m. – opened at 8:00 a.m., Saturday morning (using your delivered prices only)
five tracts — 7:00 p.m. – opened at 7:30 p.m., Saturday evening (using delivered and negotiated prices)
remaining tracts — 9:00 p.m. – opened at 9:30 p.m., Saturday evening (using delivered and negotiated prices)

Each organization is limited to 9 bid tracts, plus the one negotiated tract. Each organization must enter an offer for the negotiated tract. DISKETTES MUST BE TURNED IN WITH EACH BID!!!

Bids on each designated tract will be opened and the timber "sold" to the highest bidder. Each bid opening will be discussed to identify possible reasons for successful and/or unsuccessful bids. **Profits generated from each bid will also be evaluated.** ***You should not necessarily buy as many tracts as possible, but also consider the profit your company can generate. A summary of profit will be computed for each tract and for total profit of all tracts you purchase by successful bid.***

Collusion or discussion of weights, volumes or prices for timber among competitors, other than for negotiated product prices, is considered a violation of federal antitrust laws and can result in termination from employment, fines and imprisonment.

Eight companies are located in the same wood drain and compete for tracts of timber (1997 participants):

MAP – **M**cDonald **A**llied **P**roducts, Jon McDonald (Union Camp), Procurement Manager, "We show the way." Pine sawmill and chip-'n-saw mill, pole mill and pine plywood mill. Uses small and large pine sawtimber and pine poles.

GROWTH – **G**lasgow **R**esources, **O**il & **W**ood **T**raders and **H**andlers, Richard Glasgow (U.S. Alliance), Procurement Manager. "We grease the wheels to greater profits." Pulp and fine papers mill (40% pine, 60% hardwood furnish), pine plywood mill, pine chip-'n-saw mill and a pine pole treating plant. Uses pine and hardwood pulpwood, large pine veneer logs, chip-'n-saw logs and pole-sized pine trees.

CNS — **C**oats **N**ationwide **S**awmills. Pete Coats (MacMillan-Bloedel), Procurement Manager, "We don't waste a chip." Pine sawmill, pine chip-'n-saw mill, pulp/paper mill (50% pine, 50% hardwood furnish) and hardwood sawmill. Utilizes small and large sawtimber, pine chip-'n-saw logs, pine and hardwood pulpwood and hardwood logs.

BEST – **B**rigance **E**nterprises & **S**awtimber **T**raders, A.J. Brigance (Canal Wood), Procurement Manager, "We are the simply the BEST." Pulp and kraft paper mill (70% pine, 30% hardwood furnish), pine and hardwood sawmills, and pine chip-'n-saw mill (CNS); also buys and sells timberland and other realty. Utilizes pine and grade hardwood sawlogs, hardwood crosstie logs, pine chip-'n-saw logs and pine and hardwood pulpwood.

BOOTH – **B**ooth **O**ccidental—**O**ptimizing **T**imber **H**arvesters, Bill Booth (Georgia Pacific), Procurement Manager, "You can trust our name.", Pulp and paper mill (60% pine, 40% hardwood furnish), pine sawmill, pine plywood mill and pine pole treating plant. Utilizes large pine sawlogs and veneer logs, pole-sized trees, and pine and hardwood pulpwood.

LIMB — **L**assiter **I**ntegrated **M**anufactured **B**oard, Tom Lassiter (Mead Coated Board), Procurement Manager, "We reach out for business." The parent company is an environ-

Table 1. Summary and location of company-owned mills and woodyards.

Company	Pine Sawmill	Hardwood Sawmill/ Veneer	Pine Plywood/ Veneer	Pine Chip-'N-Saw	Pulp/paper Mill	Pole Mill
MAP	Eoda	X	Babbie	Wing	X	Babbie
GROWTH	X	X	Wing	Gantt	Danley	Wing
CNS	Pigeon Creek	Brooklyn	X	Pigeon Creek	Dixie	X
BEST	Gantt	Babbie	X	Gantt	McKenzie	X
BOOTH	Wing	X	Wing	X	River Falls	River Falls
LIMB	McKenzie	McKenzie	X	Creek	Brooklyn	X
JAM	Dozier	Goshen	Dixie	Dozier	X	X
WOOD	Brantley	Brooklyn	Brooklyn	X	X	Brantley

mental consulting firm, but they have acquired pine and hardwood sawmills, pine chip-'n-saw mill and a pulp/paper mill (30% pine, 70% hardwood furnish). Utilizes large pine sawlogs, grade and crosstie hardwood logs, pine chip-'n-saw logs and pine and hardwood pulpwood. They also develop environmental impact statements and other environmental and perform natural resource consulting.

JAM – **J**aye **A**llied **M**aterials, Allen Jaye (Alabama River Woodlands), Procurement Manager, "We dunk the competition." Pine and hardwood sawmills, a pine chip-'n-saw mill and a pine plywood mill. Utilizes pine sawtimber/veneer logs, chip-'n-saw logs, grade hardwood logs and hardwood crosstie logs.

WOOD – **W**right **O**ccidental **O**perators and **D**evelopers, David Wright (Kimberly Clark), Procurement Manager, "The WOOD business is our name and our game." Pine (rotary) and hardwood (sliced) veneer plants, pine sawmill and pine pole mill. Uses pine sawtimber/veneer logs, veneer-grade hardwood logs, and pine poles. Veneer is sold to plywood plants and to furniture manufacturers.

Weight to volume conversion factors:
15000 lbs (7.5 tons) per mbf Scribner (pine saw and poles)
5350 lbs (2.675 tons) per cord (pine pulp and CNS)
17500 lbs (8.75 tons) per mbf Doyle (hardwood saw & ties)
5800 lbs (2.9 tons) per cord (hardwood pulp)

Average market stumpage prices for the area (assume Area 2) are given in Timber Mart-South attached to this handout. Note, for comparison, weights will need to be converted to volumes using given conversion factors.

For the last two bid openings, raw material that cannot be utilized by your company or that might be sold to another company at a delivered price advantage may be sold at a negotiated price***. Use your delivered product prices only for the first bid opening***. Delivered prices at gate for each product are for your company's mills only, other company's delivered prices at their mills may be different.

Table 2. Road miles from each tract to each mill location.

Tract number and name		Mill or Yard Location: Dozier	Goshen Brooklyn	McKenzie		Gantt	Babbie	Wing	Pigeon Creek	River Falls	Eoda Dixie		Danley Brantley	
		miles												
1	Ino	34	51	65	67	40	22	57	58	42	60	27	31	13
2	Heath	17	47	33	33	6	14	42	29	7	32	10	27	29
3	Rome	46	83	14	46	34	34	13	57	24	4	41	63	49
4	Dixonville	83	118	38	68	70	74	40	87	59	30	81	88	89
5	Jack	38	20	81	68	49	44	84	49	55	82	37	34	19
6	London	73	105	30	46	59	74	54	67	55	38	80	85	89
7	Clintonville	30	32	71	64	45	28	62	54	42	66	30	28	13
8	Herbert	43	73	18	17	30	48	47	38	27	26	51	53	63
9	Black Rock	31	29	64	37	39	54	81	13	46	72	47	21	29
10	Red Level	19	50	20	20	8	30	37	16	9	28	35	30	52
11	Slapout	20	20	20	20	20	20	20	20	20	20	20	20	20
12	Owassa	53	80	30	20	43	62	60	43	39	38	58	60	77
13	Carolina	24	54	21	29	15	18	18	41	11	15	25	34	33
15	Searight	4	35	37	29	10	24	39	25	21	36	12	15	25

For the sake of comparing negotiations--the distance from tract #11, the negotiated tract, has been made 20 miles to **ALL MILLS**. This means all organizations have an equal chance of purchasing this wood. Tract #14 is the 100% measured tract and does not require cost calculations.

Table 3. Product definitions and prices.

Product	Minimum DBH	Minimum top diameter
Hardwood sawtimber (oak & ash, no. 2 & better)	14	12
Hardwood sawtimber (other mixed, no. 2 & better)	14	12
Hardwood crosstie material	12	10
Hardwood pulpwood	8	4
Pine chip-'n-saw and small sawtimber	10	6
Pine large sawtimber and veneer	14	10
Pine utility poles	12	8
Pine pulpwood	6	4

GENERAL INFORMATION

The market is strong for most products. Wood supplies have been adequate at most mills, but recent wet weather has reduced most woodyard supplies.

Cruising should be done in 2-inch diameter classes—no heights are necessary. Appropriate local weight tables are attached and are also included in the spreadsheet on your diskettes. The worksheet also provides a summary of weights and costs per acre and for the entire tract by product and a bid

summary where you can input your bid prices and compute product and total values. You may expand this worksheet to assist your work in any manner you see fit.

HARVESTING COSTS (cut, skid and load): Pulpwood & CNS — $ 9.50/ton
Sawtimber and poles — $ 5.90/ton

HAULING COSTS:

Pulpwood (zoned) — $0.09 per mile per ton (0-25 miles from mill)
— $0.07 per mile per ton (26-50 miles from mill)
— $0.06 per mile per ton (51+ miles from mill)

Sawtimber and poles — $0.07 per mile per ton (all distances)

All hauling will be done with trucks, no wood will be moved by rail or barge.

OVERHEAD COSTS: $0.30 per ton variable costs for all products ***bid.***

SEVERANCE TAXES (included in spreadsheet):

PRODUCT	TAX RATE PER TON	TAX RATE PER UNIT VOLUME
Hardwood sawtimber (all) and crossties	$0.05712	$0.50/mbf Doyle
Hardwood and pine pulpwood	$0.0862	$0.25/standard cord
Pine chip-'n-saw and small sawtimber	$0.862	$0.25/standard cord
Pine large sawtimber and veneer	$0.857	$0.643/mbf Scribner
Pine poles	$0.2143	$1.607/mbf Scribner

Example bid price determination for pine pulpwood and veneer/large sawtimber

Assume: Tract is 40 road miles from your mill or to a mill with which you have negotiated a price for the product.
Total tract size is 42.5 acres
Delivered or negotiated prices: pine pulpwood $23.50/ton; pine veneer/large sawtimber $59.75/ton

Pine pulpwood:

15.66 tons/acre (from cruise) X 42.5 acres = 665.55 tons on tract
Harvesting costs = $9/ton X 665.55 tons = $5989.95
Hauling cost =$0.07/ton/mile X 40 miles X 665.55 tons = $1863.54
Severance tax = $0.0862/ton X 665.55 tons = $57.37
Overhead/operating costs (variable)= $0.30/ton X 665.55 tons = $ 199.66
Delivered price = $23.50/ton X 665.55 tons = $15640.42
Total costs = harvesting costs + hauling costs + severance tax + variable overhead/operating costs
= $5989.95 + $1863.54 + $57.37 + $199.66 = $8110.52
Net price = delivered price – total costs
= $15640.42 – $8110.52= $7529.90
Net price/ton = $7529.90/665.55 tons
= $11.31/ton (or @ 2.675 tons/cords, $30.26/cord)

Pine veneer/large sawtimber:

25.74 tons/acre (from cruise) X 42.5 acres = 1093.95 tons on tract
Harvesting costs = $5.40/ton X 1093.95 tons = $5907.33
Hauling costs =$0.07/ton/mile X 40 miles X 1093.95 tons=$3063.06
Severance tax = $0.0857/ton X 1093.95 = $93.75
Overhead/operating costs (variable) = $0.30/ton X 1093.95 tons =$328.18
Delivered price = $59.75/ton X 1093.95 tons = $65363.51
Total costs = harvesting costs + hauling costs + severance tax + variable overhead/operating costs
= $5907.33 + $2625.48 + $93.75 + $328.18 = $8954.74
Net price = delivered price – total costs
= $65363.51 – $8954.74 = $56408.83
Net price/ton = $56408.83/1093.95 tons
=$51.56/ton (or @ 7.5 tons/mbf Scribner, $386.73/mbf Scribner)

You can afford to pay $11.31 per ton ($30.26/cord) for pine pulpwood and $51.56/ton ($386.73/mbf Scribner) for pine veneer/large sawtimber and break even (no profit). If you can buy the timber for less, the difference is profit for your company. In a real world wood shortage (wet weather, etc.), you may pay more than breakeven price for one or more products in order to keep your mill(s) running. Other products will be handled in the same manner, except delivered prices for products sold on the open market (not used at your mill) will have to be negotiated with potential purchasing companies. The total bid price will be the total amount you are willing to pay for all the products on the tract. You may gain market information from bid openings.

DISCUSSION

Table 4 is an example bid summary sheet for a single company's cruise, cost and value computations for one tract. Field cruise information is input into a spreadsheet-based inventory processor. The bid summary sheet shows weights, volumes and costs for each product. The processor calculates a "breakeven stumpage price." This is the price that can be paid if no profit or loss is desired. The company can either accept this price or adjust the price per ton for one or more products, based on delivered prices to mills and the market, to determine an "assigned stumpage price." The company can opt to simply adjust either of these bids, based on the perceived need for wood at their mill. At the later bid openings, companies often "bump" the bid in an effort to buy at least one tract during the practicum—not a sound financial decision necessarily, but one based on "company pride." Students very quickly form a close relationship among themselves and with their procurement manager. There is stiff competition and collusion would not be considered! The students and procurement foresters perceive the practicum very seriously, taking the loss of a stand or large amounts of money "left on the table" (large gap between high bid and second bid) with consternation. Table 5 gives an example summary for bids on a single tract, showing typical variation in weights, by product, and total bid values.

As noted earlier, the timber inventory is done by dbh only allowing use of local weight tables. The inventory portion of the practicum is kept to a minimum. The class is not intended to improve inventory skills, therefore field time is minimized and simplified. Emphasis is placed on the logistical and economic decisions that must accompany the decision of whether to cruise a tract, the products that will be merchandized, harvesting and hauling the wood, and other considerations that affect the price offered for a that tract. Industrial foresters discuss with students the importance of understanding your competitors and the market. Substantial time is spent in negotiating prices for products that either cannot be used by a company, or that might be sold at an advantage to another

mill due to excessive distance to a company's own mill. Managers share their own and their real-world company's wood procurement philosophy. The industrial foresters are encouraged to interact with the students on both a professional and social basis. They are reminded they are serving as role models for the students and how they conduct themselves can influence a student's perceptions and career choices.

One evening is dedicated to a panel discussion among the industrial foresters and a question and answer time between the students and foresters. The foresters are encouraged to address topics such as their company's procurement organization, negotiating with landowners and other professionals, the importance of integrity and ethics, environmental concerns related to harvesting (best management practices, protecting water quality, etc.), their educational and professional background, coursework they deem useful for students interested in procurement, and other issues related to forest management and wood procurement. The students gain an excellent understanding that wood procurement is much more than cruising timber! They realize that wood procurement involves a clear understanding of forest inventory methods, a good grasp of financial principles, an appreciation and respect for the environment, and the necessity of being able to communicate with a variety of people with diverse backgrounds and a multitude of objectives and expectations.

The industrial foresters give feedback that the practicum is also useful to them. For lump sum sales in which they participate they do not know how the other bidders inventoried the tract. They have no idea of the variability of volume estimates occurring among bidders due to either differences in sampling intensity and methods, differing objectives, or random chance. When the weights are presented by product for each company, they learn about the inherent variability and have a better understanding of the circumstances that control the range of bids submitted. The industrial foresters have also indicated that their having to verbally express their personal and company philosophies and procedures to the students enhances their understanding of their own careers and the motivations and concerns of their employer. Foresters often call the School of Forestry inquiring how they can participate in the practicum. It is not difficult to fill the eight industry slots available each year.

This course is currently one of two wood procurement courses taught at Auburn University. The other is taught by a retired woodlands manager from a major paper company. He draws on his experiences and invites a number of individuals from industry to address specific issues during 3-hour lab periods. Auburn University will be changing from the quarter system to semesters in fall, 2000. These two courses will be combined into one. A portion of the course will continue to detail important issues by industry participants, while the field practicum described here will become a required three-day "field" exercise. There are also plans to incorporate a negotiating shortcourse, taught over a two- or three-week period, where students will learn and practice personal and group negotiating skills.

Courses such as the ***Industrial Wood Procurement Practicum*** can serve to improve relations between the School and employers by giving them a direct hand in the education of forestry students. Industry participants leave the ***Practicum*** with a good idea of our students' capabilities. Many job opportunities are generated through the ***Practicum***, sometimes with job offers being made "on the spot." Not all subjects lend themselves to involving potential employers or clients. When possible, however, such an exercise is highly valuable to both students and outside participants enhancing not only the students' education, but the profession as well.

Tables 4 and 5 are on the following page.

Table 4. Example bid summary sheet showing output of inventory processor, costs and values.

FY483 -- Industrial Wood Procurement Practicum – Bid Summary Sheet

Company Name: MAP **Tract #10**

Weight and volume summary by product

	Pine				*Hardwood*				
	Pulp	CNS/ Sm. Saw.	Veneer/ Lg. Saw.	Utility Poles	Pulp	Oak/Ash Saw/Ven	Mixed Hard. Saw/Ven	Crossties	**TOTAL**
Tons	688.3	626.0	1142.3	616.4	1026.8	550.9	495.2	186.1	**5331.9**
Volume (vol.units)	257.3 cords	234.0 cords	152.3 mbf-Scr.	82.2 mbf-Scr.	354.1 cords	63.0 mbf-Doyle	56.6 mbf-Doyle	21.3 mbf-Doyle	xxxx

TOTAL COST PER TON (sum of harvesting, hauling, severance tax and overhead costs)

$	11.69	13.04	6.99	9.56	11.69	7.80	7.80	7.80

BREAKEVEN stumpage price/ton and value (delivered price - total cost)

Stumpage	$ 13.31	21.96	48.01	55.44	8.31	37.20	32.20	27.20	xxxx
Value	$ 9163	13750	54845	34172	8536	20495	15948	5061	**$161,970**

ASSIGNED stumpage price/ton (what you are willing to pay per ton) -- (OPTIONAL)

Stumpage	$ 13.00	20.00	49.50	56.00	9.50	35.00	30.00	25.00	XXXX
Value	$ 8947.90	12520.00	56543.85	34518.40	9754.60	19281.50	14856.00	4652.20	**$160,773**

Enter Actual Bid: $160,001

Table 5. Summary of bids for an example tract.

BID SUMMARY -- FY483 INDUSTRIAL WOOD PROCUREMENT PRACTICUM										
Number of bidders =4					Tract 10			55 acres		
	Summary of tons on entire tract by product									
	----------PINE----------				**----------HARDWOOD----------**					
Company Name	**Pulp**	**CNS/ Small Saw**	**Veneer/ Large Saw**	**Poles**	**Pulp**	**Oak/Ash Saw/ Veneer**	**Mixed Saw/ Veneer**	**Crossties**	**Total Pine+ Hard.**	**Lump sum bid**
	----------(tons)----------									
MAP	688	626	1142	616	1027	551	495	186	5332	$160,001
WOOD	765	696	1269	685	1141	612	550	207	5924	$183,550
BOOTH	701	685	1203	670	952	520	575	177	5483	$170,344
LIMB	598	544	993	536	893	479	431	162	4636	$136,237
MEAN	**688**	**638**	**1152**	**626**	**1003**	**540**	**513**	**183**	**5344**	**$162,533**

NATURAL RESOURCE MANAGEMENT - THE CREATION OF A NEW INTERDISCIPLINARY MAJOR AT THE UNIVERSITY OF DELAWARE

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ABSTRACT: The College of Agricultural Sciences at the University of Delaware has an excellent faculty and physical facility well positioned to educate students for managing the world's natural resources (air, land, water, plants, animals, etc.) into the next century. The college offers a variety of traditional, discipline specific undergraduate majors in five academic departments. A faculty committee worked for more than two years to formulate a new major with an interdisciplinary approach. The result is a new major, Natural Resource Management, which began admitting freshmen students in the Fall of 1997. This paper will discuss the creation of the Natural Resource Management major.

INTRODUCTION

The College of Agricultural Sciences at the University of Delaware has an excellent faculty and physical facility well positioned to educate students for managing the world's natural resources (air, land, water, plants, animals, etc.) into the next century. The college offers a variety of traditional, discipline specific undergraduate majors in five academic departments. A faculty committee worked for more than two years to formulate a new major with an interdisciplinary approach. The result is a new disciplinary major, Natural Resource Management, which began admitting freshmen students in the Fall of 1997.

This paper will discuss the creation of the Natural Resource Management major. Topics include: the College of Agricultural Sciences, the faculty committee that formulated the major, the desired goal and nature of the curriculum, the major concerns in the approval process, faculty and student reactions to the major, and a description of the curriculum. The paper will also include a discussion of methods used to promote the major and an overview of the first set of students transferring or admitted to the major.

DESCRIPTION OF THE COLLEGE

The College of Agricultural Sciences at the University of Delaware consists of five academic departments: Animal and Food Sciences, Bioresources Engineering, Entomology and Applied Ecology, Food and Resource Economics, and Plant and Soil Sciences. With approximately 65 faculty, these departments collectively offer 16 undergraduate majors with 10 concentrations. The majors are traditional agricultural majors and are typically discipline specific. Examples include: Engineering Technology , Preveterinary Medicine, Food Science, General Entomology, Food and Agribusiness Management, and Plant Science. Undergraduate enrollment in the college is approximately 600, with 100 new freshmen and 50 transfers admitted each year.

The College of Agricultural Sciences has excellent facilities accessible to students. The College's 350-acre, on-campus site includes a working farm, a wood lot, a habitat trail, a greenhouse laboratory and expansive gardens. Townsend and Worrilow Halls contain offices, classrooms and laboratories, as well as an agriculture library and a modern computing site.

NEED FOR THE NEW MAJOR

The need for a new major in Natural Resource Management arose from two sources. First, there was a need to coordinate existing course offerings in the college into an interdisciplinary major. Second, the college had many requests from prospective students for a major focused on natural resources and the environment.

The college has historically offered several traditional majors oriented toward the use of natural resources and the environment. Examples include: Wildlife Conservation, Environmental Soils Science and Agricultural Economics. However, these majors are very discipline specific with little overlap with other academic departments.

Since 1990, visits to high schools in Delaware and the surrounding region have revealed a popular interest in "the environment." The source of the interest appears to be the increasing incorporation of environmental topics into high school biology, chemistry and agriculture curricula, as well as intensifying local and global issues focusing on the environment.

Despite their interest, many students were unable to articulate an exact definition of "environment" as it related to a college major or a career choice. While the University of Delaware offered a major in Environmental Science, that title covered a limited aspect of the popular field. Similarly, other programs in our college did not completely address the interests of many prospective students. Natural Resource Management (NRM) was designed to fill the void for students who sought to have a solid training in the physical sciences but also have an understanding of economics, ethics and public policy.

THE PROCESS OF CREATING THE MAJOR

The initiation of a new undergraduate major at the University of Delaware is a complex and involved process. It involves the formulation of a detailed proposal, which is then reviewed and approved by numerous administrators and department, college and university-level faculty committees. It culminates with the approval by the University's Faculty Senate. The process can take a year or more.

The Faculty Committee

In September 1994, the Dean appointed a faculty committee to evaluate and develop a more comprehensive framework for the college's natural resource programs. Our Associate Dean had done some preliminary work and provided a outline of the issues and concerns to be addressed. The committee consisted of faculty from Entomology and Applied Ecology, Plant and Soils Sciences, Food and Resource Economics and Animal and Food Sciences. The Associate Dean for Research and Associate Dean for Resident Instruction also attended committee meetings.

The committee met frequently over the next months and struggled with issues such as:

- how could the desired interdisciplinary nature of the major be achieved;
- what would be the purpose of the new major;
- what would be the desired characteristics of a program graduate;
- how would the major be different than existing majors;
- would it draw students away from existing majors;
- were resources (faculty, labs, etc.) currently available to implement a new major; and
- what would be the career opportunities for program graduates.

The Approval Process

After endless discussion and numerous compromises among committee members, a first draft of the Natural Resource Management major was sent to the Dean in April 1995. With his concurrence, the committee began the approval process for the new major.

Per University requirements for a new major, the process began by soliciting the approval of 11 departments outside the college to include courses offered by the departments in the Natural Resource Management major. With some minor exceptions, all agreed. Next, the committee met with the Department Chairs and then the entire college faculty to solicit comments and suggestions. The input of current undergraduates was solicited and considered. The first draft was then revised to reflect many of the suggestions. Next, the major was approved with minor revisions by the faculty in each of the three participating departments. The last step within the college was the Courses and Curriculum Committee. This committee, with representatives from each of the academic departments, undergraduate students and graduate students, approved the major unanimously.

Outside the College, the proposed major was forwarded to the Faculty Senate's Undergraduate Studies Committee. This committee had several minor questions regarding prerequisites, number of credits, etc. Approval of this committee required that a university wide "open hearing" be held to hear comments and suggestions from the university community at large. With that done, the major was forwarded to the Faculty Senate's Coordinating Committee on Education for review and approval. A major concern of this committee is the need for resources (faculty, laboratories, etc.) to support a new undergraduate major. Because this major asked for no new resources, it was approved and sent to the full Faculty Senate and approved at their March 1996 meeting.

Goal and Nature of Curriculum

As articulated by the faculty committee that formulated the major, the purpose of the curriculum is to produce graduates with: 1) an understanding of the social, physical, economic, legal and political problems of managing the use and perpetuation of natural resources in the 21st century and 2) the skills and capabilities to address those problems in both public or private forums.

The curriculum was designed to insure that characteristics of graduates would include:

- the skills required to solve "real world" problems;
- the ability to write and speak effectively;
- a solid understanding of natural sciences, mathematics, statistics, economics and public policy;
- a sound knowledge of the world's biodiversity;
- a competence in using computers to manage information and solve problems;
- a broad interdisciplinary education in the arts, humanities and social sciences; and
- an awareness of the ethical issues in natural resource use and management.

The curriculum relies heavily on courses already offered by the sponsoring Departments within the College, Entomology and Applied Ecology, Food and Resource Economics and Plant and Soil Sciences, together with courses offered in other colleges across the University. A full list of the requirements is attached.

Major Concerns

Various forms of the curriculum were presented and discussed at three college-wide faculty meetings and at an open hearing within the college. In that process, several important questions arose. Those questions with their answers are detailed below.

Who is administratively responsible for the curriculum? The major is administered by a three member faculty steering committee formed with chair-appointed representatives from Entomology and Applied Ecology, Food and Resource Economics and Plant and Soil Sciences. Appointments are for six years with reappointment allowed. Initial appointments are staggered by lot to establish a rotation. The chair of this committee rotates through the Departments represented every two years. Secretarial support is provided by the Associate Dean's office.

Who receives credit for majors? The number of majors is evenly distributed among the three departments sponsoring the program: Entomology and Applied Ecology, Food and Resource Economics and Plant and Soil Sciences. These majors are reported on all college reports regarding undergraduate enrollment.

Who decides on curriculum revisions? The steering committee is responsible for soliciting input from students and faculty, formulating revisions and submitting them through the normal college and University channels (Courses and Curriculum Committee, etc.).

Who advises students? Initially, the steering committee will advise students. If the number of majors increases significantly, other interested faculty will be recruited.

How will this curriculum be promoted relative to current Department curricula? The steering committee and other interested faculty will meet with the Associate and Assistant Deans to formulate a plan to promote this program.

Do careers opportunities exist for majors in this program? The first graduates of this program will not enter the job market until the year 2000. It is therefore difficult to know definitively what career opportunities will exist. However, outside evaluation of the program by individuals in state government and private industry provided positive support for the program including possible employment and internship opportunities. Overall, it is clear that the effective use and management of natural resources will remain important and is likely to increase in importance to the public, businesses and government agencies. It is only by starting now that we can provide students who are well-trained to address these issues in the next century.

Why are 130 credit hours required? This interdisciplinary curriculum depends heavily on courses from the three supporting departments to provide majors a broad training in natural sciences as well as economics and public policy. This breadth in addition to necessary courses in mathematics, statistics, computer training, communications and ethics necessitate 130 credit hours. Several majors in the College currently require 130 credit hours. Thus, this major is consistent with others in the College.

PROMOTION OF THE MAJOR

Several methods have been used to promote the new Natural Resource Management major. The Assistant Dean for Student Services presents the major to prospective students on routine visits to local high schools. A color recruitment brochure and curriculum guide were prepared and have been widely distributed to more than 900 high-school personnel in our region, to the campus Visitors Center and Admissions Office, to County Extension Offices, and to hundreds of prospective students and their parents who visit during college open houses. A Natural Resource Management World Wide Web site (http://bluehen.ags.udel.edu/homepage/nrm/nrm.html) is in place and has been used by many students.

TRANSFERS AND ADMITS

The Natural Resource Management major first appeared in the Undergraduate Catalog in the Fall of 1996, at which time five current university students changed their majors to Natural Resource Management. The 1996-97 Admissions Prospectus was the first issue to carry the Natural Resource Management major on the admissions application. As of July 25, 1997, fourteen students had applied and were offered admission to the Natural Resource Management major; five accepted their admission for a 36% yield rate (the college's yield rate is 41%). The average verbal SAT score for Natural Resource Management applicants was 606; for enrollees, the average score was 638 (the college's average was 567). The average math SAT score for Natural Resource Management applicants was 616; for enrollees, the average score was 620 (the college's average was 561). Thus, students enrolling in the major so far are above the average academically when compared to the college as a whole.

SUMMARY

The College of Agricultural Sciences anticipates the enrollment in Natural Resource Management will continue to increase. Information requests from high-school students demonstrate a continuing interest in the interdisciplinary facet of natural resource and environmental studies, as the Natural Resource Management major provides.

NATURAL RESOURCE MANAGEMENT REQUIREMENTS

DEGREE: BACHELOR OF SCIENCE IN AGRICULTURE
MAJOR: NATURAL RESOURCE MANAGEMENT

CURRICULUM	**CREDITS**
UNIVERSITY REQUIREMENTS	
ENGL 110 Critical Reading and Writing	3
Three credits in an approved course or courses stressing multicultural, ethnic, and or gender-related content	3
COLLEGE REQUIREMENTS	
Mathematics and Computer Science	
Mathematics course	3
Computer Science course	3
Agricultural and Biological Sciences	9-12
Minimum of one course in three of the following areas: Food and Resource Economics, Agricultural Engineering, Animal and Food Science, Entomology and Applied Ecology, Plant and Soil Sciences, or Biology.	
Literature and Arts	6
Six credits selected from the general areas of English, Art, Art History, Communication, Music, Theater, or Foreign Language.	
Social Sciences and Humanities	9
Minimum of one course in three of the following areas: Anthropology, Black American Studies, Criminal Justice, Economics, Education, Geography, History, Philosophy, Political Science, Psychology, Sociology, or Women's Studies.	
Physical Sciences	8
Minimum of eight credits selected from one of the following areas: Chemistry, Physics, Geology or Physical Science.	
MAJOR REQUIREMENTS	
Courses taken to satisfy Major Requirements may also be used to satisfy University and College Requirements.	
<u>External to and within the College</u>	
AGRI 165 Mastering the Freshman Year (or any equivalent Department freshmen seminar)	1
BISC 207 Introductory Biology I	4
and	
BISC 208 Introductory Biology II	4
or	
PLSC 101 Botany I	4
CHEM 101 General Chemistry	4
or	
CHEM 103 General Chemistry	4
CHEM 102 General Chemistry	4
or	
CHEM 104 General Chemistry	4
ECON 151 Introduction to Microeconomics	3
ECON 152 Introduction to Macroeconomics	3
ENTO 201 Wildlife Conservation and Ecology	3
MATH 221 Calculus I	3
MATH 222 Calculus II	3
FREC 135 Introduction to Data Analysis	3
FREC 150 Economics of Agriculture and Natural Resources	3
FREC 424 Resource Economics: Theory and Policy	3
FREC 444 Economics of Environmental Management	3
FREC 480 Geographic Information Systems in Natural Resource Management	4
PLSC 201 Botany II	4
PLSC 204 Introduction to Soil Science	4
<u>Group I - Communications: 6 credits from the following (including, a minimum of three credits in oral communications):</u>	
Any course satisfying the College of Arts and Science second writing course requirement. Recommended courses are: ENGL 301- Expository Writing, ENGL 312 - Written Communications in Business, ENGL 410 - Technical Writing, ENGL 415 - Writing in the Professions.	3
AGRI 212 Oral Communication in Agriculture and Natural Resources	3
FREC 345 Strategic Selling and Buyer Communication	3
UNIV 401/402 Senior Thesis (Any student successfully completing a Senior Thesis may count three credits toward the writing course requirement of this group.)	3
<u>Group II - Chemistry / Physics: 8 credits from the following:</u>	
CHEM 213 Elementary Organic Chemistry	4
CHEM 214 Elementary Biochemistry	
CHEM 216 Elementary Biochemistry Laboratory	1
CHEM 321 Organic Chemistry	4
CHEM 322 Organic Chemistry	4
CHEM 220 Quantitative Analysis	3
CHEM 221 Quantitative Analysis Laboratory	1
PHYS 201 Introductory Physics I	4
PHYS 202 Introductory Physics II	4
<u>Group III - Statistics: 6 credits from the following:</u>	
FREC 408 Research Methods	3
and	
FREC 409 Research Methods II	3
or	
STAT 201 Introduction to Statistics I	3
and	
STAT 202 Introduction to Statistics II	3

Group IV - Ecosystems: 6 credits from the following:

BISC 302	General Ecology	3
ENTO 325	Wildlife Management	3
ENTO/PLSC 440	Integrated Disease and Pest Management	3
GEOG 235	Conservation of Natural Resources	3
or		
GEOG 236	Conservation: Global Issues	3
or		
GEOG 230	Humans and Earth Ecosystem	3
PLSC 304	Environmental Soil Management	4

Group V - Plants and Animals: 6 credits from the following:

BISC 371	Introduction to Microbiology	4
ENTO 205	Elements of Entomology	3
ENTO 305	Entomology Laboratory	2
ENTO 406	Insect Identification - Taxonomy	3
ENTO 318	Taxonomy of Birds	2
ENTO 418	Avian Biology	2
ENTO 425	Mammalogy	3
ENTO 426	Aquatic Insects	3
PLSC 212	Woody Landscape Plants	4
PLSC 303	Introductory Plant Pathology	4
PLSC 402	Plant Taxonomy	3

Group VI - Land and Water Management: 6 credits from the following:

EGTE 103	Land and Water Management	3
EGTE 113	Land Surveying	2
EGTE 328	Waste Management Systems	3
GEOL 107	General Geology	4
GEOG 101	Physical Geography	3
GEOG 206	Physical Geography: Topography-Soils	3
GEOG 220	Meteorology	3
GEOG 320	Water and Society	3

Group VII - Natural Resource / Environmental Policy: 12 credits from the following (including,a minimum of six credits in Food and Resource Economics):

ECON 306	Public Choice	3
ECON 332	Public Finance and Fiscal Policy	3
ECON 360	Government and Business	3
EGTE 416	Project Economic Analysis	3
FREC 406	Agriculture and Natural Resource Policy	3
FREC 429	Community Economic Development	3
FREC 450	Environmental Law and Policy	3
POSC 220	Introduction to Public Policy	3
POSC 350	Politics and the Environment	3

Group VIII - Ethics: 3 credits from the following:

PHIL 200	Business Ethics	3
PHIL 202	Contemporary Moral Problems	3
PHIL 203	Ethics	3
PHIL 340	Cross Cultural Environmental Economics	3
PHIL 448	Environmental Ethics	3

ELECTIVES

After required courses are completed, sufficient elective credits must be taken to meet the minimum credit requirement for the degree. Elective credits may include Military Science, Music or Physical Education (only four credits of activity-type Physical Education and/or four credits of performing Music organization credit may be counted toward the degree).

Credits to total a minimum of 130

RESHAPING EXPECTATIONS FOR WEB-BASED COLLABORATIVE LEARNING

George Hess[1], Robert Abt[2], and Robert Serow[3]

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ABSTRACT: We offered an experimental graduate course built around a World Wide Web-based collaborative learning experience; five graduate students participated. The World Wide Web served as the primary platform on which knowledge was compiled, shared, and synthesized. We built a WWW-based annotated bibliography and synthesized information from several disciplines. NetForum-based discussions included student responses to questions posed by the instructors and by other students. The Web was valued most as a tool for information dispersal. As a result, students learned more from their peers than they had in other courses. However, students found brainstorming and "conversation" using NetForum, a list server, and electronic mail cumbersome and intimidating. Participants noted a need for personal contact to develop the sense of community critical to fruitful collaboration. Complex issues were brought to closure in several face-to-face meetings. In future offerings, we envision an extended course that begins with community-building meetings (live or video) before migrating to intense Web-based collaboration. We will use the Web's text and image capabilities for sharing complex information over long distances and time periods, and we will downplay the expectation of immediate response and focus instead on considered response. We will use Web-based conferencing technology for brainstorming and real-time interaction among participants. Institutions may have to increase flexibility in the timing and structure of courses to facilitate inter-institutional offerings.

INTRODUCTION

What do you do when you want to make inroads into a complex question such as "What are the ecological and economic effects of forest clearcutting at regional scales over long periods of time?" Many effects of clearcutting have been studied intensively, but separately, and typically over relatively small areas and short time periods. In our view, addressing the more complex question of long-term, large-area effects calls for the synthesis of existing knowledge in a modeling framework. Yet, existing knowledge is scattered across the writings of many disciplines, each with its own perspective and jargon. One response to this situation would be to seek funding for a team of graduate students to gather and synthesize the information; another to work collaboratively with experts from appropriate disciplines. We decided to create a World Wide Web-based collaborative learning experience — The Ecology and Economics of Clearcutting — that could serve as one model for Web-based.

OUR VISION OF WEB-BASED COLLABORATIVE LEARNING

Our vision was of a group of experienced and highly motivated Ph.D. students, drawn from multiple disciplines, collaborating with us as peers. The World Wide Web would serve as the primary platform on which knowledge would be compiled, shared, and synthesized. We also planned to bring "stakeholders" — representatives of timber industry and environmental organizations interested in clearcutting — to the table to provide students with a variety of perspectives. Because we wanted to preserve the option of face-to-face meetings, our offering was advertised locally at North Carolina State University, Duke University, and the University of North Carolina at Chapel Hill. Our long-term vision is that an effective collaborative learning forum will attract participants world-wide.

The discussions that led to the development of this course were based on our interest in exploring potential long-term, regional consequences of various clearcutting policies. For example, many forest product companies are beginning to limit

the size of clearcuts under an industry-sponsored Sustainable Forestry Initiative. The overall ecological consequences of this policy are unclear. Smaller clearcuts are probably good for aesthetics and water quality but may fragment the landscape, to the detriment of wildlife that need large blocks of relatively undisturbed forest. Reviewing the literature covering clearcutting from a variety of disciplinary perspectives was a necessary first step in our effort to expand our understanding of these issues. By bringing together Ph.D. students from different fields, we felt we would strengthen our analysis and, by allowing students to participate in the synthesis of knowledge, provide a valuable educational opportunity.

Several factors led us to the Web as a vehicle for our effort. The Web has been promoted as a medium well-suited to the collaborative learning process and the model of "instructor as facilitator" that we wanted to use. The construction of an annotated bibliography and the interdisciplinary exchange we sought seemed amenable to a Web-based approach. Web-based discussion would allow everyone to react to new materials as they were posted and allow participation by geographically dispersed students and stakeholders. The North Carolina State University libraries offers access to a wide range of on-line, searchable bibliographic databases, and the Web would also be an excellent resource for following current debates on the ecology, economics, and politics of clearcutting. Given our vision of a collaborative learning experience, we felt the Web would enhance our ability to act as peers and facilitators rather than lecturers.

Many universities see the Web as an important new medium for education that will allow them to meet changing and expanding demands for learning opportunities. North Carolina State University and the College of Forest Resources are strong supporters of innovative teaching experiments and encouraged us to pursue our interests. The College of Forest Resources, in partnership with the NCSU Libraries and the Computing Center, was bringing to completion a two-year project focusing on "Student-Directed, Information-Rich" education. This project explored the use of Web-based multimedia materials, databases, and other information resources to create a more student-driven, self-paced educational experience. The project had prepared the library staff to offer support in delivering Web-based course materials. Carolyn Argentati, head of the Natural Resources Library, played a pivotal role in this project and was eager to support our experiment in Web-based collaborative learning. The University supported our efforts with a grant that enabled us to hire a part-time Web consultant to take care of day-to-day operations, and to contract with education specialist Dr. Robert Serow to evaluate the outcome of our efforts.

COURSE ORGANIZATION, STRUCTURE, AND PHASES

The face-to-face course organizational meeting brought us a reality rather different from our vision: a group of four enthusiastic, but inexperienced, Masters students and one Ph.D. student. Three of the students were from North Carolina State University and two were from Duke University. We considered canceling the course but decided that there was still ample opportunity to test some of our ideas and to provide these eager learners with an exciting educational experience. We laid the groundwork for the course and made it plain that we were not clearcutting experts ready to profess our knowledge to receptive students. Instead, we intended to function as both peers and facilitators in an intensive, collaborative process of synthesizing existing scientific knowledge.

We created a Web site flexible enough to change with the nature of our activities. The home page (http://www2.ncsu.edu/unity/lockers/class/for692e/) was streamlined so that course participants and other browsers could find information quickly. Early on, we developed the concept of a "workroom" as the focal point for current activities (Figure 1). The workroom included links to the project we were focusing on at the time, a Web-based bibliographic entry system, a text-based electronic discussion forum for the interchange of ideas among participants, and archival links to information gathered during earlier phases of the course. We used NetForum, a software system developed by the University of Wisconsin's Biomedical Computing Group (www.biostat.wisc.edu/nf_home), for Web-based discussion. Because our investigation was to be science-based, we insisted that NetForum postings include citations of relevant scientific literature. A list server was provided for more informal conversation, and on-line contact information included electronic mail and telephone numbers for all participants. We did not install any security measures to prevent Web surfers at large from posting information or comments on our site.

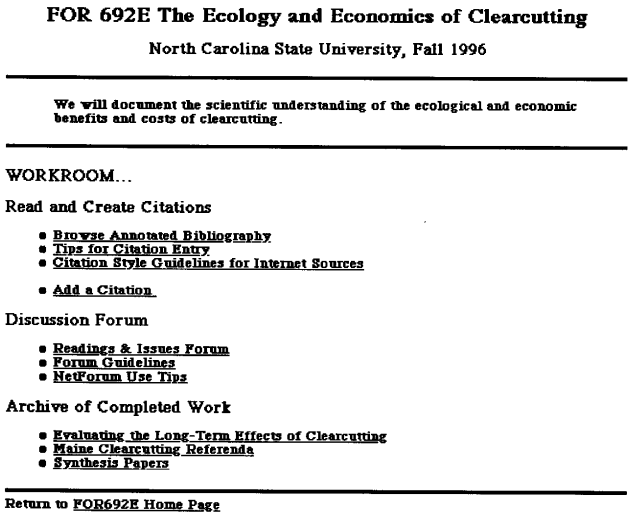

Figure 1. The workroom was the center of activity and evolved throughout the course to focus on current projects.

The course moved through three phases, only the first of which was planned in advance: 1) literature search and summarization, 2) synthesis through analysis of a current issue, and 3) design of research to fill knowledge gaps. In our original vision we had imagined students coming to the table with a strong background in some field relevant to clearcutting. Instead, most students were in the early stages of their graduate studies and needed to build their own knowledge base before meaningful collaboration could occur. During the organizational meeting we each selected an aspect of clearcutting to research and share with the group over the next five weeks. To ensure progress, we agreed on weekly milestones in terms of the number of citations to be entered into the on-line bibliography by each participant.

The second phase required application of our newfound knowledge to a current issue in clearcutting. After group discussion, we agreed to analyze the competing clearcutting referenda on the 1996 Maine ballot. Each participant was to analyze the referenda from the perspective of his or her area of study, and the group would synthesize these perspectives. During the first phase we learned that face-to-face interaction among participants was needed to bring issues to closure in a reasonable amount of time. Therefore, we scheduled a face-to-face meeting — on election eve — during which we would develop a one-page consensus recommendation designed to be distributed to voters. Again, milestones were set for each step.

During the third phase, participants were asked to begin designing a research program to address some of the key unanswered questions we had uncovered. Each participant was to determine the research needs in their area of study, and the group was to determine how to address all needs in a coordinated effort. Several milestones were set and two face-to-face meetings were scheduled. We also scheduled a final presentation of results before a panel of forestry experts.

EVALUATION

To evaluate the course, we conducted pre- and post-class surveys and focus groups, and we administered our department's standard course evaluation. The departmental evaluation is designed to determine if expectations are communicated clearly by the instructors, whether a balanced presentation of material is provided, and that instructors and students each uphold their responsibilities in the learning process. Through the surveys we collected information about experience with, and expectations for, Web-based learning; knowledge and attitudes about clearcutting; and reactions to the teaching techniques we used (Table 1). Focus group sessions were conducted in our absence. They provided information about students' reactions to the course as a whole and to five specific issues we identified in advance: 1) learning and attitude changes about clearcutting; 2) the interdisciplinary nature of the course; 3) the peer-group model of instruction; 4) the use of Web-based communication technologies; and 5) the involvement of stakeholders.

Good Tool For Information Dispersal

It's no surprise that the Web was highly valued as an information dispersal vehicle. We used the Web to post assignment details, enter bibliographic citations and notes, share ideas using NetForum, and post preliminary and final documents we produced. Participants were able to read and comment on the work of others at their convenience.

A Whole New Way Of Creating Permanent Citations

One of the most successful aspects of the course was a Web-based bibliographic entry system developed specifically for our use. Chris Floyd, a North Carolina State University library computer consultant, developed software that

Table 1. A summary of our vision and expectations, what we learned from the course evaluation, and a reshaped vision based on our findings.

Our original vision • A group of motivated, experienced graduate students from multiple disciplines, collaborating with us as peers. • Use the Web's text- and image-based tools as the primary means of compiling, sharing, and synthesizing knowledge. • Use text-based forums for brainstorming and "conversation" among participants. • Bring "stakeholders" — representatives of organizations interested in our research — to our Web site to provide a variety of perspectives.

Expectation
The Web will enhance collaboration and learning.
What we learned (7 participants)
Yes and no.
• Valuable for sharing detailed, written information.
• Web-based bibliography an excellent information sharing tool.
• Web could not replace face-to-face meetings. Participants needed personal contact to develop the sense of community critical to fruitful collaboration. Some felt that video technology might substitute for face-to-face meetings.
• NetForum was an unsatisfactory substitute for conversation.
• Participants became frustrated when they did not get quick responses to their postings. Some participants were intimidated by the prospect of posting their thoughts for all the world to see.
Expectation
Participants will learn more from one another using a Web-based, collaborative approach.
What we learned (7 participants)
Yes, but . . .

• Participants felt they learned more from their peers in this course than in other courses, largely because of the ease with which complex information can be shared using the Web.
• Personal interaction is needed to build a sense of community among participants before they will buy into Web-based collaboration.
• Face-to-face interaction was more highly valued than Web interaction for brainstorming and bringing complex issues to closure.

Expectation

The Web will enhance our ability to bringing diverse stakeholders to the table.

What we learned (7 participants)

No.
• Some stakeholders agree to participate, but none did.
• Failure to participate attributed to lack of time and concern about voicing opinions on controversial issues on an open Web site.
• Personal interaction is needed to build a sense of community before stakeholders will buy in to Web-based collaboration.
• Providing restricted access forums might increase participation.

Our reshaped vision

• A group of motivated, experienced graduate students from multiple disciplines, collaborating with us as peers.
• First build community identity among participants through face-to-face meetings when possible, and Web-based conferencing technology if participants are scattered geographically.
• Migrate to Web interaction as participants become more comfortable with one another.
• Use the Web's text and image based tools for in-depth analyses and considered responses.
• Provide a mixture of secure and open forums to reduce intimidation and increase probability of stakeholder participation.
• Form teams in response to common interests, geographic proximity, and scheduling realities.
• Schedule progress meetings with individual students, either in person or using a video link.

allowed us to enter complete citation information and notes for all the literature we read. As citations were entered, the software created a citation index. Using this system participants could discover what everyone was learning as soon as citations were entered. Web-savvy participants were soon putting hyperlinks to bibliographic entries in their written submissions and NetForum postings. The students had several suggestions for improving the bibliographic software, most of which were implemented during the early weeks of the course. With our guidance, staff members from the North Carolina State University Libraries are currently enhancing the software to include edit, search, and other capabilities. Once improved, this software has potential for wide application in collaborative research projects.

Intimidating Forum — Cannot Retract Statements

As part of the first phase, we began a NetForum discussion about the definition of clearcutting. Students are accustomed to writing for the instructor alone, and some in the class were intimidated by the prospect of exposing their ideas to classmates and Web surfers at large in such a public forum. Given time for adjustment, we feel this is a positive force that will drive students to put more thought and effort into their work. For our course, it unfortunately meant that several participants were largely silent in NetForum discussions.

This phenomenon was not limited to student participants, but explains partly the lack of stakeholder participation. We approached people from several environmental organizations and forest products companies about participating in our course. We pitched it as an opportunity to educate an open-minded group about the role of clearcutting in forest management and the environment. Most of those we approached expressed interest, and two were enthusiastic enough to agree to participate. In the end not one stakeholder joined in, despite our attempts to make participation as easy as possible. This was a great disappointment to our students who viewed stakeholder participation as an excellent way to bring a "real world" perspective to our analyses. After the course was over, we learned that failure to participate was due in part to concern among stakeholders about voicing opinions on controversial and sensitive issues on an open Web site.

Our demand that postings contain appropriate citations further increased anxiety about the process. This requirement was a two-edged sword. It reduced the number of postings, but it generally increased the quality of the postings that were made. Several early postings were heavily documented and well reasoned and set a standard that some participants felt they could not meet; the reaction of some was to withdraw from discussions. Based on the level and quality of our one Ph.D. student's participation, we suspect this would have been less of a problem had we attracted the group of Ph.D. students we initially envisioned. Nevertheless, we feel that quality is more important than quantity and will maintain the citation requirement in future course offerings of this type.

Several "flames" — a term used to describe inflammatory statements sent by electronic mail or list servers — from outside readers reinforced feelings of intimidation. We encouraged the students to respond in a reasoned manner or to ignore "flames," but to avoid involvement in "flame wars." The negative comments petered out quickly. We might have avoided this problem by installing security features, but we had made a conscious decision not to do so because we wanted to expose participants to varied perspectives. However, lack of security hampered open discussion among our students and between students and stakeholders. In the future, we may

provide a balance of secure forums for class members and stakeholders and open forums for wider participation.

It's Easier To Procrastinate On The Web

With the flexibility to complete work at one's convenience comes the flexibility to procrastinate, particularly in the face of other more immediate deadlines. The first milestone of the second phase was for each participant to post an analysis of the Maine clearcutting referenda on NetForum. Almost everyone missed this milestone, and one participant never posted an analysis. This hampered our ability to move forward on a project that required sharing knowledge among individuals. While this is not a phenomenon limited to the Web, we find it hard to imagine that so many students in such a small group would arrive so unprepared for a traditional class. During the post-course interviews, students indicated that the flexibility inherent in our Web-based course led them to approach their academic responsibilities more casually than in a conventional course. The lack of face-to-face accountability makes it much easier to procrastinate, and even to "blow off" an assignment. One way to overcome this barrier is to schedule a progress meeting with each student. We found this effective in a later assignment for which we scheduled a one-half hour face-to-face meeting with each participant. This meeting could easily be conducted using Web-based audio-video technology.

By The Time You Got A Response, You Had Forgotten The Question

When a participant posted a burning question or a hard-won insight, there was an expectation of quick response from others. Often, that expectation was not met. Students became frustrated after checking frequently for replies and finding none. This frustration ultimately led participants to stop posting. Our reaction was to maintain an almost constant presence on the Web, firing off comments about postings and reacting quickly to student inquiries. This shifted the dynamics from interaction among participants to interaction between participants and instructors. The group dynamics we sought just didn't materialize using text-based Web tools.

One response to this situation is to require postings by a specific deadline. We tried this but felt that it was counter to the spirit of the course, which was to be a free and open exchange of information. The students did not like being forced to say something about everything, and we disliked having to police the Web site to make sure people were participating actively. This is a problem of unrealistic expectations that is perhaps best addressed by reshaping expectations.

We're Human, We Need Contact

The students felt strongly that the human chemistry of face-to-face meetings was critical to the full development of ideas. We agree. As instructors, we clearly saw a difference between face-to-face and on-line interactions. The students were more open and took more risks in person. Technology-oriented people have been quick to offer Web-based conferencing software as a solution to this problem. Although imperfect, this software allows people to see one another, converse in real time, and share visual information while discussing it.

While conferencing technology may help, this cry of frustration — "we're human, we need contact" — may be at the heart of the difficulties we encountered. In their article on "Universities in the Digital Age", Brown and Duguid (1996) stressed the function of Universities as a place where students — and especially graduate students — gain access to the communities of practice relevant to their disciplines. They also note that on-line participation in substantive, collaborative thinking may be "significantly dependent on a deep base of off-line experiences." We brought together a group of students who did not know one another and expected them to collaborate using Web-based tools; we also expected stakeholders to join us under the same conditions. "We need contact" was the students' way of telling us that they need to know, understand, and trust one another before they can collaborate using a medium that filters out much of the social context that drives fruitful collaboration. Lack of participation by stakeholders may be viewed in the same light. We find ourselves agreeing with Dan Huttenlocher's comment, as quoted by Brown and Duguid (1996), that "The Net isn't a good place to form communities, though it's a very good place to keep them going."

RESHAPING EXPECTATIONS

The expectation that the Web will duplicate a classroom experience is a problem. This expectation is part of the phenomenon discussed by Batson and Bass (1996) in their article on "Teaching and Learning in the Computer Age" — namely, an attempt to use this new medium to teach in the same manner we already do. As instructors, we created the expectation that Web-based interaction would be like an ongoing conversation in the classroom. It is not, and we don't believe emulating the classroom experience should be the goal of Web-based discourse. Our instructional approach changed in reaction to unmet expectations, and we found ourselves imposing more and more of a conventional structure on the course. The students also reacted to unmet expectations by abandoning the exchange of text-based ideas in favor of the more conventional and comfortable format of face-to-face meetings. We all wandered back to more familiar territory. The key question is "Why?"

One might argue that scheduling face-to-face meetings allowed us to retreat too easily to more familiar ground. We don't believe we could have forced the kind of interaction we sought on the Web by simply eliminating face-to-face meetings. Quite the opposite, we believe that early face-to-face

meetings, or perhaps video conferences, are critical to establishing the sense of community needed for the kind of collaboration we sought. People need time to get to know one another personally and to "buy in" before they will commit themselves to an intense, collaborative effort.

We're convinced that courses based on the concept of Web-based collaborative learning can work, but we believe they must be built on the foundation of an established community. Our initial instinct was to enroll experienced doctoral students. Although we didn't recognize it at the time, perhaps what we really meant was "students who are already part of an established community of learners." Unless the participants already know one another, some early portion of the course must be devoted to community building. We expect that more time will be required for this phase for students early in their academic career. During this part of the course, frequent face-to-face or video conference meetings will be needed. One of the students evaluating our course suggested a "pre-course" in which the fundamentals of the subject are presented before launching into the main event — intense, Web-based collaboration. This would have been difficult for us because our intent was that we all learn together. However, the idea has merit as a way of involving undergraduates and new graduate students in collaborative learning efforts. In fact, efforts like ours would be more fruitful if students were exposed and acclimated to this kind of learning earlier in their careers.

The rub here is that scheduling meetings recreates one of the problems Web-based interaction is designed to circumvent. A major advantage the Web offers — and one attested to by participants in our course — is the flexibility to work when one can or wants to. We had difficulty scheduling meetings among seven participants from two universities separated by 25 miles and can imagine the difficulties created by spanning time zones and mixing semesters with quarters. One way to resolve this is to have teams meet and report the outcome of their deliberations by posting minutes or through audio-video meetings among team leaders. Each team might need independent faculty and technical support, particularly if they are spread among institutions. This, of course, creates the need for another level of community building among teams or team leaders.

Web-based collaborative learning courses may also have to be designed without regard to semester and quarter constraints, particularly if more than one institution is involved. The integration of personal and group schedules to meet deadlines is difficult, particularly for students with job responsibilities and heavy course loads. It may be more realistic to schedule collaborative courses for a full academic year or as on-going forums to which people come and go. Filling these prescriptions will require significant intra- and inter-institutional organizational effort and cooperation.

OUR RESHAPED VISION

Our reshaped vision is of a multidisciplinary, collaborative effort in which the Web serves a central role in cementing together a community of learners. We envision an extended course, the first portion of which relies heavily on personal contact and face-to-face meetings to establish a sense of community and obtain buy-in from all participants. As the course proceeds and the participants become comfortable with one another, we can move more activity to the Web. The Web provides a varied and powerful set of tools, each of which should be used to its own advantage. We will use the Web's text and image capabilities for sharing complex information over long distances and time periods, and we will downplay the expectation of immediate response and focus instead on considered response. We will use face-to-face meetings or Web-based conferencing technology — depending on the geographic distribution of participants — for periodic brainstorming and consensus-building sessions. Teams will be formed as needed in response to geographic limitations, common interests, and scheduling realities. Finally, we will hold periodic face-to-face, video-link, or telephone progress meetings with class members and team leaders to maintain a level of personal interaction and accountability.

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TEACHING NATURAL RESOURCES 101 AS MANAGING FOR SOCIAL VALUES AND HUMAN-ECOSYSTEM RELATIONSHIPS

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ABSTRACT: From the beginning lecture in their Principles of Natural Resource Management course, College of Natural Resources students at Utah State University (e.g., wildlife/fisheries managers, foresters, geographers, rangeland managers or environmental studies majors) are taught that they will not just manage for ecosystems and not just for people, but for valued *relationships* between the two (Brunson and Kennedy 1995, Koch and Kennedy 1991). These people-ecosystem relationships generate social values that are communicated to managers by interrelated economic, sociocultural and political/legal systems for society living and (to a lesser extent) for generations of humans and other life-forms yet to be born.

How these concepts evolved in American society and natural resource education, and the professional attitude and spirit in integrating them into a curriculum, are also discussed.

INTRODUCTION

Most of my undergraduate forestry education in 1958-62 was hard-science, mathematics and silviculture-similar to the European-model forestry curriculum proposed for the U.S. by Hough(1878). In a forstmeister tradition (Miller and Gale 1986), my Principles of Forestry course focused on protection and efficient wood production, with other human forests values and uses usually presented as constraints, costs, annoyances or of marginal benefit. For about 20 years I have taught Principles of Forestry at Utah State University as managing for complex, diverse and evolving natural resource *social values*, of which wood production has been declining in the Intermountain West (Kennedy 1985). In the last couple of years my colleague Mark Brunson has helped me carry this one step further, presenting the fundamental goal of natural resource management as providing for valued human-nature or human-ecosystem relationships (Brunson and Kennedy 1995). From managing forests for obviously good deer, wood of water stuff, to managing natural resources for social values, to providing for valued human-ecosystem relationships is quite a transition in manager, natural resource, and client roles and relationships.

This paper presents how managing natural resources for social values and its extension to managing for human-ecosystem relationship was developed and integrated into a basic Principles of Forestry course, that soon will be the initial Principles of Natural Resource course required of all College of Natural Resource majors (e.g., foresters, rangeland managers, geographers or wildlife managers). The basic premise and course strategy will be discussed, but so will the convictions and excitement in teaching it—for spirit in education is often as important as content or technique.

WHY REQUIRE PEOPLE/SOCIETY EDUCATION FOR NATURAL RESOURCE MANAGERS?

An attempt to display the range of justifications for teaching people/society aspects of natural resource management is briefly presented in Table 1. It indicates how and why these three educational modes evolved, plus the motivation and the spirit for including people/society education in natural resource management curriculae. Note that integrating the social sciences into natural resource management education is not the issue here, for that is too limited. To understand important people/society interactions and influences in natural resource management will also require the inclusion of broader knowledge, in the arts or humanities, in history or religion, and more.

Traditional Educational Mode: Natural Resources Foremost and Forever.

This traditional perspective of natural resources (Table I) assumes that ecosystems have obvious human value in long-standing wood, game or water outputs, and emerging wildlife or recreational services. The preface to the first textbook on silviculture (and an initial handout in my course) is a poetic, passionate and traditional description of German forester's

roles and social responsibilities at the beginning of the 19th century (von Cotta 1817), that largely reads fresh and true today.

Such a forest protection and wood-focused silviculture focus was probably an adequate appraisal of natural resource social values in the Agricultural or the Industrial Stages of Western-world socioeconomic development (Gulick 1951, Koch and Kennedy 1991, McGee 1910). Economics was the only social science willingly introduced early in forestry and latter natural resource management curriculae. But the focus was usually microeconomics efficiency, with much less attention to human aspects in demand or regional socioeconomic development (Hays 1959). This orientation was rather bluntly stated by one of the fathers of American forestry, Professor Fernow (1902:85), in the first American forest economics textbook: "The first and foremost purpose of a forest growth is to supply us with wood material; it is the substance of the trees itself, not their fruits, their beauty, their shade, their shelter, that constitutes the primary object..." Any questions?

Changing U.S. social, economic and political forces increasingly conspired to insert themselves in natural management after W.W.II, and professional educators and managers were increasingly required to include them. This inclusion of people/society considerations was often not done eagerly or willingly, but prudently (Cliff 1963). We young natural resource managers often heard from our elders in the 1960s that in a more perfect world, there would not be all this public and political interference in our professional wisdom, and we would be liberated to "manage for the good of the resource". This good was usually not well articulated, and often involved more intensive wood or deer production, but somehow we were convinced that it would emerge from our science and professional ethics. The American public, it seems, was not so convinced (Reich 1962).

TABLE 1. Rationales for providing people/society education to natural resource (NR) managers.

Educational Modes:	Educational Rationales:	Human-NR Relationships:	Motto For NR Management:
Traditional Mode: NRs Foremost & Forever	Changing socio-economic & political pressures compel us to incorporate social sciences.	NRs foremost within people & societal constraints	Regardless of people or political distractions, stive always to mange for the good of the resource.
Transition Mode: NR Management Involves People, for Better or Worse	NR management is driven and impacted by socioeconomic & political systems.	NRs first, but their manage-ment is driven & impacted by people.	Manage NRs on sustained yield basis for people now & in future.
Relationship Mode: NRs = People and People = NRs	NR definitions, use, protection and management are human-ecosystem relation-ships.	NRs & people & society are equally & inextricably intertwined.	Manage not for ecosystems or for people, but for their relationships.

Transition Mode: Natural Resource Management Involves People.

Increasing 1960s outdoor recreational and other "multiple" uses of wildlands (Cliff 1963, Hopkins 1970) and the turbulent 1970s (Duncan 1971, Reidel 1971) was natural resource managers' introduction to the complex and diverse social values of an emerging urban, post-industrial (Drucker 1993) and globally integrated (Reich 1991) U.S. society. Few natural resource professionals by the 1980s believe that foresters or other natural resource managers were omnipotent (Behan 1966). Few would deny, for better or worse, that socioeconomic, political or legal aspects are an increasing and important part of their management, and require more education in that area. For myself and many colleagues, the transition was often a confusing and threatening journey.

A 1983 Fullbright Scholar appointment at Trinity College, Dublin, provided the time 20 try to make sense of all the different sociocultural, economic and political systems impacting natural resource management that I had observed in the U.S. and on several international assignments. I was also searching for a new central construct to make my forest economics courses more integrated with other social and political systems, and inclusive of broader natural resource values impacting the Intermountain West in the 1970s. The concept of managing natural resources for multiple, diverse, long and short-term social values was the result (Kennedy 1985). After several years of teaching these concepts on campus, it became a core concept in a USDA-Forest Service shortcourses taught with a suspicious wildlife biologist colleague, by the name of Jack Ward Thomas. After he became convinced that social value concepts could legitimately incorporate biocentric values, we refined it and jointly wrote another paper (Kennedy and Thomas 1995). For over 15 years this has been the central management paradigm in my introduction to forestry and resource economics courses. The concept includes all my student's values and all the active systems (i.e., economic, social and political/legal) driving and impacting natural resource management.

The *Readers Digest* version of the concept goes something like this:

1) We do not manage natural resources for fixed, unchanging and intrinsic values that fall from the sky, are generated only by the economic system, or are whispered in our ears by the ghosts of Gifford Pinchot or Aldo Leopold, but for multiple, diverse, long and short-term *social values* as the natural resource system interacts with interrelated sociocultural, economic and political/legal systems.

2) Natural resource social values *originate* in only one of these four systems (the sociocultural) as it interacts with the natural resource/environmental system. These values originate: from human needs, are not part of our feelings or intellect upon birth, and are largely socially learned. Natural resource

values, like human needs, range from human-dominant to human-mutual relationships with the natural world. At the human-dominant end of this value continuum, ecosystems and their natural resources have worth only as they fulfill human needs—be these needs material, recreational or spiritual (Kennedy and Thomas 1995). On the human-mutual end of the continuum, more biocentric worth of the natural world (independent of utilitarian values) is recognized. Here plants and animals have value (and often rights) similar to the human species.

3) Natural resource social values are *communicated* individually and jointly by three of these four interrelated systems: the *economic* (in prices, taxes or jobs), the *political/ legal* (via laws, budgets or litigation) and the *sociocultural* in symbols/messages on T-shirts, social protest, newspaper articles, interest group pressures, community acceptance or shunning of managers and family, awards and recognition.

This management paradigm accommodates the full spectrum of evolving human-nature values in our diverse urban, post-industrial society—from the human-dominant and utilitarian perspective to more biocentric human-equal orientations. It also includes all those systems other than economics that seem more present today in natural resource planning and management decisions. In addition, it can be applied to forestry (Kennedy 1988), range (Kennedy et al. 1995) or wildlife (Kennedy and Thomas 1995), in North America or Europe (Koch and Kennedy 1991). Although effective at the management level, this model can be enriched by looking deeper at the origin of social values and the ultimate justification for managing natural resources in the first place—human-nature relationships.

Relationship Mode: Manage for Valued Relationships Between Humans and Ecosystems.

In discussions and writing with critics and kindred-spirits (Brunson and Kennedy 1995), it became apparent that a relationship perspective lay behind the social value concept—and could be the initial, fundamental concept teaching natural resource management as if people really mattered (Egan 1996, Magill 1988).

Initial lectures in defining what are and are not natural resources illustrate to students that they are: 1) very personal and often passionate mental constructs, 2) heavily shaped by one's culture, and 3) considerably different in the heads and hearts of a class of 100-250 young adults. Since religion is an important aspect of Utah society, we begin by examining the central role that relationships between natural resources, humans and God played in the most common creation story in Western culture (Genesis I)—why not begin at the beginning. Neither God, humans or the Garden ecosystem in this story can be understood in independent isolation, only in relationship to each other. Ecosystems and natural resource are also central to the story plot in: 1) God's first six days of labor, 2) humans being gifted almost all his creation, 3) invited to name the important plants and animals (i.e., identify and claim those worthy of natural resource status), and 4) the first natural resource conflict over a wilderness-type allocation around a sacred tree.

The central paradigm from course start to finish, is:
1) we never manage ecosystems just for themselves (whatever that might mean), or...
2) just for people,
3) but for the many meaningful and valued relationships between ecosystems and people (which may or may not include a god in the matrix)—whether that relationship is artistic or wood-constructi on, a rancher or backpacker self-image and life-style, bird watching or bird shooting, mining or photographing a landscape, biocentric or preservationist meaning (Table 2 is a class handout that summarizes these concepts).

People-natural resource relationships is not where we *end* the course, in a lecture or two on outdoor recreation, wilderness or other new values and uses. It is where we begin and what we emphasize *throughout* the course (Table 2). With such a human-ecosystem relationship perspective, there is little resistance or antagonism rationale in not incorporating people/society considerations into natural resource education or management. Which is the topic of the next section.

Natural Resource Manager Attitudes Toward People and Social Institutions as an Essential, Legitimate Part of Planning and Management.

Many of my undergraduate professors, in the forstmeister mode, took an antagonistic attitude toward people and political involvement in natural resource management. The transition mode (Table I) is a more enlightened perspective. It is also more likely to survive in a democratic U.S. society that increasingly demand s such processes occur in natural resource planning and management—especially on public lands (Kennedy 1988, Reich 1962). Yet there is often professional natural resource manager reluctance and sense of sadness in this human/society inclusion, similar to Victorian sexual attitudes encountered in my youth.

Even in the transition mode, people flocking to wildlands or heavy involvement by the press or politics is often discussed as unfortunate events, in an imperfect world, with which we professional managers must learn to cope, whether we like it or not. Such a modern world might require increased cross-campus social sciences and natural resource policy/ administration education to more effectively react to these increased people/society complexities in our professional lives. But like spinach or Victorian sex, they may be good for us or are required means to necessary ends—but probably should not be enjoyed for their own sake. What a sad way to learn and live life.

The left column of Table 3 is a less dramatic illustration of traditional natural resource aversion or reluctance in embracing people/society as an essential and Legitimate aspect of natural resource management. The right column (in contrast) begins with a human-ecosystem relationship premise, that remains a central and binding concept throughout. Yet note that although the traditional and relationship natural resource management perspectives in Table 3 start with very different perspectives, both reach the same ultimate conclusion: that our paramount management responsibility is to *pass on adequate, diverse, sustainable ecosystems to future generations*. After all this prolonged and often reluctant acceptance of human beings as a central and legitimate ingredient in the definition and management of natural resources, we end up where forstmeister von Cotta (1817) started in his classic jewel of a preface to the first textbook in silviculture! Good for us. Good for society, too, if we can only walk our talk—in spite of a discouraging record of our species in doing so (Perlin 1989).

TABLE 2. Core concepts in natural resource/environmental (NR/E) management—a class handout

1. Natural resource/environmental (NR/E) managers (especially of public resources) manage more than *things* (e.g., deer, trees, water or recreational opportunities)—regardless of how useful, beautiful and personally-cherished these nature "things" may be to you or me.

2. Consider that we manage these NR/E things for *social value*...
for clients living, and ...
for millions of humans yet to be barn (see: Kennedy and Thomas 1995).

3. Thus a new definition of NR/E management (whether wildlife, forest, recreational or environmental management) could be:
Provide a mix of social values from healthy, sustainable ecosystems for society living—with adequate, diverse sustainable ecosystems available for social values and options of future generations of humans and other life forms.

4. NR/E social values originate from human *needs*, for a wide spectrum of human-nature *relationships*, that range from:
commodity and consumptive...to... non-consumptive and appreciative relationships;
direct and short-term..to...indirect and long-term values/ relationships;
concrete and practical...to... abstract and symbolic nature values.
Thus NR/E management can be viewed as *human-nature relationship management*. What!! ! I will be a relationship manager???

5. When NR/E managers enhance or diminish important, valued human relationships, we had better do it with:
deep awareness and empathy...
sensitivity and caution...and...
good, valid intentions.

6. Many human-nature and society-nature relationships are highly valued and in sociopolitical conflict today. Therefore NR/E management can also be viewed as *sociopolitical conflict management*. What!!! I will be a NR/E sociopolitical conflict manager! ! !

Generations of NR/E managers have selected their professions to protect and manage personally-cherished trout, tree, water or scenery things, in rural settings away from human and urban complexities, where seldom would be heard a discouraging word. After an education focusing on math, science and tree or wildlife thing management, NR/E professionals are often shocked and disappointed in their initial jobs to discover how much people/social aspects of'management dominate their work-week. You should not be surprised. Start working now on your insecurities and attitude barriers to learning bow to better understand and respond to people and their institutions. Without such attitudes and skills, you will not be very satisfied in your career or very effective in protecting and managing those deer, tree or scenic beauty things you (and society) cherishes.

STRATEGIES FOR INCLUDING PEOPLE/SOCIETY VALUES AND CONCEPTS IN A NATURAL RESOURCE MANAGEMENT EDUCATION

I have surveyed and interviewed hundreds of entry-level and mid-career USDA-Forest Service employees on the professional impacts of their education (Kennedy 1985 and 1991, Kennedy and Mincolla 1985). Never once did a professional employee recall a course title, its general content: or specific scientific concepts that greatly impacted them, without a memorable human educator being recalled. Almost all name and describe an intelligent, caring and involved educator who taught *what they knew* by *who they were* , and how that educator role-modeled their values and knowledge. Often this acquired special power in a mentor relationship (Kennedy 1991, Kennedy and Mohai 1987).

So I never use the verb educate alone. Educate and role-model (pardon making a verb of this) is what we do most powerfully to educate our children, students and the public. We are always in the education business, and role-modeling is one of the most impactful and enduring educational processes I know. And faculty role-modeling will enhance or marginalize any well

planned and executed people/society educational strategy that we might propose below.

Strategy I. Values and Concepts Integrated Into Natural Resource Faculty Professionalism and Core Courses.

A natural resource faculty can effectively teach and role-model many subjects within their own community, whether they be traditional skills (e.g., measurements) or more recent additions (e.g., ethics, the role of art or poetry, or international aspects of natural resource values and management). Even with developing the best new course on natural resources and society (Strategy II, below) or cross-campus course options (Strategy III), they will be marginalized without meaningful integration by core natural resource faculty role models and their courses. This is as true of integrating writing or statistical knowledge learned across campus and/or in a specialized natural resource course, as it is for people/societal values and concepts.

Let me share an example of integrating people/society concepts at the most basic, traditional and technical levels of forestry education in timber cruising. On the first morning of measurements week, in our six week summer camp, students are as eager as race horses to engage in this macho/a professional ritual. Yet we sit them down and ask, "Why we are going to measure some characteristics of some tree species today and not others? We may feel in charge and cool today, but we will be behaving as puppets in many of our measurement 'decisions'. What values and systems will be pulling our strings?"

Although the first moments are often meet with student impatience and confusion, within 30 minutes we unravel the traditional strings that connect to U.S. wood preferences and tree construction or pulping qualities, expressed through prices in the economic system, that will direct us to throw a diameter tape around a Douglas fir and not other species. We also discuss our evolving professional attitudes toward dead trees. How and why they were only recently considered neutral or negative stuff in a well managed forest, the role of changing wildlife values of an urban, post-industrial US society and subsequent laws they passed, and how/why we will now measure certain quantitative and qualitative snag characteristics is also discussed. "Okay, now let's go measure the height and DBH of socially valued trees, and also remember to not ignore the rest!"

To repeat, teaching and role-modeling (with me in my battered cruising, vest) this pre-cruising people/society module requires about 20-30 minutes. We also reinforce these concepts working in the woods or in casual conversations over lunch. The complexity, diversity, interrelatedness, beauty and wonder of socioeconomic and political systems are presented jointly and in an integrated fashion with those same qualities of the forest ecosystems that fill our hearts and minds that week. Without the motivation of exams, this learning is integrated and enduring (e.g., months later on campus, students routinely use the snag lesson in discussions and on exams).

TABLE 3. Rationale for people/society considerations in natural resource (NR) management.

Traditional, Scientific Natural Resource (NR) Management for Obvious and Inherent Values-We Manage for Good NR Stuff
1) Start with NRs: Ecosystems provide obvious, long-standing goods and services society needs (e.g., wood or water) and resources of more intrinsic value, such as wildlife or wilderness.
2) To provide long-term flows of these valuable resources, they should be protected and managed in an efficient, sustained-yield manner.
3) Best people to manage NRs are objective, scientifically-trained professionals (traditionally foresters), who also understand economics and management.
4) Because people use NRs and impact their efficient management, they must (for better or worse) be considered in NR protection and management.
5) More, different and often conflicting human use, interest groups, laws, etc. are involved in NR management today .
6) Somehow and somewhere, NR management education must effectively incorporate social sciences into the curriculum to efficiently protect and sustainably manage NRs.
7) With all these people concerns and politics, never forget that natural resource managers should pass on adequate, sustained-yield NR systems to future generations.
Managing Ecosystems for Social Values Generated by People-Nature Relationships—We Manage for Valued Human-Ecosystem Relationships
I) Start with Human Relationships: In the Western-world perspective, human perceptions and values are the "re-" and ecosystems the "source" in conceptualizing and managing NRs.
2) People are born with few or no NR perceptions or values that must be learned, will vary with culture, and change over time.

3) Goals of NR management are based on socially learned human-ecosystem relationships, that are expressed to managers through interacting social, political/legal and economic systems.

4) Educating NR managers in human-ecosystem relationships, plus the origin and expression social value, is as essential as physical, biological and management knowledge.

5) In this social value orientation, NR managers must never forget that the majority of human stakeholders are vet to be born.

6). NR social values driving management are based on human-ecosystem relationships, thus NR managers are ultimately and basically relationship managers.

7) Since human-ecosystem relationships and social values 10 or 100 years in the future cannot be accurately predicted, society should pass on adequate, diverse, sustainable ecosystems to future generations of humans and other life forms.

Strategy II. Specialized Natural Resources Course(s).

Offering a special natural resource course in GIS applications, ethics or people/society aspects of management usually displays faculty commitment. Depending on how well this option is conceived, presented and integrated, this can be an enjoyable and effective educational strategy. But faculty community attitude in its support and integration are still critical.

Strategy III. Cross-Campus Model.

Often when new subjects or perspectives are required in a technical engineering or natural resource curriculum (be it writing, speaking or social science skills) it can be more economical, effective and convenient to send students across campus. Natural resource faculty can negatively role-model an "appendage", "sacrifice" or "penance course" attitude here—where they communicate (in many overt or subtle ways) that these courses are marginal, a waste of time, or required for real or imagined professional sins (e.g., "Sorry gang, but you must take a sociology course with those long-haired students and professors in Hippie Hall because the public doesn't understand or appreciate efficient wood production silviculture, and we are forced to better understand their ignorance and naiveté.").

Now there are times when students and faculty are just fortunate to have relevant, well taught cross-campus courses available, with little coordination and collaboration required. But for strategy #3 to succeed, usually requires colleague collaboration, respect and support in providing natural resource case studies, references, problems or guest lectures to cross-campus educators.

CONCLUSIONS

As a forestry student, I spent more hours in silviculture lectures than any other natural resource subject. In it we were usually taught, in a what's good for General Motors is good for the rest of the country fashion, that if American forests were managed to be healthy and fast growing that other wildlife, water or recreational values would take care of themselves. What forest manager need worry about people or their social values with such a simple and convenient mind-set?

Later I would learn that this was formalized as the "wake theory" in European silviculture (do good high yield and sustained-yield silviculture and good multiple use will follow in the wake; FAO 1988 and 1989)-which probably gave such rubbish more potency in minimalizing the need for natural resource majors to respect and study humans and their institutions. Fortunately some of my undergraduate forestry professors were in the "transition mode" of recognizing, for better or worse, that people and society were of increasing importance in managing the resources we cherished. Yet even by the action and inaction of the more enlightened faculty (i.e., their role-modeling), it was communicated that, like our sex education in the 1950s, learning about people and society was something we would have to do mostly on our own and usually as on-the-job training.

Reserving such critical knowledge in achieving a satisfying and successful life and career for an informal, experimental education in the real-world could have worked better, if we were provided effective *attitudes* and *skills* to be good on-the-job learners. We were usually provided neither. Most of us learned how to be the lovers and the people-natural resource managers we needed to be the hard (and sometimes tragic) way-and in spite of many dysfunctional attitudes and role models we took along with our diplomas into the real-world. We can do better than that for the young people entrusted to us for a few years of education and role-modeling, and for the natural resources they may someday manage.

I've observed two contrasting educational perspectives in my professor career:
Empty Vessel Model—Fill students up with what they need to become professionals in the few years that they are in our control.
Continuous Learner Model—Provide students adequate starting professional knowledge to get a job, but focus on the values, concepts and skills for them to be eager, effective, adaptive learners throughout life.

I believe educating and role-modeling students that will manage a wide spectrum of natural resources for diverse and

changing social values, resulting from human-nature relationships, can be very effective and enduring in the continuous learner educational model. First and foremost it is people/society embracing and responsive, stressing our public service role (Magill 1988), and it concludes with the obligation to bequeath future generations adequate, diverse and sustainable ecosystems. Such a perspective also meets many generic requirements for natural resource management in the 21st century (Kennedy and Dombeck 1995), because it is: 1) *inclusive* of interrelated natural resource, socioeconomic and political systems, 2) *integrative* in illustrating the system interdependency of a complex, interrelated world, and 3) *adaptable* in the fluid way it introduces change as a natural, long-standing way for social, economic or ecological systems to interact and adapt. I also believe these social value and human-nature relationship concepts can and should be taught from students' first, beginning principles of natural resource management course(s) or traditional, sacred field rituals (e.g., timber cruising).

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LINKING SENIOR FORESTRY COURSES

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Abstract: Learning has been described as a cumulative process that allows students to build knowledge and skills as they progress through their undergraduate programs. Courses offered at the senior level usually have prerequisites, or require concurrent enrollment in other courses. In the Department of Forestry at Michigan State University, we have recently started offering two senior-level courses concurrently (rather than sequentially): Forest Management and Natural Resources Planning and Policy. In an effort to better integrate our curriculum, we are building linkages between these courses based on content (to reduce redundancy), quantitative analysis, and data sets.

Forest Management is taken mostly by Professional Forestry majors, whereas Natural Resources Policy and Planning has a mixture of students from Forestry and other disciplines. Traditionally, concepts and technical skills learned in the management were used by students on interdisciplinary planning teams in planning/policy. This distribution of material created some inherent equity problems that we are addressing by offering the courses concurrently. Our experiences and the pros and cons of linking these courses are presented.

INTRODUCTION

As with most forestry programs in the U.S., Professional Forestry majors in the Department of Forestry at Michigan State University complete a set of core, required courses during their senior year. Until 1997, they enrolled in Natural Resources Economics and Social Science, Forest Management (taught by Fried), and Conservation Biology in Fall Semester and Natural Resources Planning and Policy (taught by Leefers) in Spring Semester. The planning and policy course is the capstone course in the Department, and until recently, all other required Forestry courses would be completed prior to the capstone course. Then students could apply their conceptual and technical knowledge and quantitative skills to the planning component of the course (Leefers et al. 1996). This component uses interdisciplinary student teams to develop a plan for an 18,000-acre forested area in northern lower Michigan.

This "capstone model" presupposes that students retain knowledge and skills from previous semesters. Unfortunately, we have found that while students may retain knowledge, they are less likely to retain technical skills, and that only the best-performing students retain enough technical skills to be successful in applying their skills in the capstone course. Because there can be as few as one student per interdisciplinary team who has completed the forest management course, this presents an equity problem that only deepens over the course of the semester. To overcome this difficulty, we must provide a better mechanism for arriving at a more equitable distribution of technical skills among planning teams.

The first step was to offer Forest Management and Planning and Policy concurrently in spring semester. In Forest Management, students are taught technical skills such as simulation and optimization of harvest schedules (e.g., using linear programming) and analysis and presentation of spatial data (via GIS). The second step was a thorough review of both courses and a re-sequencing of topics to better match the development and application of quantitative analysis.

We are now in our second year with this concurrent-course approach. This paper describes the courses' objectives and how we are linking the courses to provide better program integration and more equity for planning teams in planning/policy. As is true for most experiments, we have realized both positive and negative outcomes, and believe they will be of interest to our teaching colleagues.

COURSES' OBJECTIVES

Forest Management Course

Since forest management is fundamentally about satisfying the goals and objectives of forest landowners within a framework defined by society, students in Forest Management need to develop problem-solving expertise in the context of the many facets of the forest management "problem", including 1) identification of amenity, habitat, commodity, economic and

other forest outputs desired by landowners and society, and the translation of these desires into goals, objectives, and criteria, 2) assessment of the bio-physical capacity of the forest system to provide desired outputs sustainably over time, 3) effective and efficient management of people, capital and land towards goal achievement, 4) evaluation of alternative management programs against criteria, and 5) accurate conveyance of this information to parties interested in the forest system. Students need to become proficient at building, linking, and using analytic models of forest systems to form a solid technical support for forest management decisions. At the same time, they learn to recognize the inherent limitations of such approaches. As part of this learning process, students gain "hands-on" experience with optimization and simulation software used by natural resource managers. Through this structured approach, we believe students are better prepared to work in analytical and planning situations at the start of their careers.

Natural Resources Planning and Policy Course

The overall purpose of this course is to provide students entering natural resource professions with a holistic approach to problem solving. Natural resources planning and policy issues provide the settings for examining complex problems facing natural resource professionals and society. The emphasis is on renewable resources and related uses, especially forests, outdoor recreation, wilderness, and wildlife. This course has served as a capstone course for students from two majors: Professional Forestry (administered by the Dept. of Forestry) and Wildlife (administered by the Dept. of Fisheries and Wildlife).

Course objectives are to (1) provide an overview of natural resource planning and policy-making, (2) describe the planning and policy-making processes as they relate to the interaction of human and natural environments, (3) examine case studies in natural resource planning and policy making, (4) provide teams representing different disciplines the opportunity to develop multiple-resource plans for a selected area, and (5) enable teams and individuals to participate in policy-making exercises.

Use of Teams

Students work on team projects in both courses. In Forest Management, the integrative experience which dominates the final third of the course is a harvest scheduling project intended to represent a near-real world example of an analytic problem common in forest planning. This experience is designed to be completed as a group project (generally 3 Professional Forestry students per group), with each group member contributing to the analysis and the oral and written presentation of analysis results. In Natural Resources Planning and Policy, the 5-person teams generally have 1-2 Professional Forestry students along with several Wildlife and other students. Their focus is on developing a plan that considers the ecological, economic and social context of planning within a selected institutional framework (i.e, federal, state, or private ownership) (Leefers et al. 1996).

In Forest Management, students are taught technical knowledge and skills (i.e., the mathematics and application of linear programming for a harvest scheduling problem, and concepts and application of GIS software), and are required to apply those skills to well-structured problems. Natural Resources Planning and Policy, on the other hand, requires students to apply those skills to a problem that they structure through team deliberations. Though students are expected to apply harvest scheduling and spatial analysis to this problem, the extent of its use depends, in large part, on the problem they have defined and how they structure it. For example, maximizing revenue or specific wildlife habitat is rarely an institution's dominant objective. In such cases, simulation will likely prove more useful than optimization modeling.

OUR OLD WAY OF TEACHING AND ITS PROBLEMS

Several years ago, Michigan State University made a transition from a quarter-based academic year to a semester-based one. At that time, all curricula and courses were reviewed by the entire faculty and most were modified. During our post-transition review, we identified some difficulties associated with the sequential offering of our management and planning/policy courses. We noted some unintended redundancy (e.g., both courses included the Stewardship Incentives Program) and some conflicting approaches (e.g., we used 2 different software packages to teach harvest scheduling). Eliminating redundancy was a reasonably straightforward process which involved agreeing about the importance of each topic and the most appropriate course in which to teach it. And we agreed to use common software packages.

Several other issues surfaced during our review. Because students in the two courses used different data sets, we were missing an opportunity to make students intimately familiar with an actual forested area and the data that describes it. In addition, the harvest scheduling exercises in Forest Management were not linked tightly to the spatial analysis exercises. Finally, the planning exercise in Natural Resources Planning and Policy relied on students' having competency in harvest scheduling and spatial analysis; this was problematic for several reasons. First, students were rarely able to quickly apply their newly developed knowledge and skills to a completely new problem, area, data set, and modeling approach. Second, the overview of some techniques presented in Natural Resources Planning and Policy provided all students with ideas about analytical tools, but this was insufficient for consistent application across planning teams. Finally, some students had been more successful than others in mastering Forest Management material; this meant that planning teams with better-performing students were able to

more easily complete planning exercises in Natural Resources Planning and Policy.

As a result of our review, we decided to shift the Forest Management course to the Spring Semester so that students could gain knowledge and skills in a structured environment in one course and apply them in a concurrent course. As part of this change, we agreed to use the same area, data sets and models for the major projects in both courses; however, the students' projects (the problems) have a different focus.

OUR NEW WAY

Most aspects of our courses did not change, but we believed there were some teaching efficiencies to be gained by integrating the courses, and it allowed us to reinforce material in each others' courses. We were also fortunate because we had a transition semester during which we jointly taught harvest scheduling and spatial analysis to a group of graduating seniors who were affected by the semester shift. This allowed us to better understand our respective courses and some of the obstacles and opportunities of integrating them.

Selecting a Common Area, Data Set, and Model

Selecting a common area and data set was accomplished easily because Dr. Fried was cooperating with the USDA Forest Service's Huron-Manistee National Forests (HMNF) on some of their initial GIS work, and Dr. Leefers had been using different data sets from their compartment-stand records for many years. With assistance from Matthew Sands (Forester, HMNF), we selected a relatively hilly, 18,000-acre area in Wexford County near Cadillac, Michigan that contains a variety of forest types, age classes, and ecological land types (Figure 1). We call it Caberfae Forest, after the ski resort located on private land within its boundaries. Spatial data on forest stands and ecological land types were provided by HMNF personnel as CMAP boundary files and Dbase formatted attribute files which we massaged to generate Arc/Info coverages and eventually, Arc View shape files. There are 996 forest stands with over 40 stand attributes of varying usefulness including compartment and stand boundaries, forest type, year of origin, mean DBH, and area (Figure 2). Additional GIS coverages for roads, rivers, lakes and land use were obtained from the MSU Center for Remote Sensing's MIRIS data archive (a state-wide GIS database dating to 1980).

For the larger course projects, it would be unrealistic to expect students to construct complex harvest scheduling models from scratch. Instead, we agreed to develop an updated version of FORSOM (FORest Simulation-Optimization Model), a spreadsheet-based harvest scheduling Model (Leefers and Robinson 1990), for Caberfae Forest. The updated model uses the Frontline Solver optimization package available as an integral part of Microsoft Excel version 5 and above. The FORSOM developed for Caberfae Forest in 1997 has 199 decision variables representing a variety of combinations of rotation ages and silvicultural regimes for stands aggregated by age class and forest type.

Examples of Course Changes and Assignments

A number of lecture/laboratory scheduling changes were needed to facilitate integration of the two courses. In previous

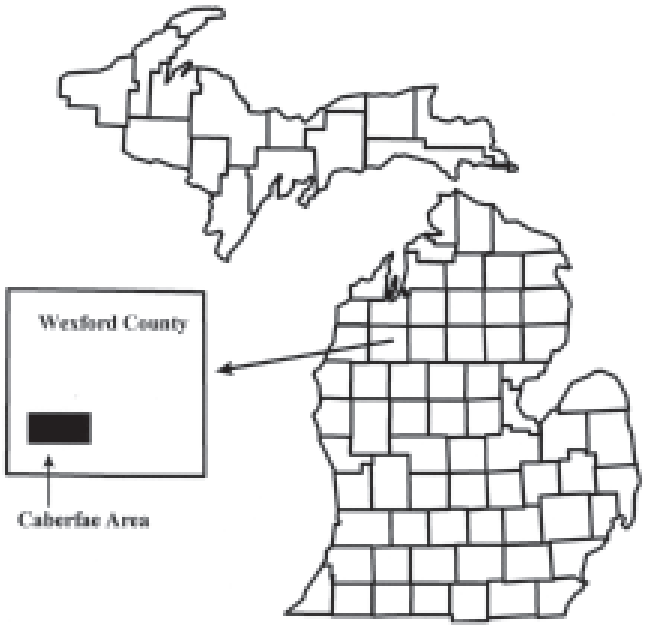

Figure 1. Location of Caberfae Forest area in northern lower MI.

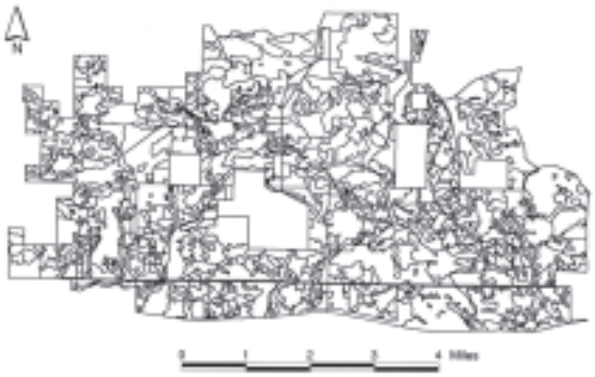

Figure 2. Stand boundaries for the Caberfae Forest area.

iterations of Natural Resources Planning and Policy, we used the first part of the semester to focus on planning and the second part to teach policy analysis. Because it takes about half of the semester to introduce students to harvest scheduling and GIS in Forest Management, we reversed the planning-policy sequence. Several topics in Forest Management were also shifted in order to move harvest scheduling and GIS as early in the semester as possible. As part of the integration, each of us participate in or lead one or more laboratory sessions in the other's course. The remainder of this section provides examples of assignments students receive.

In the GIS unit of Forest Management, students learn basic functions such as spatial queries, overlay analysis and map algebra. Here are 2 example problems: (1) To minimize the scenic impact of harvesting, select all stands more than 500 meters (1640 ft) from a road. How much harvest area would this be? How does this compare to the total forest area (all stands, regardless of distance from the road)?, and (2) Allocate a riparian protection buffer for old growth stands within 500 meters of streams, to stabilize the riparian zone and to foster the generation of the kind of coarse woody debris thought critical to the health of aquatic ecosystems. How many acres of each forest type will be present in this buffer? Print a chart of this data.

Students in the planning/policy course may pursue similar analyses, but they are responsible for defining the problem and completing appropriate analyses. So, for example 1 above, they would start with the owners' objectives and eventually develop a harvesting plan. One portion may deal with scenery, but wildlife habitat, timber revenue, and other objectives would be factored in as well. The same is true in example 2; here all land allocation decisions would be part of the plan.

The Forest Management term project requires:

1. A clear statement of the problem and assumptions used in the analysis,
2. A table or tables of activities to be performed each period of the 5 decade planning horizon (including the number of acres by stand class on which each activity will occur),
3. Tables or figures representing the undiscounted revenue and costs occurring for the first period and the PNW for the whole planning horizon,
4. Tables or figures representing the annual volume of sawtimber and pulpwood produced during each period (by species group and for all species combined), and
5. A map showing one possible implementation (not necessarily an optimal one) of your harvest schedule during decade one as an allocation of harvest acres to stands on the ground by species group and harvest type for one scheduling alternatives with spatial constraints.

Teams are given specific project scenarios to analyze. For example, one team had the following project in 1997:

> Scenario #1: Owner: Caberfae ski area; objective: MAX PNW subject to scenery constraints; discount rate: 6%. To avoid cutting into their ski area revenue, owners want all harvest activity to occur at least 1 mile from the boundaries of the Caberfae ski area, and all clearcutting to occur at least 2 miles from the ski area. Everything within 1 mile of the ski area will remain as a "park" in unmanaged condition, possibly to be developed with cross-country ski trails in the future. You will also need to do a no spatial cutting limit run to assess the impact of these assumptions. (2 alternatives).

Students in the planning/policy course develop their own objectives and evaluative criteria. As a result, the problems become much more complex, and some parts are more amenable than others to quantitative analysis. Nonetheless, the structured approach in Forest Management allows students to understand how to move from simpler to more complex analyses. We believe that having both experiences concurrently helps students apply their new skills to new problems.

SUMMARY OF LESSONS AND NEW DIRECTIONS

Some Lessons

By teaching the courses concurrently, we eliminated the "retention" problem. The "equity" problem was reduced by requiring Forest Management students to submit reports on the structured assignments, and using these reports as examples in Natural Resources Planning and Policy. Our course review reduced redundancy and led us to coordinate data sets and analysis models. Students also became more familiar with the Caberfae Forest because it was used in 2 courses. We have become more familiar with both courses as a result of the teaching collaboration.

Linking these courses also has some drawbacks. More time is required in course preparation due to the use of a "real" forest and its associated data. It is also hard to coordinate courses because the best timing for material in one course may not match well with the needs for the other course. Due to these interdependencies, the courses must adhere to their schedules; falling behind can cause difficulties in the concurrent course.

New Directions

As our courses and projects evolve, there are some logical extensions for expanding data sets. For example, ecological classification work has been completed for the Caberfae Forest. However, tabular data for various overstory and understory flora have not been used to date. Adding these data would allow students to identify sites where endangered, threatened, or other species are likely to occur. Soils maps have recently been digitized and tabular data for soils (e.g.,

permeability, texture, etc.) may be added to provide more management insight for the area. These data will open opportunities to link with ecology and soils courses. In addition, there may be opportunities for using the harvest scheduling exercises to link with economics and silviculture courses. Finally, more mapped social and cultural information for Michigan is now available via internet. This provides students with a better starting point for social analysis.

Overall, linking senior-level forestry courses has improved the learning opportunity for students and our ability to convey fairly complex course material. More changes are envisioned, and we plan to link with other courses in the future.

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EDUCATION'S ROLE IN SUSTAINABLE DEVELOPMENT: UGANDA'S KIBALE NATIONAL PARK

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ABSTRACT: Kibale National Park (KNP), located in western Uganda, offers a rich diversity of tropical flora and fauna. The Park's mid-altitude, moist tropical forest supports 11 of Uganda's 20 non-human primate species, some of which occur in very high densities. The region around KNP is home to seven national parks and numerous protected areas. Located within KNP is the Makerere University Biological Field Station (MUBFS), with an extensive 25-year research history and a mandate to assist KNP in protecting the ecosystems of the region through management-relevant research.

While KNP and MUBFS have received much visibility within Uganda, East Africa and the tropics as an important biological resource, both institutions face formidable obstacles in meeting their respective conservation mandates. For KNP, severe human population pressures around the Park, coupled with chronic shortages of capital, personnel, and other resources, make maintaining current Park resources problematic, let alone ensuring their long-term viability and protection. For MUBFS, declining donor support make it increasingly difficult to fund research programs and operations. Together, these challenges highlight the need for revenue-generating activities that can bestow direct and tangible benefits to KNP, MUBFS, and surrounding communities.

This paper examines the contributions that study abroad programs can make to resource protection efforts in the KNP region. Direct benefits include income generated through course fees, meals, housing accommodations, miscellaneous purchases, and staff and instructor fees. Indirect benefits include the increased awareness of the region's economic, scientific and ecological value by study abroad participants, local communities, institutions, and policy makers. Since the challenges facing KNP and MUBFS are common throughout Africa and much of the developing world, the issues and opportunities discussed here have widespread application.

INTRODUCTION

In the fall of 1995, the U.S. Agency for International Development (USAID) awarded a two-year Cooperative Agreement to the Consortium for International Development (CID) to promote the sustainability of a biological field station located within Uganda's Kibale National Park (KNP). The Makerere University Biological Field Station (MUBFS) had been the recipient of financial aid from various donors since its inception in the 1970s. Most recently, USAID had supported the Station and its programs.

The Cooperative Agreement specified three areas of technical assistance: infrastructure development, training, and marketing. These three activities were to be geared toward increasing the Station's ability to self-finance its operations through increased Station use, streamlined operations, and the proactive solicitation of funds. Much has taken place at the Station since the contract was awarded in 1995. CID's program of infrastructure consolidation has carefully enhanced the Station's facilities by undertaking water development, electricity, and telecommunications projects. The Station's operating budget has been reduced by one-third while improving the level of services. Training has ranged from computer skills and accounting, to meal preparation and hotel accommodations. Aggressive marketing has increased the Station's visibility among research and training groups through dozens of presentations at professional meetings and various other promotional media like the Internet (via a MUBFS homepage), brochures, and newsletters.

This paper discusses how revenues generated by study abroad educational programs can complement broader conservation strategies designed to protect significant ecological resources in developing countries. It describes a trial course held at MUBFS in May of 1997, and details the Station's plans for expanded future course offerings. The paper also discusses how public-private linkages can be used to develop self-sustaining study abroad programs that can operate amid growing uncertainties over continued donor support.

UGANDA'S KIBALE NATIONAL PARK

Description and Significance

Kibale National Park (KNP) covers 766 km2 (190,000 acres) in western Uganda—a region of great scenic and scientific value that is home to over half of Uganda's 10 national parks (Figure 1). KNP is representative of mid-altitude moist tropical forest, and offers spectacular scenery and extraordinarily high levels of biological diversity. The Park, managed by the Uganda Wildlife Authority (UWA), is situated within Uganda's primary tourist zone, and is adjacent to Queen Elizabeth National Park (QENP), the Mountains of the Moon (Rwenzori National Park), and Uganda's Rift Valley.

KNP has long been recognized as an ecologically significant area. The region was first gazetted as a Crown Forest in 1932 by the colonial British administration. Later, in 1948, Kibale was designated a Central Forest, and in 1964 a Forest Reserve. In November of 1993, the entire Kibale Forest, as well as a southern game corridor to QENP, were designated as Kibale National Park.

The Park's climate is tropical, with rainfall averaging approximately 1,700 mm per year (67 in/yr). Two rainy seasons occur--March through May, and September through November--with the northern part of the Park receiving more rainfall than the southern region. Minimum annual mean temperatures average 15° C (58° F), and maximum annual mean temperatures average 27° C (80° F).

Three major ecosystems form a mosaic of vegetation in KNP—forests, wetlands, and grasslands (Lilieholm et al. 1997a). The forests of the Park are classified as mid-altitude moist tropical forest. Trees reach over 55 m (180 ft) in height and form a semi-closed canopy of stratified tree crowns. An estimated 229 tree species are found in KNP—approximately half of Uganda's total. Important timber species listed as endangered include *Cordia millenii*, *Entandrophragma angolense* (naturally rare), and *Lovoa swynnertonii*. Non-timber tree species of economic importance include wild robusta coffee, *Coffea canephora*. Flat, low-lying areas in the southern part of the Park, which are often flooded, support thick stands of palms, including the Phoenix, raffia, and screw palms (*Pandanus* spp). In the extreme rocky and riverine habitat of southern KNP, two rare species of cycads are found in isolated patches.

The fauna of KNP is one of the best studied in the tropics. Prominent are 11 species of non-human primates (two-thirds of the total for Uganda), including chimpanzee (*Pan troglodytes*) and the endangered red colobus monkey (*Colobus badius*). Terrestrial mammals include red and blue duikers, bushbucks, bush pigs, warthog, buffalo, water buck, the giant forest hog, sitatunga, and the African elephant. Carnivores include lions, leopards, golden cats, civets, palm civets, ratels, and the Congo clawless otter. Of the small mammals, rodents are diverse and abundant. At least 23 species of fish are found in the fresh waters of KNP, including air-breathing lungfish (*Protopterus aethiopicus*).

KNP's avifauna and invertebrate fauna are also very rich, and 325 species of birds occurring in 46 families have been reported in the Park. Those noteworthy due to their limited distribution include the olive long-tailed cuckoo, western green tinker bird, Willcock's honeyguide, collared apalis, red-faced woodland warbler, white-bellied crested flycatcher, blue-headed sunbird, and the Kibale Prigogine's ground thrush (*Turdus kibalensis*), which is endemic to the Park. Reptiles and amphibians are abundant in the Park, but little is known about them. The Park's invertebrates include an estimated 140 species of butterflies.

Makerere University Biological Field Station

MUBFS, located inside KNP, started as a small primate research facility in 1970. In 1987, the research Station became affiliated with Makerere University (MU), Uganda's premier university located in the capital city of Kampala. Today, MUBFS is a year-round field research station that can accommodate up to 65 researchers and trainees. Accommodations and services are available at reasonable rates, and include lodging (ranging from private to shared housing), laundry, phone, fax, e-mail, a library, and limited transportation and computer access.[2] Meals can be arranged, particularly for groups of 10 or more persons. Uganda's political stability, English language, and favorable climate make the Station readily accessible year-round, although some activities may be restricted during the rainy seasons.

MUBFS has two main research centers--Kanyawara and Ngogo (Figure 1). The Kanyawara site houses the Station's main facilities, with administrative offices, lodging, classrooms, a mess hall and kitchen, laboratory space, and a small health unit staffed with a nurse.[3] The MUBFS library houses many books and periodicals, along with a collection of past MUBFS research. Kanyawara is also home to KNP's headquarters. Adjacent to the site is a grid of marked forest trails covering 15 km^2. Ngogo is a limited-use research site located a four-hour hike from Kanyawara. Accommodations at Ngogo are modest, and the site includes a second forest trail system covering 10 km^2. In total, roughly 200 km of trails are

maintained by MUBFS. The nearby Kanyanchu Visitors' Center offers opportunities for ecotourism research.

MUBFS and KNP are accessible by road from Kampala via Mubende (five to six hours). While this route is the shortest distance from Kampala, the last 110 km of the road is unpaved, and travel by four-wheel-drive vehicle is recommended, especially during the rainy seasons. An alternative paved route travels south through Masaka, Mbarara, Kasese (via QENP) and Fort Portal. Travel time is roughly eight hours from Kampala.

While MUBFS is a renowned primate research facility,[4] the Station is actively seeking to expand the range of Station activities and develop into one of Africa's premier field stations. MUBFS encourages high-quality, multidisciplinary research and training activities that integrate the biological, physical, and social sciences. Proposals for training and basic and applied research are reviewed by the MUBFS research subcommittee. The Station particularly encourages proposals that include Ugandan colleagues and/or have application to KNP management. While the Station is typically near capacity during the summer months, more activities can be accommodated during the off-season from October through April.

Ongoing research projects conducted by local and international scholars include: (1) ecological and behavioral studies of a variety of taxa including primates, fish, birds, insects, and amphibians; (2) studies of forest regeneration in logged areas, under pine plantations, in grasslands, and on abandoned croplands; (3) long-term ecological monitoring, including climatic monitoring, chimpanzee demography, plant phenological patterns, fish population dynamics, and swamp and river limnology; and (4) socio-economic and socio-ecological studies, including studies of the effects of animal crop raiding.

Socio-Economic Environment

Nearly 60% of KNP's boundary borders heavily-populated villages, with the remaining areas bordered by QENP, tea plantations and wetlands (Lilieholm et al. 1997b; Whitesell et al. 1997). Overall, surrounding regions are densely populated, primarily by people from the indigenous Batoro and Bakiga ethnic groups. The region's dense population results from high birth rates and immigration from the populous Kabale and Rukungiri districts of southwestern Uganda.

About 90 percent of the population around the Park is engaged in subsistence farming. Bananas, beans, millet, sweetpotatoes, corn, cassava, and groundnuts are the principal crops. Occasionally crops are sold for income. Most land holdings are less than one hectare per family, and fields receive no purchased inputs. Some households have small woodlots (primarily eucalyptus, with some pine), and a limited number of livestock. Because KNP has no buffer zone around its periphery, the villagers' fields share common borders with the Park. Human pressure on the land is greatest in the north, where a fallow system of one-to-two years is used to maintain soil fertility. Other activities include brewing of local beer, working in tea plantations and fishing in the southern portion of the Park.

Local communities have historically relied on the forest for a wide range of products and services, including logging, hunting, land for crops, collection of medicinal plants, firewood, poles, crafts materials, and the harvesting of wild coffee for income. The region's rapidly growing population, coupled with poor agricultural practices and political instability during the 1970s and early 1980s, led to illegal settlement in what is now KNP, especially within the former game corridor.

CONSERVATION OUTLOOK FOR THE PARK AND REGION

Uganda, once described as "The Pearl of Africa," experienced a wave of political instability under Idi Amin and others during the 1970s and 1980s that all but eliminated investment and tourism for a generation. By the 1990s, however, Uganda was rebounding from its earlier decline, with a stable government. The turn-around has assured the security of lives and property, and has also attracted foreign investment to the country. The country's resurgence contrasts with the growing instability and economic decline of neighboring Kenya and Tanzania. Tourism is growing 20% per year, and living conditions are improving—over the last 5 years, the percentage of Ugandans with access to clean water has more than doubled.

Increased tourism is significant for the protection of parks like Kibale for several reasons. First, tourist visits provide direct revenues for the country's parks. Second, tourism benefits local residents, thereby giving local communities a common interest with the Park's conservation mandate. But significant barriers limit Uganda's ability to increase tourism. These include the country's remoteness, a lack of capital for developing the infrastructure needed to attract and service ecotourists, and poor perceptions of Uganda due to past instability and a high rate of AIDS infection among the population. Additional challenges specific to KNP include the high human population density around the Park, and local residents' animosity over the loss of access to Park resources.

Before Kibale was designated as a national park, access to and use of the forest by local residents was not strictly regulated. Following national park designation in 1993, however, virtually all use of Park resources was curtailed, and people that had illegally settled in the game corridor were evicted and re-settled elsewhere. Moreover, elephants, baboons and other wildlife increasingly use the Park as a safe-haven from which

to raid the fields of surrounding villages. In short, local communities have borne the costs of resource conservation while receiving few if any tangible benefits from the Park. While Park regulations are intended to protect the area's natural features and wildlife, continued ill-will between the Park and local people may in the long run undermine the region's protection.

Although the creation of KNP in 1993 led to a prohibition on the collection of Park resources, the Government of Uganda (GOU) revised its policy and regulations for national parks in 1995 to encourage benefit-sharing and environmentally-sustainable use by local communities. In keeping with this new policy, KNP's recently-approved management plan includes local community participation in Park decision-making, and the provision that 20% of Park revenues be allocated to the Districts in which the Park is located. Moreover, the plan allows for the creation of collaborative management agreements (CMAs) between the Park and local communities to restore local access to some Park resources. Under the Plan's guidelines, border areas within the Park periphery have been designated as "Multiple Use Zones," where villagers can sustainably harvest resources under monitored and controlled conditions.

In addition to strained community relations, both KNP and MUBFS face severe financial limitations. Since their creation, both MUBFS and KNP have been highly dependent on outside funding from various international donors. In an environment where such support is increasingly limited, both institutions are seeking ways to diversify and expand their income sources. KNP and MUBFS have already taken actions to become more entrepreneurial. These include: (1) the submission of proposals for funding research and basic operations; (2) the design and production of various promotional items like t-shirts, posters and field guides; (3) active promotion of the Station and Park to potential users and tourist groups; and, more recently, (4) the expansion of training and educational programs at the Station. This last activity is described below.

HOW STUDY ABROAD COURSES CAN CONTRIBUTE TO REGIONAL PROTECTION

History of Educational Course Offerings at MUBFS

MUBFS is ideally suited for both field research and classroom instruction. Since the Station is situated within in a national park, it operates like a "living laboratory" in a largely untouched natural environment. Here, classroom instruction makes the easy transition to field observation, located only a few meters away. And unlike East African savanna parks, where the presence of large carnivores limits visitors to buildings or their vehicles, KNP is visitor-friendly. One can walk through many kilometers of forest trails and touch, feel, smell, and hear the forest. Although primarily a tropical forest, KNP also has large areas of grassland and wetlands. This diversity of ecosystems and their flora and fauna provides an unlimited range of educational opportunities.

For many years, MUBFS' facilities have been available to organizations that offered and managed their own courses, and took care of locating instructors and attracting participants. KNP's setting, combined with MUBFS' modest but adequate support services at affordable prices, attracted many courses from East Africa, Europe, and North America. Organizations offering regular courses include the UK-based Tropical Biology Association (TBA), the United Nations High Commissioner for the Refugees' (UNHCR) Environmental Program, The U.S. Peace Corps, The University of Florida, Makerere University, and others. Oftentimes, MUBFS staff and visiting researchers offered evening or guest lectures to supplement course instruction.

Although MUBFS continues to welcome such courses, these activities generate only modest income for the Station. Moreover, most courses are scheduled during the peak use summer months of June through August, when the Station is already near full capacity.

The MUBFS-sponsored Tropical Ecology and Management Course

In the fall of 1996, MUBFS began investigating the prospect of offering its own field courses. Offering courses was seen as a way to raise substantial revenues for the Station, while expanding use in the low-use season between September and June. Initial marketing research suggested that the course could be very competitive with current offerings. First, since this was a trial course, a limit of 24 students was set to make instruction and transportation manageable, while still generating a reasonable profit for the Station. The tuition was set at $750 for the three-week course, with a lower rate of $400 charged for African nationals. This covered all expenses from their arrival at the Entebbe airport (about 40 km from Kampala) until their departure (the participants paid their own air fares). The fee was substantially less than any other competitor's courses in Africa.

North American university students seemed most likely to attend, although course marketing reached all continents to some extent. While airfare to Africa was more expensive than fares to Central or South America, MUBFS could make up much of the difference through lower tuition. Moreover, course planners felt that there was a large segment of potential participants that wanted an African experience and would pay for it.

A one-page course announcement was developed and sent to groups and individuals on a 500-member MUBFS mailing list that had been gathered over the previous year. The list represented people that had visited the Station, or people that had expressed interest in MUBFS at various professional

meetings where lectures on KNP and MUBFS were presented. Listings were also placed on the Internet, and in various study abroad catalogs. Finally, up to 12 undergraduate or graduate credits were available from Utah State University's Division of Continuing Education for a recording fee of just $10 per credit.

After six weeks of marketing the course, 24 participants were registered. Participants ranged in age from 18 to "40 something," and came from a variety of backgrounds. Most were college seniors or students in the early stages of graduate school. One each came from Canada, England and Australia, two from Uganda, and the rest from the US. All but two had strong interests in primatology. Overall, the group was diverse, very bright, and highly motivated.

Most of the instruction was provided by two MUBFS-based Makerere University Senior Lecturers with a combined total of 40 years of research experience in KNP. They were joined by a third instructor--a Conservation Officer from the Smithsonian Institute who had conducted his doctoral research at Kibale in the 1970s and donated his time and services to the course. In addition, four Makerere University graduate students provided assistance with field work and course logistics in exchange for a $400 stipend and room and board during the course.

Benefits from Offering the Field Course

A student evaluation completed at the end of the course elicited much praise for the course. Comments included the course's inexpensive tuition and opportunities for university credit, the beautiful setting, friendly people, excellent food, outstanding instructors, etc. Many wanted MUBFS to offer an advanced course so they could return. Obviously, students were very pleased with what they had learned over the three week course. Some students also felt that the field experience would give them a competitive edge when applying for jobs and graduate school. For many this was their first visit to a developing country. The awareness generated by experiencing how so much of the world lives was a life-altering event. Moreover, the course's low fee, coupled with modest tuition, enabled many students to earn 12 credits in Africa for less money than if they had stayed at their host institutions.

MUBFS received many benefits from offering the course. First, the revenue generated by the course paid all of MUBFS' operating expenses for an entire month, and two MUBFS staff earned extra income as instructors. The Station also hired 5 to 6 extra persons from the community to provide support services, and four Makerere University graduate students served as student instructors, receiving valuable teaching experience, food and lodging for three weeks, and a stipend. Moreover, MUBFS staff gained the confidence that they can coordinate, manage and teach quality field courses on their own--an important step in institutional capacity building for the Station. The Station also benefitted from re-establishing linkages with the Smithsonian Institute, and the goodwill generated by course participants.

Less direct but also important are the benefits MUBFS and KNP have gained through positive publicity generated by course participants. One student wrote a very favorable article about the course that appeared in the Bulletin of the Australasian Primate Society. Word of mouth advertising has resulted in many inquiries about future courses, and several participants have requested advanced courses and/or plan to return to Kibale in the future.

The KNP region has benefitted from the greater awareness generated by the course. In addition, villagers in surrounding communities earned income providing services for the group, and some of the participants extended their visits in Uganda after the course, thus contributing to the country's economy. Cultural events like a closing dance also created benefits for the community, as well as a greater appreciation of the region's culture.

Lessons Learned

MUBFS also learned some valuable lessons from offering the course. First, the course allowed the Station to refine its management with respect to housing, accommodations, and meals. Participants soon made it known that a larger breakfast would help them endure long hours in the field. The logistics of transportation, always filled with uncertainty in developing countries, lead to the creation of contingency plans. Flexibility in program design is also important. An unplanned weekend visit to the savanna ecology of adjacent QENP did little to help the program's overall finances, but generated considerable interest among course participants. Students also enjoyed a balancing of class and field time, as well as time off for seeing other areas of interest near KNP. Finally, the course evaluations provided many suggestions that will be incorporated into future courses.

The Tropical Ecology and Management course also highlighted some potential dangers of offering study abroad courses. First, agreements between all parties--from students to instructors-- need to be carefully thought out and agreed upon from the outset. Participants need to be fully advised of the risks of traveling in developing countries, and the need for immunizations, visas (if required), and medical evacuation insurance. The host organization also needs to be aware of any special dietary or medicinal needs of participants and visiting instructors.

On an institutional level, there needs to be a consensus that offering courses is beneficial. Ill will between established researchers and course participants can lead to conflict and a bad experience for everyone. Finally, institutions offering such courses need to be fully advised by legal experts to minimize potential liability.

CONCLUSIONS AND FUTURE PLANS

Offering study abroad courses can serve a valuable role in increasing regional sustainability. In the case of KNP and MUBFS, course offerings can be used to increase Station use during low-use seasons, and generate significant revenues for operating budgets and staff. Such courses can also increase recognition of the region's ecological significance at local, regional and international levels. Finally, study abroad courses can give institutions the entrepreneurial spark needed to successfully expand programs and reach self-sufficiency.

MUBFS is planning on offering several courses this year. The Tropical Ecology and Management course will be offered twice, and joined by a new course designed for primate keepers at zoological parks. Moreover, the Station has entered into a partnership with East Africa Studies Abroad (EASA), a private firm that facilitates the creation and marketing of study abroad opportunities in East Africa. EASA's involvement is self-funding from a percent charged on course fees. This directly links EASA's economic return to the course's success, and creates a self-financing partnership that is independent of outside donor support. Other plans for the future may include fee-sharing with KNP, and having selected KNP wardens participate as Teaching Assistants so they can receive additional training.

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Lilieholm, R.J., K.B. Paul, and R. Nankya. 1998. Developing sustainable ecotourism in Uganda's Kibale National Park. Proceedings of the 2nd International Tourism Conference, Girne American University, Girne, Cyprus (*in press*).

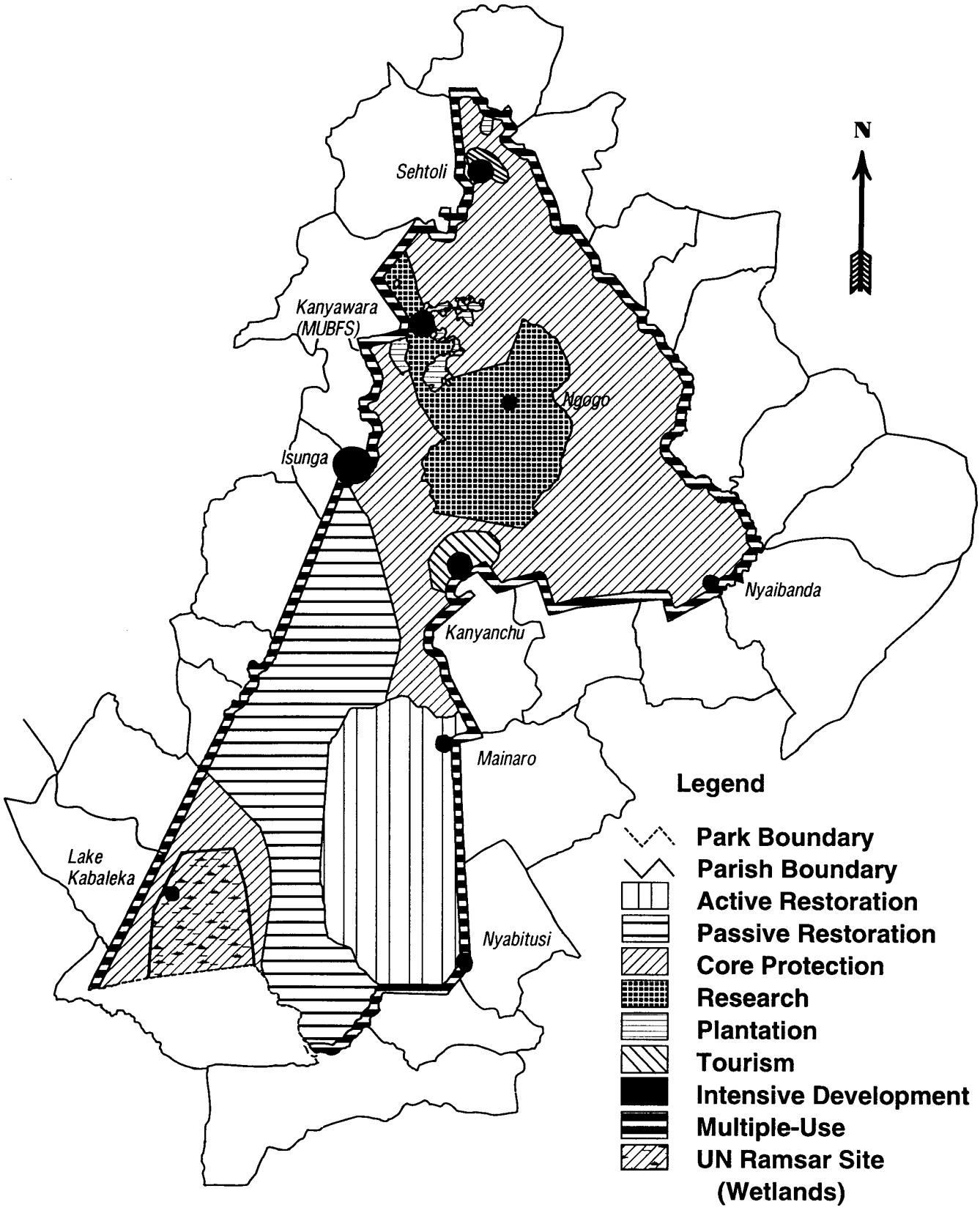
[2] For more information contact the MUBFS Homepage on the World Wide Web at http://www.usu.edu/~mubfs/index.html.

[3] Fort Portal is located 20 km away and has three medical facilities.

[4] MUBFS has a long history of use by primatologists from Harvard, Yale, Duke, Purdue, The University of Michigan, The University of Wisconsin-Madison, and others.

Figure 1 is on the following page.

Figure 1. Management zones of Kibale National Park.



WESTERN GOVERNORS UNIVERSITY: IMPLEMENTATION OF THE VISION

Jeff Livingston

This session will review factors that have impacted higher education and were considered by the governors of 17 states as they agreed to join the consortium to create Western Governors University. The institution was incorporated in Utah in January of 1997 and has since made significant progress toward implementation of the motivating vision of providing competency-based learning, using technology as a medium of delivery. Since its inception, WGU has been described as a metaphor for the future of higher education.

Implementation has included moving forward on such issues as developing competencies for both an Associate of Arts degree and an Associate of Applied Science degree as initial academic offerings, securing financial aid for students enrolled in a competency-based curriculum, seeking accreditation of an institution without an instructional faculty of its own, overcoming state licensure and registration barriers, and developing an appropriate fee structure for students and institutions providing academic content. Other issues include the imposing challenge of dealing with various constituencies in 16 states and 1 territory, creating a National Advisory Board of representatives from interested industries, and considering various non-profit/ profit structures for creating the necessary financing options for this private, educational institution.

Following a computer slide show presentation, session participants will have the opportunity of discussing additional issues and questions of interest.

1

Second Biennial Conference on University Education in Natural Resources

Utah State University March, 1998

2

Factors Impacting Higher Education

- **increasing demand for access**
- **increasing costs**
- **disappearing education monopoly**
  - **distance education by traditional providers**
  - **non-traditional providers of content**
- **focusing on competency-based education**

3

Factors Impacting Higher Education

- expanding access to technology
  - technologically literate students
  - quality enhancement of instruction
  - flexibility for individual learning styles
  - availability of information resources
- moving from campus-centric to consumer-centric (competition or choice)
- changing role of faculty and staff

4

Brief Background

5

Goals

- expanding access through technology (wide variety; not just Internet)
- providing formal recognition of acquired skills and knowledge by focusing on competencies of students
- minimizing the costs of replication and duplication; <u>not a replacement for traditional campus</u>

6

Academic Services Provided

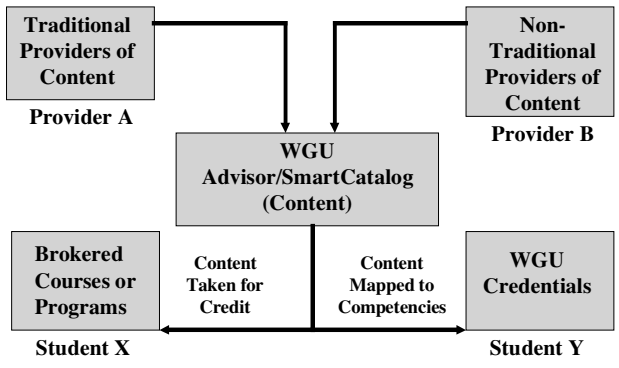
- full spectrum of WGU credentials based on competencies and learning outcomes
- brokered programs and courses based on credit hours for transfer to a traditional institution
- WGU will not grant credit, be a credit bank, or award a credit-based credential

7

Academic Content

- WGU will not employ teaching faculty and will not develop its own courseware
- all academic content, both for the WGU credential and the brokering function, will be furnished by other providers through a solicitation process
- providers must meet WGU quality standards

8



9

Initial Academic Offerings

- WGU competency-based associate of arts degree (general education component)
- WGU competency-based associate of applied science degree for electronics industry
- brokering of credit hour programs and courses for transfer

10

Traditional Faculty Functions → WGU Counterparts

- Curriculum Design/Oversight → WGU Program Councils
- Instructional Delivery → Education Providers
- Developmental Advising → WGU Advisor/Mentors
- Assessment of Student Performance → WGU Assessment Council
- Academic Planning and Coordination → WGU Associate Academic Officers

11

Next Two Phases

- 21 pilot institutions; providing content and/or enrolling students; February 1998
- test systems and integration; provide input on policies and procedures
- solicit content from providers; early 1998
- open WGU to broader audience of providers/students later in 1998

12

Response to Vision and Goals

- 16 states and 1 territory in consortium; others expressing interest
- interest from multiple states and countries
- business/industry support
- reduced barriers
- a metaphor for what is coming

13

States	States
Alaska	Nevada
Arizona	New Mexico
Colorado	North Dakota
Guam	Oklahoma
Hawaii	Oregon
Idaho	Texas
Montana	Utah
Nebraska	Washington
Others	Wyoming

14

International Interest

- collaborative agreements with institutions in:
  - Great Britain
  - Japan
  - British Columbia
  - Mexico
- discussions with Korea, Russia, China, Malaysia

15

Accreditation/ Federal Financial Aid

- four associations for the participating states
- joint accreditation/inter-regional accrediting committee
- common standards and requirements for eligibility, candidacy, and accreditation
- DoEd willing to work with WGU through experimental site status for financial aid

16

Market for Academic Content

- English 101 from many qualified providers
- WGU will not choose a best provider; rather will list all English 101 courses
- WGU will provide information to student: tuition, technology, success rate, schedule
- student makes informed choice; resulting in market for academic content

17

The Business Enterprise

18

Incorporation

- incorporated with administrative offices in Utah; academic offices in Colorado
- board of trustees created; 4 governors, 3 higher education officials, and 7 business leaders
- staff appointments as appropriate; transitioning from contractors to staff

19

Outsourced WGU Functions

- instructional delivery
- assessment
- bookstore
- information resources
- administrative ("backroom") functions

20

Initial Revenue Sources

- state amounts received/committed $1,700,000
- foundation grants: $750,000
- corporate donations (cash and in-kind): $3,600,000
- $3 million curriculum development grant from Colorado

21

On-Going Revenue Sources

- **tuition--determined by providing entity**
- **fees from students**
- **fees from providers**
- **fees and revenues from local center**
- **fees from other business services**

22

Partners

-IBM*
-Sun Microsystems*
-Micron
-AT&T*
-International Thomson Publishing*
-Microsoft*

Partners

-3COM*
-Apple Computer*
-US West
-Matrixx Marketing
-KPMG*
-Novell*
-Sloan Foundation*

***members National Advisory Board**

23

Industry/Business Interest

- **believe in vision of WGU**
- **desire competency-based education for in-house education and training**
- **anticipate revenue opportunity with WGU**

24

Issues and Considerations

- **tuition (resident/non-resident)**
- **financial aid (state/federal)**
- **state licensing/registration barriers**
- **state subsidy for WGU students**
- **strategic use of WGU services**

25

Issues and Considerations

- **communicating to various constituencies**
- **WGU corporate structure for various services**
- **business planning and strategy (central and local)**
- **business partnerships (nature and form)**

26

For additional information:

www.westgov.org/ smart/ vu/ vu.html

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DEVELOPING COMPUTER COURSEWARE FOR FOREST MANAGEMENT

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ABSTRACT: Computers are an important tool for managing forests, and they can be used to help teach forestry students about forest management. This paper describes a project to develop computer-based learning models that will be integrated in a comprehensive courseware package suitable for teaching an entire undergraduate forest management course. The forest management courseware will supplement a traditional textbook and take advantage of the things that can be done better with a computer-based approach. While the computer is not likely to rival the textbook in the areas of depth and portability, it can provide an interactive medium to relieve some of the more tedious aspects of traditional course materials. Some of the more promising features of computer-based instruction are the non-linear, multi-level possibilities of hypermedia, interactive tutorials, animated graphics, computer-administered problem sets, and simulation programs. These features can relieve the student and the instructor of some of the more tedious traditional teaching activities to allow more focus on concepts and more general issues.

INTRODUCTION

Forest management is a senior level course in most forestry curricula. Students learn to use a variety of techniques and concepts related to making decisions regarding the management of forested properties. Subjects covered typically include: 1) principles of financial analysis; 2) stand-level management planning, including using growth and yield models and decision criteria for managing future and current even- and uneven-aged forest stands; 3) forest-level strategic planning, including traditional forest regulation concepts, harvest scheduling, sustained yield, and multiple-use management.

It has been my experience in teaching this course for five years that most of the students find the course to be one of the more difficult courses they have to take. I believe that the students are right – that it is a difficult course, primarily for two reasons: 1) there is a lot of material that is covered in the course, and 2) the material involves a lot of math, which forestry students are not used to doing. In addition, as I currently teach it, the course is hard for me to teach. Because of the mathematical content of the course, I believe problem sets are an important element of the course. However, problem sets take a lot of time to develop and to grade. My grading style could be streamlined, but I believe that the feedback I provide on the homework is an important part of its educational value. I considered two ways to make the work-load of the course more reasonable. The obvious and simplest solution is to reduce the content of the course. I have done this to some extent, and I continually consider what subjects could or should be dropped. However, I feel reluctant to exclude any additional course content – I simply think the subjects that are covered now are essential to a complete forestry education.[1]

The second way to reduce the difficulty of the course is to teach the same material more effectively so that the students catch on to the material more easily. This is certainly not the easy solution. I have spent a considerable amount of time developing teaching materials designed to make it easier for the students to meet the learning objectives of the course. Over five years of teaching the course, I have developed a fairly comprehensive set of handouts, each of which is comparable to a chapter in a textbook. In addition, I have developed Visual Basic programs to take some of the drudgery out of the course exercises. This year, I developed a course web site, which, for now, is used primarily for outside-class communication with the students and for making documents available to the students. I have plans to use the web for much more in the future. I believe that this solution is working. This year there were fewer complaints that the course is too hard and I am hearing more feedback about how interesting and valuable the course is.

I have now developed enough course material that, collectively, it can be considered the rough draft of a new forest management textbook. However, the materials constitute more than a traditional textbook. There are several programs that I use and several multimedia elements that have been developed. This year, I hope to organize all these materials into a draft CD-ROM textbook for forest management. Since many of the products are computer-based, I prefer to call the collected materials "courseware." This paper describes the key elements of the courseware that has been developed and plans for future development. A key to the further

development of the courseware will be to get others who teach forest management to adopt the courseware and try it in their classes. This will provide an important source of feedback so that the courseware can become useful to others.

COURSE OUTLINE

Management is fundamentally decision making. The approach to decision making espoused in the courseware described in this paper follows six fundamental steps: 1) clearly identify problem the decision maker needs to solve, 2) identify the objectives of the decision maker and the criteria by which alternative solutions should be judged, 3) formulate alternative solutions to the decision maker's problem, 4) analyze and rank the alternatives using the criteria identified in step two, 5) implement the preferred alternative, and 6) obtain feedback on the results of the management action. Much the material in my forest management courseware focuses on the fourth step in this process. Steps 1 and 2 are largely policy questions, but students are frequently reminded of the need to carry out these steps before any analysis can be done. Step 3 is generally a silvicultural question. As mentioned, the techniques taught in my forest management class focus mostly on step 4 in this process. Steps 5 and 6 are discussed, but are difficult to apply in an academic setting. In most cases, the courseware assumes that the objective of the landowner is to manage the forest for maximum financial return – generally from timber production. This may be a drawback of the courseware, given the importance of non-timber values for many forest landowners. However, as discussed earlier, there is limited time in the course, and it is necessary to focus on the most essential aspects of forest management.

Course Outline for FOR 466W

1. Introduction: what is forest management?
2. Financial Analysis.
   - A. Basic financial analysis.
   - B. Financial analysis with inflation.
3. Managing individual forest stands.
   - A. Basic growth and yield concepts.
   - B. The Land Expectation Value.
   - C. The Forest Value.
   - D. Thinning.
   - E. Uneven-aged management.
4. Managing large forested areas.
   - A. Regulation.
   - B. Linear programming.
   - C. Basic harvest scheduling models.
   - D. Incorporating non-timber values in harvest scheduling models.

Figure 1. Course Outline for FOR 466W – Forest Resources Management at the Penn State School of Forest Resources.

The outline of the course I teach is shown in Figure 1. The philosophy of the courseware is founded on the basic objectives of teaching forestry students to write management plans for forested properties. Because the tools and concepts are different for small and large properties, the bulk of the course is divided accordingly into two parts that address management problems at each scale. In order to give the students the basic financial tools necessary to evaluate forest management alternatives, two chapters are included in the beginning of the course on the basics of discounting – with and without inflation. The key concepts in the second part of the course are the Land Expectation Value (LEV) and the Forest Value for even-aged management, and Q-factors, cutting cycles, and financial maturity for uneven-aged management. These are the appropriate tools for assessing alternate management scenarios for individual stands when the landowner is primarily interested in maximizing the financial return of the property from timber production. In addition, the techniques can be generalized to accommodate a wider range of objectives. The second part of the course concludes with an assignment where the students write a management plan for a hypothetical 50-acre property. On the list of future improvements for the courseware is the addition of growth and yield simulators and tract-mapping software to increase the realism of this exercise and give the students more experience with important computer-based forest management tools.

The third part of the course addresses the management of larger properties and introduces many of the basic concepts of forest planning, including regulated forests, long-term sustained yield, even-flow, and harvest scheduling. Forest regulation is taught in the course because it gives a relatively simple framework within which to introduce the students to many forest-level concerns. In addition, regulation is still applied on many forests, so it is useful for the student to know what it is. In the regulation section, the students learn the basic concept of the cycling of forest acres through age classes, they learn to calculate the inventory and growth of a forest from the age-class distribution, and they develop an intuitive understanding of allowable cuts. The students then learn to formulate relatively simple harvest scheduling linear programming models, and they learn to incorporate some basic non-timber concerns into the models. For their final project for the course, students develop a management plan for a large (approximately 30,000 acre) forest using linear programming. I have written a user-friendly interface to facilitate this project that is discussed in more detail below. In addition to developing the management plan, the students give oral presentations to the class on their management plans.

COURSEWARE FEATURES

A basic question with computer-aided instruction is what can be done better with the computer than with traditional media such as a textbook. I do not believe that computer-based courseware should replace the textbook. I have observed that students tend to print copies of most of the material that I put on the web site. It is hard to beat the portability of a paper copy. I make the chapters of my textbook available to the students in Adobe Acrobat© format so they can print it up and take it with them. However, some things can be done better on a computer. In this section, I will discuss the computer-based elements of my courseware.

Hypertext

Hypertext can be an extremely useful medium because it offers many alternative paths through a set of material. With a textbook, the material tends to follow a predefined path; but with hypertext, the possibilities are much more varied. The advantages of this are significant. Some readers may want to follow the shortest path through the material, not needing any additional explanation and not wanting to delve any deeper. Other students will welcome some additional explanation, including links to earlier material that may need to be reviewed. Still others will be interested enough to follow some "advanced topics" links. In addition to more detailedexplanations and advanced topics, links allow students to jump to related sections, example problems, animated graphics, photographs, videos, a glossary, and a catalog of formulas. Figure 2 shows the Contents page of the Financial Analysis chapter.

Figure 2. Screen Capture of the Contents Page of the Financial Analysis Chapter

The hypertext medium is different from traditional texts, and developers of hypertext courseware must follow some basic rules. First, the limit to the amount of material that people will read is much lower on a computer screen than in a textbook. It is necessary to keep hypermedia relatively short and shallow. This is one of the main reasons why hypermedia is not likely to completely replace textbooks. I use hypertext to cover material at about the same level as I cover it in a lecture. For more depth, the students must generally read the text. A second potential pitfall of using hypermedia is that it is easy to lose sight of where the start and finish points are. In some cases, this may be by design, but when there are specific course objectives that must be met, the students need to be able to tell what is the required material and when they have covered it. Each learning module I develop has a well-defined set of main pages. Links are clearly identified, for example, as a providing "more detail" or as an "advanced topic." Each module begins with an overview of the learning objectives of the module and ends with a summary of the key points and a set of study questions.

Animated Graphs

Graphics can be extremely useful for teaching mathematical concepts. For example, graphs dramatically illustrate the power of compound interest and can help students gain a more intuitive understanding of concepts such as optimal rotation ages, stocking-mortality relationships, and the development of age-class distributions over time. With the computer, animated charts can be developed that allow students to interactively change key parameters and see the impact of these changes on the shapes and positions of functional relationships. For example, in one graph, students can change a price assumption or the interest rate and observe how the cost of holding timber and land shift when those parameters are changed. Students can also observe the impact on the optimal rotation for an even-aged forest stand and on the predicted value of the property.

Tutorials

A computer can act as a student's personal tutor. Interactive practice problems have been developed that walk students through example problems step-by-step. Each problem has been broken down into sub-problems to help the student learn how to solve the problem systematically. At each step, the student can either select an answer, ask for a hint, or ask the computer to show them the correct answer and provide an explanation. For example, the solution process for a financial analysis problem can be broken down into the following steps: 1) select the correct type of discounting formula, 2) identify the relevant information from the problem and put the appropriate numbers in the formula, 3) enter the numbers in a calculator to obtain the correct answer. If the student selects the wrong answer, the computer gives an explanation of why that answer is incorrect and gives the student the opportunity to try again. Thus, the tutorials give students immediate feedback on whether they understand how to do the exercises correctly.

Web-Based Homework Assignments

Because much of the course material is mathematical, I believe the students must do problem sets in order to learn the material. Problem sets push the students to keep up with the material and give them early feedback on how they are doing in the course. In a course like forest management, where each subject builds on another, students cannot afford to wait until the first midterm to find out that they don't have an adequate grasp of the material. I also believe that the problem sets should be graded, or many students will not do them. Furthermore, graded homework assignments help students earn some points outside of a testing environment where some students simply do not perform well. One of the main drawbacks of giving problem sets, of course, is the amount of time it takes to grade them. There tends to be a direct relationship between the amount of time spent grading problem sets and the value of the feedback given to the students as a result of the exercise.

One of the key advantages of giving homework assignments is that it encourages students to work together. This is generally good, since students can often understand a peer's explanation better than the one given by the professor. Also, for those students doing the explaining, the exercise of trying to explain concepts from the course helps them to improve their own understanding of the material. However, a common problem with homework is that some students will simply copy another student's homework.

Computers provide an opportunity to eliminate many of the problems of giving problem sets and, at the same time, enhance many of their benefits. While we have not perfected this system yet, the intention is to develop the capacity to let the computer give and grade the problem sets. Ideally, the system will work as follows: 1) students will each be given a unique problem set which they will obtain by logging into the course web site, 2) after working the problem set, the student will log back onto the web site and enter his or her answers, 3) the computer will immediately respond by indicating which questions were missed, and the student's score will be logged in a file. The problem sets would all be unique – or at least there would be enough unique variations to discourage trying to find someone with the same set of problems. However, the questions would be similar on each problem set, perhaps with only a few numbers changed. The system could be set up to allow students to re-enter their answers as many times as they wish, or to only allow a limited number of re-takes. This system would improve on the traditional approach to problem sets in many ways:

- It would give the students immediate feedback on what they understand and what they don't understand.
- It would encourage the students to go back and study the material related to the questions they missed.
- Students would have to do their own work, but they would still be able to collaborate on understanding the concepts common to all the homework sets.
- The effort of grading the assignments would be eliminated, allowing professors and teaching assistants to spend their teaching time explaining concepts, rather than in grading.
- Instructors can get timely feedback on which questions the students are having to re-take so they can review the material in class and/or consider re-wording the question for future assignments.

This approach to managing problem sets is not new. It has been implemented at Michigan State with a Unix-based system called CAPA (Computer-Assisted Personalized Approach, **http://www.pa.msu.edu:80/educ/CAPA/,** Kashy, et al. 1993). The CAPA system is very promising, but I decided not to use it because it requires that students work on a local, Unix-based network. I believe that I can implement this type of approach over the Internet, which would make it more available to students and easier for other instructors to implement.

WriteLin: A Harvest Scheduling Model Formulation Interface

As mentioned earlier, for their final project for the class, students develop management plans for a large forested area. The students are organized into teams of three to four students. By mixing and matching different parameter sets a large number of unique management plan problems can be generated, and each team is given a unique problem. This assignment is difficult and time-consuming. In an effort to reduce busy-work for the students and to make it easier for me to check their work, I have written a stand-alone Visual Basic program called WriteLin that allows users to interactively enter information about their forest and their management goals and constraints. The program then creates a linear programming formulation that can be solved by a separate program. WriteLin includes extensive help, which is coordinated with the harvest scheduling chapters of the text. Virtually every window available in WriteLin has a context-sensitive help button. The program is easy to use, allowing the student to enter their current forest inventory data, yield tables, economic data, and formulation parameters interactively and easily. The program works well and has been well-received by students, but there is still work to do to integrate it into the textbook's format. Figure 3 below shows the main screen in WriteLin. Figure 4 shows WriteLin's model formulation screen where students specify the formulation parameters of their model.

The next step is to develop a back-end system to facilitate the organization and interpretation of the information provided in the linear programming solution. Ultimately, I would like to integrate a GIS component in the system to help students visualize the results of the planning model. Linking the output

of the system to a GIS would also provide a setting for addressing the many spatial issues that arise in forest planning.

CONCLUSIONS

Forest management is an ideal class to teach using computers. Computers are becoming essential forest management tools. Computer models are widely used to manage forest inventories and to simulate stand development. Geographic Information Systems (GIS) are used by forest industries and agencies to store and update inventory information, to map management areas, and for performing analyses of management policies. Today, spreadsheets and word processors are essential basic tools in virtually all fields. Familiarizing students with computers and forestry-related and general-use software has become a key element of a professional forestry education.

The forest management courseware described in this paper will supplement a traditional textbook and take advantage of the things that can be done better with a computer-based approach. While the computer is not likely to rival the textbook in the areas of depth and portability, it can provide an interactive medium to relieve some of the more tedious aspects of traditional course materials. Some of the more promising features of computer-based instruction are the non-linear, multi-level possibilities of hypermedia, interactive tutorials, animated graphics, computer-administered problem sets, and simulation programs that can relieve the student and the instructor of some of the more tedious activities to allow more focus on concepts and more general issues.

LITERATURE CITED

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[1] The subjects covered in the course are listed later in this paper, and comments or suggestions regarding the course content are welcome.

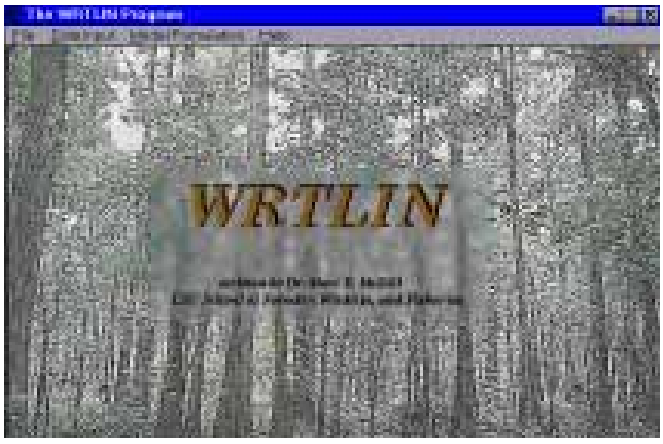

Figure 3. The Min Screen in WriteLin.

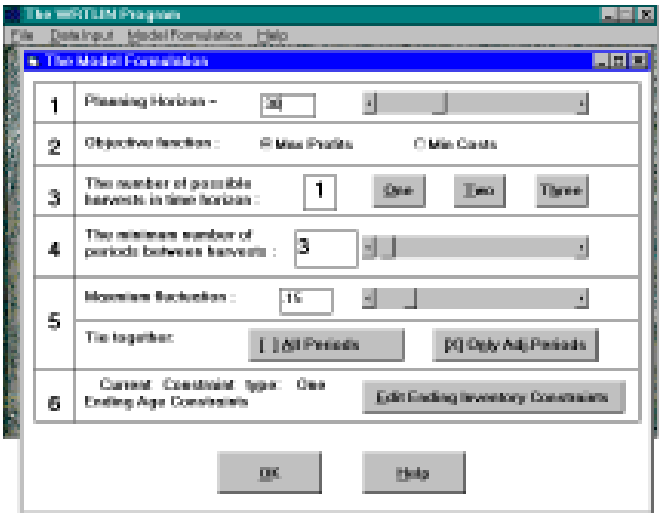

Figure 4. The Model Formulation Screen in WriteLin.

AN ETHICS PRIMER FOR UNIVERSITY STUDENTS INTENDING TO BECOME NATURAL RESOURCES MANAGERS AND ADMINISTRATORS

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ABSTRACT: Natural resources managers and administrators frequently face problems which have ethical dimensions. This paper is intended to help students learn how to become more comfortable and sophisticated with ethical aspects of their management studies, to learn to include ethical tools more in their decision making, and consequently to become better prepared to manage resources later placed in their care.

Many of us realize that ethical questions are fundamental to our work. Most of us feel that we have an adequate understanding of and ability to distinguish between "right" and "wrong" behaviors. But we are unable to discuss ethical ideas fluently and we feel insufficiently well prepared to include them in public forums where management alternatives are discussed. A "primer," discussing and illustrating a small number of basic concepts and principles, will not make philosophers of us but it can give us basic building blocks and sufficient confidence that we can continue to grow in our study of and our abilities to use those ideas.

For example, how large is the "moral community"? To whom or what do I have obligations? Aldo Leopold's land ethic argued that an extension of ethics would include the land; that is, we have moral responsibilities to other living creatures (and perhaps to non-living components of our environment). In public meetings we hear it argued that all animals (and all plants, or some animals only, or all nature, or rocks and waterfalls) have rights. We hear it said that hunting is immoral, that allowing deer to starve is wrong, that any interference with nature is ethically questionable. If we can better understand, not just the emotional depth, but logical, cultural, and religious sources and the arguments for and against these various positions and their ethical ramifications, we will find ourselves better prepared to enter into ethical aspects of public discussions regarding resource management, and further, to use ethical tools more effectively in making management decisions.

This paper discusses this and several similar fundamental concepts and illustrates their importance in resource management.

INTRODUCTION

In early June of 1958 a baby deer was left in a cardboard box on the front steps of the Indian River station of what is today called the Michigan Department of Natural Resources. I was a wildlife biologist then, stationed at Indian River. It was clearly impossible to return the fawn to its mother. Also, no zoo or animal "orphanage" wanted more deer. Individual deer had been raised more or less successfully in the past, although this practice is generally illegal, and the adult deer then may become a nuisance or a danger. It was generally agreed that the fawn had to be killed. I took it into the woods, cut its throat, and left its corpse.

When I tell this story to my freshman class of natural resources majors, the long and relatively unsophisticated discussion sometimes centers around the rightness and wrongness of killing the deer, but usually focuses on possible ways to keep it alive. When I encountered this problem almost 40 years ago, I was completely unprepared to raise or consider any moral questions related to the situation. I very frequently faced (and our students will face) similar questions which had (or have) ethical or moral dimensions. Is sport hunting itself a morally right or neutral or wrong activity? What about fishing? Are certain kinds of traps cruel? And are they therefore wrong to use? How should I deal with the information that I have regarding a man who illegally kills a deer to help feed his very poor family? Should "chicken hawks" be killed because they kill the farmers' chickens? Should bisons be killed because they may transmit brucellosis to cattle? If we have reduced predators by various human activities, do we have a responsibility to replace them or their behaviors to retain a certain "balance of nature"? Should the last few members of an endangered species be captured in an attempt to "save" the species?

I could have been far better prepared. And our students and the public deserve that our future professional workers in the

natural resources receive a much more sophisticated university education and that professionals become much better prepared to deal with ethical aspects of their work. Clearly, all of us could benefit from fullblown courses in environmental and natural resources ethics, taught by philosophers who also understand environment. And I argue for the inclusion of such courses in our curricula. Meanwhile, I believe that it is possible for each of us to become gradually more sophisticated and comfortable with this discipline.

I am not thinking of "professional ethics," those questions which arise as a part of my relationship with colleagues and employers. (Should I put in a full day's work each day when my state government temporarily institutes "payless paydays"? What is my obligation as a consultant when I know that my client is behaving illegally? As a government employee, may I accept gifts from citizens or from prospective contractors with my agency?) These are important, but deserve a separate treatment. I am thinking instead of the ethical questions which arise during the making of policy decisions and during the conduct of management practices which relate primarily to the ways I treat our natural resources and environment.

AN ETHICS PRIMER

I believe that each of us, whether faculty, other college or university staff people, natural resources students, or professional managers and policy makers already in the field, with only a little help, can grow in the following ways:

1) increased confidence in our ability to deal with ethical subject matter
2) increased ability to recognize and begin to explore ethical questions
3) increased ability to recognize moral dimensions of and analyze the positions of others
4) increased "mental fluency" and thus ability to participate in public discussions over moral aspects of our work.

In my case, to the extent that I may have grown, it has come from a determined effort to badger my philosopher colleagues, participation in ethics-related short courses and workshops, reading extensively, and having the nerve to step into waters of unknown depth and write papers related to ethics. All of this, of course, includes a willingness to accept the embarrassment that comes, as every student knows, with trying to discuss a subject with which one has a limited acquaintance.

This paper is not intended to be an ethics primer but to argue that each of us can prepare his or her own primer by actively engaging in intellectual exploration of the obvious moral aspects of our professional subject matter. Reading, note-taking, attendance at conferences and workshops will help one to grow. Particularly, I believe that the preparation of a personal "encyclopedia of ethics," with personally created definitions and accompanying descriptive materials can be a powerful learning technique. Perhaps 30 to 50 concepts, with a maximum of two pages devoted to each, will result in a basic tool of sufficient scope to deal with many ethical questions and at the same time not so large as to overwhelm one with its content. This "primer" can grow and become more sophisticated and detailed as notes are gradually added.

In addition, I have found that concept maps are an extremely powerful tool which can help us to understand concepts and the relationships between them. A concept is, according to Novak and Gowin (1984), "a regularity in events or objects designated by some label" (for example, see moral community as discussed below). A concept map visually displays several related concepts; one's notion of the interrelationships between them is demonstrated by the use of connecting words. For each of the concepts in your "primer," you should be able to draw a diagram or concept map showing a few other concepts and their relationships with the central concept of interest. Novak and Gowin (1984) describe methods for making concept maps.

Also, to ensure contacts with expert philosophers, it is useful to become a member of an organization such as APPE, the Association for Practical and Professional Ethics; ISEE, the International Society for Environmental Ethics; or IDEA, the International Development Ethics Association.

Finally, regular reading of a journal such as Environmental Ethics will help you to grow in your understanding of this subject, as well as providing a source for further notes for your primer.

WHAT IS ETHICS?

"Ethics is a branch of philosophy concerned with morals (the distinction between right and wrong) and values (the ultimate worth of actions or things). It considers the relationships, rules, principles, or codes that require or forbid certain conduct" (Cunningham and Saigo 1990). Natural resources ethics and environmental ethics are subsets of ethics.

Some Ethical Theories

Stewards of natural resources and of aspects of our natural environment are likely to find 1) that they draw their own ethical conclusions from more than one source or ethical theory, and that 2) members of the public with whom they interact in their professional work will also have drawn upon several different ethical theories or sources. Generally, ethical theories provide frameworks which help us to reach ethical conclusions in some consistent, logical, and defensible way. Clearly, it is useful to understand the basis of both one's own and of others' ethical arguments. The following materials draw mainly from Shannon (1987) in general construction and some details.

Consequentialism. Consequentialism, and its most common subtype, utilitarianism, analyze possible actions by asking "which possible action will (or would be expected to) bring about the most good (or happiness, or pleasure, etc.) for the most people"? This is closely related to economists' ideas of utility, and can be traced back to Jeremy Bentham (1748-1842) who was both an economist and a philosopher (Becker and Becker 1992). A consequentialist might ask whether certain proposed hunting or fishing regulations might produce the greatest overall good for all affected people. Would the consequences of allowing larger Canada goose harvests by native peoples in Canada offset the possible reduced recreational opportunity in the United States?

Rule-based theories. Rule-based theories specify obligations or duties, that is, they stem from rules. The "ethical act is one in which I meet my obligations, my responsibilities, or fulfill my duties . . . obligations and rules are primary" (Shannon 1987). Rule-based ethics often go by the awkward name, deontological ethics ("deon" is Greek for "duty"). The ten commandments are the best example.

Rule-based ethics tend to have a clear and certain starting point but an insensitivity to consequences. I must tell the truth, even though it badly hurts a friend's feelings. I must report the law violation by the deer poacher whose family is truly hungry.

Rights-based theories. This set of theories begins with statements about rights (moral, not legal, rights) being entitlements to certain "social goods" simply because one is a human being (or as we will expand this term later, a being of a certain kind). One need not earn rights; they simply exist because we exist. The claims of individuals are central to rights-based moral theories, and it is common to find conflicts between claims of different individuals to rights. Do you have a moral right to cross my private property to reach otherwise inaccessible public land? May I defend my lambs against the depredation of your (our) public eagles or wolves? Do I have a moral right to "more important" (e.g., subsistence farming) withdrawal uses of water than does the city of Richville which has a prior legal claim and is now using that water for lawns, golf courses, and car washes?

Intuitionism. Some people (all of us?) argue that sometimes we cannot cite rules or argue logically but we "just know that something is the right thing (or the wrong thing) to do." One of the greatest difficulties we can encounter in a public forum is that this source of ethical judgment is not logical nor susceptible to rational argument or discussion.

Virtue ethics. Virtue ethics is a moral theory which bases right behavior on virtues, that is, on dispositions such as "courage, temperateness, liberality, magnanimity and justice" (Becker and Becker 1992). Long lists of virtuous behaviors can be created as guidelines for virtuous acts.

We are all likely to find, or to know already, that we use (and that we "believe in") one kind of ethical theory primarily. But as we observe our own thinking processes more closely, we may be surprised to see ourselves moderating our primary stance by the use of a secondary theory. (I know that I am supposed not to lie, but the truth would hurt his feelings terribly.) And, as we continue to observe others' choices of actions, we can begin to see in their discussions that they are using, individually as well as within a community, several ethical theories.

SOME SAMPLE ETHICAL CONCEPTS

As beginning students in moral philosophy, the tools that we need at first are mainly a vocabulary and an extended understanding of the meanings of concepts as used by writers in discussing ethics. The following concepts are typical of those encountered most frequently in discussions of, for example, environmental ethics, and should present a short-cut into much of the relevant literature. Much of the following, where there is no citation, is drawn from Becker and Becker's (1992) Encyclopedia of Ethics.

Moral considerability. Moral considerability refers to the questions of what people and what things have rights or to what things we must give moral consideration. What things can be treated simply as property or as objects and what ones deserve to be thought of in terms of the rightness and wrongness of our treatment of them? May I treat my dog or my horse in any way that I wish, or must I consider their interests? May I conduct classroom experiments on live animals without considering their welfare? May I hunt or fish or trap or cut down a tree as I please (within the law) and without regard to the possible feelings of those organisms?

Some people argue that only human beings are morally considerable; they deserve moral consideration; the treatment of other living things is only a matter of our preference, not of right or wrong. Leopold (1948) uses the example of slaves hanged by Odysseus after the Trojan Wars. The slaves were regarded solely as objects, and their treatment "only a matter of expediency, not of right or wrong."

Moral agent. A moral agent is one who has the capacity to make decisions regarding the rightness or wrongness of one's proposed actions, and to act upon those decisions. A newborn baby cannot make moral decisions and so is not a moral agent. An adult human being living in a coma similarly is not a moral agent. But note that we (who are moral agents) nevertheless have obligations to those people. If I cannot act upon a decision that I might mentally be able to form, then I may not be a moral agent with regard to that particular question.

Moral subject. Today we almost universally believe that all human beings are moral subjects. That is, the way that we treat each other person is a matter of rightness or wrongness.

All people have interests and rights, and they should be subjects of our moral concern.

It is not so easy for us to agree what other (if any) things are moral subjects and thus deserve moral consideration.

Moral community. Moral agents and moral subjects are often considered to be members of a moral community. But how large is that moral community? Besides human beings, do other beings have rights? If so, which beings? (And what rights?) Among the most frequent and most violently argued questions which wildlife biologists, and to a lesser extent fisheries biologists and foresters, encounter these days are those over the presumed rights of other beings, and our obligations to treat those other beings as deserving moral consideration. How we treat them then is a question of right and wrong based on their moral standing; they are moral subjects.

How do we decide what are proper subjects of moral concern? One common set of arguments stems from the respects in which other beings resemble human beings? Are they alive (do we need to treat rocks and waterfalls with moral concern?) Do they have "interests," e.g., to remain alive? Perhaps plants qualify. Can they feel pain? (Are they "sentient"?) Perhaps most vertebrate animals would qualify under that standard. Can they think? Do they have intellects (e.g., whales, porpoises, squid)?

Animal-welfare and animal-rights groups such as PETA (People for the Ethical Treatment of Animals) tend to concentrate their arguments on mammals and birds. But we have also heard the emotional discussions about classroom dissections of frogs and other organisms. I remember very distinctly the clear discomfort of a student when an instructor dumped a seine-haul of fish before a class on the shore and unconcernedly began to lecture while the fish flopped around on the sand. I have before me as I write a wallet-sized card with the photo of a round goby, an exotic species rapidly spreading in the Great Lakes region since 1990. This University of Minnesota Sea Grant card advises fishers to "Always dump your bait bucket on land, never into the water." Are living fish moral subjects; are they members of our moral community? This is, I think, typical of the difficult questions that students and professionals in natural resources majors will need to deal with much more frequently than we did in the recent past.

Many people seem to include all vertebrate animals in their moral community; legal rights are often similarly defined. For example, at Cornell University "all vertebrate animals used for teaching, demonstration, or research at Cornell (including cold and warm vertebrates) are subject to protection by both federal and state laws" (OSP 1997).

Moral extensionism. What we think of as the moral community seems to be growing rapidly larger. Extending rights to animals is often called zoocentrism, and to all living thing things, biocentrism. Some go further and speak for ecocentrism, that idea that all of nature has rights, or alternatively, that we have obligations to all of nature.

This expansion of our moral community was proposed by Leopold (1949) in his discussion of a "land ethic." By "land" he meant not only the surface of the earth, but all of the plants and animals, the ecosystems, the natural processes occurring there. Leopold suggested that stages in our ethical development included 1) the personal (I must not steal from you), 2) the relation between an individual and her community (I must pay just taxes; I must participate in civic activities) and 3) our relationship with the land. Rather than seeing land as only property and entailing no rights or obligations, we need to see it as a community of which we are a part and which requires moral consideration. Although Leopold did not speak much of an international community or of the longterm future, as an ecologist he surely would include them in his moral community. Astronomer Carl Sagan would extent the moral community still further: "The cognitive abilities of chimpanzees force us, I think, to raise searching questions about the boundaries of the community of beings to which special ethical considerations are due, and can, I hope, help to extend our ethical perspectives downward through the taxa on Earth and upwards to extraterrestrial organisms, if they exist" (Wilson 1997).

Many other concepts could be defined and discussed here, but that is the reader's job. Your primer will be different from mine, but no doubt we will both include ideas such as rights, obligations, autonomy, intrinsic value, reverence for life, and many others.

MORAL DILEMMAS

Moral dilemmas (if they occur at all; some say that there is no such thing) are situations in which there is a conflict between two right things to do, not between a right and a wrong choice. And the need to choose one action over another results in a morally difficult situation.

Kidder (1995) argues that there are four common types of moral dilemmas:

1. between truth and loyalty
2. between the individual and the community
3. between short-term and long-term interests
4. between justice and mercy.

Dilemmas Between Truth and Loyalty

I probably have no moral dilemma when my brother asks me how I like his new necktie. I can gently break the news to him with a minimally stated truth. But a critically injured mother who asks about her baby's welfare, when the baby has just died

in an accident, may present me with a dilemma.

I may have discovered the first cattle egret to be seen in Michigan (McNeil, Janson and Martin 1963). When I went to a university museum and asked to see some study skins, the curator's first response was to ask me where I had seen the bird. Knowing that his intent was to collect the bird with a shotgun, I refused to tell him (until a few months later); I gave him only a general and perhaps misleading reply. This may have been a genuine dilemma: did I have an obligation as a scientist to reveal the location of the bird? did I have an obligation to protect the only known individual of its species ever to be found in the state from a would-be predator?

Dilemmas Between the Individual and the Community

We all know of the classic cases where refugees are hiding from a despotic regime, and a mother smothers her coughing baby to avoid discovery of the group. If we have extended our moral community to include individuals and populations of wild organisms, related questions arise. Should we capture the last few members of an endangered species in hopes that captive breeding programs will generate a viable population? Should wild horses be killed if they become so numerous as to damage seriously the range where they are resident? Should fish-eating cormorants be slaughtered for the benefit of trout fishermen around Lake Ontario? Should individual oiled birds be rehabilitated at great expense when those resources used in different ways might have important positive effects on habitat for the same species?

Some of the most difficult discussions between animal rights activists and wildlife managers occur because the former tend to look at the rights of the individual and have a limited regard for the more abstract ideas of population health and habitat conditions while the biologists thinks mainly in terms of the larger units and tend to be less careful about the way they choose to treat individual animals--the orphan deer, the trapped coyote, the caged experimental animal.

Dilemmas Between Short-term and Long-term Interests

Deer hunters like to have lots of animals around. In some places, winter feeding programs to reduce starvation have resulted in long-term damage to habitat from overpopulations of deer brought about by those "artificial feeding" programs. Similarly, hatchery-raised trout and game-farm-raised pheasants may provide more animals for our short-term recreational interests but negative effects on the qualities of the wild stocks of animals. The masses of snow geese that the bird watcher loves to see in their wintering areas in the U.S. are now causing longterm damage to their nesting grounds in northern Canada.

Dilemmas Between Justice and Mercy

These possible dilemmas seem mostly to deal with human beings. Examples in environment include: if we say that animals have rights, how should we deal with sick or injured and dying individual animals? Does the dying pheasant that I find at the edge of a marsh deserve to be left alone and to die "naturally" or to be killed quickly and thus to avoid extended pain? Or is this a matter of no moral question at all? It may be useful to remind ourselves here that many administrative decisions and management choices do not include much moral content. Extending a duck hunting season for a few days or revising the boundaries of a big-game management unit does not require a substantial moral inquiry. And moral dilemmas do get solved. By our actions or our inactions we express our choices; if we have been dealing with a true dilemma, it is appropriate that we feel a little bit uncomfortable with our choice of action.

SOME SUMMARY POINTS

Regarding ethics:

1. There is no one uniform "god-given" system of ethics to which all knowledgeable philosophers subscribe and from which they derive their positions about right and wrong behaviors.

2. Many people take and argue ethical positions without much prior reflection or understanding of the implications of their positions. (And they may not know that they are making moral statements, or they think that they are when, in fact, they are not.)

3. It is possible to start from quite different presumed sources of ethics or to use quite different moral theories and to come out with logically defensible positions which are quite similar.

4. It is possible for two philosophers working from the same moral theory to come out with quite different positions about the rightness or wrongness of an act.

5. The world is complex; morally-charged situations are complex. It is often a genuine advance to have simply identified and considered the moral aspects of a situation without unduly worrying about whether one's decision is the best possible in the sense of rightness or wrongness.

6. Genuine dilemmas arise and exist.

7. Some management problems and some policy problems do not have important ethical content.

Regarding how we deal with ethical questions:

1. We can all become deeper in our understanding and more skilled in our ways of dealing with ethical dimensions of our work.

2. Personal work plus occasional consultation with trained philosophers will help us to reach fairly quickly and easily a level of understanding which will make us capable of using ethical tools in our student, faculty, and professional career activities.

3. A little patience and considerable humility are in order when we discuss these deep and complex issues with trained philosophers (who, alas, are also deeply trained and experienced in, and perhaps genetically selected for, argumentation). Their work is important, and knowing how to ask for and use their help should be high on our list of how to deal with questions of ethics.

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THE KENYA MODEL: DEVELOPMENT AND IMPLEMENTATION OF AN OVERSEAS STUDY COURSE ON AFRICAN WILDLIFE ECOLOGY AND MANAGEMENT

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ABSTRACT: The brochure declares: "What better place to study a diversity of wildlife species and ecosystems than Kenya's spectacular National Parks and Conservation Areas?" Enticing! Exhilarating! A once in a life time experience! *African Wildlife Ecology and Management in Kenya* is an intensive two and a half week overseas study program offered by Michigan State University's (MSU) Department of Fisheries and Wildlife. Through this hands-on experience, students apply wildlife management principles to issues in Kenya's National Parks and Conservation Areas.

Planning and coordination of this course requires a year's worth of thoughtful preparation in order to provide students with a dynamic yet placid in-country experience. To better aid other educators and coordinators in development and implementation of similar courses, we present a detailed account of the history and evolution of *African Wildlife Ecology and Management in Kenya*. How was this course conceived? How was support garnered from the University? What is required for developing such a course?

Furthermore, we present information on why different sites within Kenya were selected and how the order of visitation to these sites allows for a logical progression and increasingly more elaborate acquisition of knowledge of course material. Finally, we describe the various projects assigned to students and the rational for assigning them; the basis for using student groups throughout the in-country experience; the use of alternative forms of assessment to evaluate student learning; assigned readings and course packet development and contents; and implications of limited time and lack of technology while in-country.

INTRODUCTION

> *"Deciding to study abroad is the first step in changing your life. It is an enriching experience both academically and personally. The lessons you learn abroad cannot be duplicated on any campus in the United States."* (Michigan State University's Study Abroad Program Pamphlet, 1997 - 1998)

At Michigan State University (MSU) a continuing commitment to expanding international perspectives in academia, research, and outreach is at its pinnacle. Under the direction of the President of the United States and the President of MSU, the importance of international exchange for students at MSU has been amplified. A formidable goal has been set attempting to provide all students with at least one international experience in their educational career. Opportunities to reach this goal abound at MSU. Currently, MSU provides over 90 overseas study programs to such places as Australia, the Bahamas, China, England, Ireland, Kenya, Nepal, Portugal, Sweden, and Zimbabwe. While the number of programs may be numerous, few have strong science-based curriculums.

One such course that has answered this call is a program developed by MSU's Department of Fisheries and Wildlife. This class focuses on wildlife management issues in Kenya, Africa. It is appropriately titled *African Wildlife Ecology and Management in Kenya*. Since its inception in 1995, the course has been oversubscribed and stands in high demand by undergraduate and graduate students from MSU and other institutions.

The purpose of this paper is to provide educators and coordinators with a detailed account of the history and evolution of MSU's *African Wildlife Ecology and Management in Kenya*. It is our aim to address the following issues. How was this course conceived? How was support garnered from the University? We also will discuss the logistics required for developing such a course. We will present information on why different sites within Kenya were selected and how the order of visitation to these sites allows for a logical progression and increasingly more elaborate acquisition of knowledge of course material. Finally, we will describe the various projects assigned to students and the rational for assigning them; the basis for using student groups throughout the in-country experience; the use of alternative forms of assessment to evaluate student learning; assigned readings and course packet development and contents; and implications of limited time and lack of technology while in-country. It is our intent to afford fellow educators with a framework with which to develop overseas programs at their home universities.

PROGRAM HISTORY AND PLANNING

The concept for teaching *African Wildlife Ecology and Management in Kenya* came into being in 1994. After plans were made by two MSU instructors to visit Kenya and Tanzania to investigate progress of a field research project, the possibilities and opportunities for developing an overseas study program in Kenya and Tanzania were also considered. University administrators enthusiastically supported this venture because this promoted the University president's goal of involving students in at least one international exchange program during their educational career. So, in addition to investigating research activities, time was spent learning about socioeconomic and ecological issues in the country; inquiring about lodging facilities, modes of transportation, and travel arrangements; meeting prospective guest speakers for this course; and obtaining estimates for course expenses.

We discovered that an initial faculty-only visit to a country of interest is crucial for designing an academically rigorous, safe, efficient, and enjoyable overseas study course. Visiting a country without students will allow you to learn about socioeconomic and natural resource management issues associated with the country before introducing course material. Imagine teaching a hands-on course if your preparation was merely reading a textbook related to the course. Your first exposure to the dynamics of the site would be with the students, thereby causing you to experience the site and material at the same time as the students potentially disabling you in being an effective instructor or group leader. We have experienced such a dilemma. Colleagues of ours who did not have the opportunity to visit a country prior to working with students found recruiting and teaching problematic.

One issue that arises when attempting to plan an initial site visit, however, is funding. Our initial site visit was funded by a grant received from the MSU Overseas Study Program, the College of Agricultural and Natural Resources, the Department of Fisheries and Wildlife, and various funding sources in Kenya provided by Dr. Perez Olindo and Ms. Chiaki Nakamura. Potential sponsors, other than universities, that may provide funding for faculty to teach internationally include the U.S. Department of Education (i.e., Higher Education Education Grants, International Grants), U.S. Environmental Protection Agency (i.e., Environmental Education Grants), and Rotary International.

Due to the dynamic nature of air travel, another element must be addressed. Traveling with a group of students overseas can be challenging - after all very few of us experience traveling to professional meetings and conferences with 15 to 20 people "in-tow." We advise, when planning class travel arrangements, that every effort be made to have the fewest number of layovers as possible. When layovers are inevitable, it is highly recommended that layovers are of substantial length so all members of a large group can make connecting flights. Please note: To ensure that flight arrangements for students were as expeditious as possible, instructors making a preliminary site visit traveled on an airline itinerary that most closely followed the one that the students would eventually travel the following year.

We felt the course should begin in early June - allowing instructors two weeks of final preparation time after courses ended on the MSU campus. This would also assure better weather conditions for a field-oriented course (early June is the beginning of the dry season in Kenya). The initial faculty-only site visit was also held at this time so we could experience comparable weather conditions, tourism intensity, animal distributions, and habitat conditions. Knowledge of these parameters was essential for informing students of the types of equipment to bring and what they might expect to see during the course, and allowed us to plan the course itinerary, activities, and assignments.

Upon arrival in Nairobi, Kenya, instructors identified the need for the first two days in-country to be relatively restful days for students. Starting the course slowly (introducing students to the course and the Nairobi area) would allow students to acclimate to the time change and recuperate from the nearly 18 hour flight.

A major goal of the initial site visit is to investigate where students should be taken during the course to provide them with a diversity of experiences. We visited eight national parks and reserves in Kenya and Tanzania as well as the Kenyan National Marine and Fisheries Research Institute and Lake Victoria. During this trip we stayed at and/or visited 11 lodges in 11 days. In addition, we were also able to talk to many of the national park wardens, rangers, and researchers associated with wildlife services in Kenya and Tanzania.

Through our efforts, we established contacts who were interested in talking and working with students the following year.

Visiting numerous sites on this trip was insightful for realizing that covering such a vast geographic area in a few days would not be practical with students. Participants in an overseas study course need time at each location to learn and reflect upon the ecology of the parks and the species in them, as well as learning about the socioeconomic issues surrounding the parks. Having students engage in activities and assignments related to these topics are crucial for developing a rigorous academic experience for students. This eliminates the potential for their travels to be "photo safari" in nature.

Therefore, we have learned that:
- Students require time to adapt to cultural changes and time changes before working on academic activities.
- A number of areas should be visited to facilitate the planning of where students will travel and what types of academic exercises work best at those locations.
- It is important for instructors to make a faculty-only visit to learn about the area and possible subjects they will teach.
- Traveling through customs of some countries with a large group may be problematic. Make sure that you, as instructor, have traveled through all the customs in your faculty-only trip. You will be better prepared when visiting with students.
- Make contacts with professionals and local people you may want to visit with the class. These contacts will serve two functions: As instructor - to learn more about the park and issues in specific geographic regions and to potentially act as guest speakers for the class. For those individuals you want to talk to the class - contact them periodically prior to the course offering to facilitate scheduling a time and place for their guest lecture.
- Traveling with students will be much more complicated and slower than when traveling with your peers. Take into account the number of students in your group, whether they have traveled out of their own country, let alone their own state, and also consider their reactions to new cultures.
- What medical information and preparedness is necessary for a safe, healthy trip? What immunizations are needed? What types of medical facilities are available in the countries they will visit? What medical documents do they need to carry with them on the trip? What is the medical history of each program participant? Having answers to these and other questions will be helpful for students and their families. It will also help prepare you as an instructor for any medical emergencies that may arise.
- Student safety is paramount. Where can you take students during this course so their safety is not jeopardized?
- While traveling in-country, some people often have adverse reactions to new food and/or different water. Students and staff should be aware of how to deal with this possibility. First, how to cope with this medically is necessary. Secondly, the course should be developed so that the course can still proceed should an individual, (staff or student), become sick or injured.
- Purchase literature from the country you are visiting. Some of the literature (i.e., books, maps, local publications or writings) that you might want for course development and/or assigned readings may not be available in the United States. It is also possible that the literature available in the host country may give you a more in-depth view of ecological topics, management techniques, and cultural issues.
- Take a plethora of slides, especially of lodging and dining facilities and places the class will be visiting. These will be useful for recruiting students and reassuring their parents in subsequent years.

NOW THAT YOU HAVE THE IDEA, HOW DO YOU MAKE IT WORK?

After the initial faculty-only visit to Kenya, it was obvious that *African Wildlife Ecology and Management in Kenya* was warranted. In this section we will address budget development, the most critical component for ensuring success of a program. Later, we will discuss our in-country visitation itinerary and the topics we cover in the class.

Important to be noted is that budget development will provide you with figures which will fall into three categories: Program Costs, Tuition Fees, and Airfare. Students will be responsible for covering the fees in these three categories.

In order to begin developing a budget, it was necessary to decide upon the locations for visitation and the number of days at each site. This task was expedited through the assistance of our in-country contact, Dr. Perez Olindo. Many costs arise when planning such an intense field experience and every effort should be made to identify these costs early on so you do not find yourselves "short of change" when in-country. When possible, we suggest that you overestimate your costs to allow for a financial cushion in the event that an emergency arises. If this extra money is not needed, it can be refunded to students at the close of the trip.

PROGRAM COSTS: Below is a list of the items which will incur costs and are viewed as necessary expenses falling under the umbrella of Program Costs. We present them to provide you with an idea of the variety and variability of different program costs. Please be aware that the total amount of the program costs will be divided equally among the number of students you take with you on your overseas study program.
- Transportation: This includes travel for instructors to and from the United States' international airport, instructors airfare and in-country travel. (Students are responsible for their own transportation to and from the airport in the United States and associated airfare).

> When we arrived at Kenya's airport, tour vans picked us up and served as the method of transportation

throughout our stay. A tour company provided and arranged the vehicles for us. Using this type of travel not only relieved instructors from the responsibility of locating safe and properly functioning vehicles but was also beneficial because van drivers were included in the vehicle package cost. These resident drivers were an added bonus because they were familiar with the country and the locations we were visiting. In addition to the tour vans, we covered the expenses of one four-wheel drive field vehicle. The purpose of including this type of vehicle in our transportation needs was to carry baggage and to be available in the event of poor road conditions (i.e., pulling vans out of mud holes).

• Per Diem: As with all travel, an instructor per diem for travel days between the United States and the host country was included.

• Entrance Fees: The bulk of our course is spent in national parks and national reserves. While we have often been able to negotiate a reduced entrance fee or no fee at all due to our education group status, we have never been sure of this expense until arriving at the park or reserve gate. We encourage you to budget full-rate entrance fees, as the actual fee will remain an uncertainty until you arrive at each destination. Being prepared for full-fee entrance rates is crucial because there is no guarantee that prearranged reduced rates will be honored.

One such situation occurred at a national reserve. Reduced rates had been previously arranged for our group, but upon arrival, we found out that a lack of communication among park officials made a reduced fee for our entire stay within the reserve boundaries unrealizable, regardless of our negotiation efforts. Although this is an isolated case and we have been fortunate in avoiding full-rate fees for the majority of our site visits, we highly advise you to be prepared for any mishaps.

• Lodging: Most of this class is supported and enhanced by visits to national parks and reserves. Because many of the lodges are located within the boundaries of the national parks and reserves, the availability for lodging is limited; sometimes leaving only one or two possibilities. We strongly recommend reserving spaces early to ensure accommodation of large groups. Often times, meals are included in the overall lodging fee. This needs to be investigated, however, for each lodge. If you can arrange lodging at different sites with the same company that provides transportation it saves time and effort expended when paying bills. Additionally, wiring of funds to secure lodging also becomes less cumbersome.

• Meals: While most meals are covered with lodging arrangements, the cost of some meals, especially while in transit from one area to another, will need to be taken into consideration. For our trip, this was a relatively minimal expense as most of our meals were provided by lodging facilities.

• Miscellaneous: These expenses include all other costs (tips, immunizations for instructors, exit taxes, instructor VISA's and passports, course packet binding, incidental expenses of instructors, water, and wiring of funds). These costs will vary depending on the country to be visited.

TUITION FEES: In addition to program costs (i.e., in-country travel, instructors expenses, lodging, meals) and airfare, students also pay course credit to participate in the class. Costs for course credits are set by the University and generally are considered separate from other program costs and are not a part of the operating budget. We deemed six credit hours necessary for this course. The number of credit hours for a class such as this is based on the amount of academic work required of the students and number of contact hours with the instructors as well as the need to cover costs associated with class development, Office of Study Abroad overhead, and the instructional budget, (i.e., faculty salaries, honorarium). These items are detailed below.

• Instructor Salaries: For those on a 12-month appointment, overload pay may be appropriate. The same consideration might also be given to accompanying graduate teaching assistants. Depending on the level of involvement of the teaching assistant, we allotted up to $1,000 for an individual's participation.

This amount, $1,000, is appropriate when a teaching assistant is instrumental in promoting and contributing to the program's success. An example of how we justified such an award arose from a unique situation. One of our teaching assistants for the class was performing research in Kenya and had lived there for eight years. This person arranged many of our guest speakers, faxed messages back to the United States, gave presentations, and ensured an adequate water supply for the class participants. This teaching assistant's efforts allowed instructors to focus their attention on their primary task of class delivery.

• Honorarium: For guest speakers a nominal fee, for example $40, was paid to recognize their contribution to the program. If our guest speaker shared a meal with us, we covered that cost as well. Conversation during these meals provided an added bonus. Often times we could secure their participation in our program for subsequent years. Resident experts, who may not be included on the guest speaker roster, can add dimension to the country visit, as well. These experts, at times, accompanied us on excursions. During their stay with us, we covered honorarium, lodging and food costs. Their presence awarded us with cultural information which, may or may not have been relevant to the course, but enhanced the overall experience the students had while in Africa.

• Administrative Expenses: This includes costs associated with brochure production, advertisement, telephoning and faxing, and overhead charged from the Office of Study Abroad. If you are not working with a Study Abroad Office, costs associated with overhead may not be realized.

AIRFARE: The final cost for which students will be responsible is their own airfare. We highly recommend working with an experienced travel agent when purchasing tickets. Although students on this program can arrange their own flights, we also worked with a travel agent to obtain consolidator tickets. Because this reserves a section of tickets, fares are lower than if booking individually. We encouraged students to purchase these consolidated tickets because of the lower fees, and in securing these tickets students were able to travel together with instructors. This, therefore, relieved some of the anxiety of students and parents on departure day. We encourage you to book your flights as early as possible and to verify with the students that their tickets are in order. When traveling to Kenya you must also obtain a VISA to enter the country. A travel itinerary is necessary to process this paperwork, thus it behooves you and the students to obtain tickets as early as possible to avoid any unnecessary last minute worries.

In keeping with the financial arrangements of the program, wiring of funds before traveling is an issue which we feel necessary to address. Because no funds were wired in advance the first year we traveled, we were forced to find creative ways to carry substantial amounts of money. Obviously this caused unnecessary stress. This stress was compounded at the end of the trip because almost an entire day was needed to pay bills. This cut into class time and removed some of the instructors from contact with students.

If at all possible we recommend wiring funds in advance not only to secure lodging and vehicles, but to reduce the anxiety associated with carrying thousands of dollars "on person." We recommend that prior to wiring funds that you verify that a procedure exists with your school to allow this easy transfer of money. Miscommunications among different units in a university can cause discrepancies in how and when funds get wired and may potentially impact the efficiency of the class.

Impacting the final cost of traveling abroad is the number of students participating in the program. In most cases, the greater the number of students participating in the program, the lower the program cost is per student. However, when there is a greater number of students, there is a chance for less group adherence and less individual attention for students from instructors. Often times, larger groups make it more difficult to transmit and share information thus reducing the quality of the overall experience.

We debated about the number of students that could participate in an educationally stimulating and enjoyable program. For the first three years of the program, 16 or 17 students participated per year. Based on comments from the students, this class size proved most effective. However, to accommodate the growing demands of this program, our Office of Study Abroad asked us to increase the number of students we admitted to the class. Maximum number for our program now stands at 20 students. This number addresses the request of our Office of Study Abroad, assures quality of the educational experience, and also makes securing accommodations and transportation feasible. With an increase in size of the class, we were also able to include an additional teaching assistant for our instructors.

WHO GETS TO GO AND WHY?

For our first year, we depended on "word of mouth" and informal recruiting meetings to promote this course. As the program grew in popularity, "word of mouth" still proved to be our best method of advertisement. However, we continue to offer recruitment meetings, (approximately one per semester), publish brochures, (sent to a variety of other institutions and new students entering our Department of Fisheries and Wildlife), and enlist students through the Office of Study Abroad recruiting fairs and supporting documents (i.e., advertisements in the University paper).

Deciding which students qualify for participation in your program can be tenuous. In the first year of our program, all students who applied to the program were admitted. Students educational backgrounds covered a wide range, from fisheries and wildlife to art history. The diversity of this group proved exhausting at times because students with a strong science background often felt as if they were required to "carry" their fellow students who did not come from a science-based program. Instructors were often required to bring non-science based students "up-to-speed" to allow for a smooth flow of program material.

This class is science based in nature. Initially, applicants were only required to have an introductory biology or ecology course during their undergraduate studies to be considered for the program. Currently, however, we require a more advanced general ecology course or it's equivalent in order to be considered for the program. A minimum grade point average of a 2.0 is also imperative for admission to the program.

To help "weed" out students who are more interested in a vacation abroad than a study opportunity, students must submit a one-page letter of intent or interest stating their reasons for wanting to take the course. These letters also assist in determining which students have a good grasp of science-related topics. When reviewing files, we also take into account a student's level in school (i.e., junior, senior). Generally, we attempt to accommodate those students who are further along in their course of study as this may be their last chance to participate in an overseas study program.

In our class we must also take into account the ratio of males to females. In Kenya, it is generally not accepted that unmarried males and females share common sleeping space. We also cannot make the assumption that this practice is acceptable to all participants of the class. Because we house two students to a room we must have even numbers of males and females in the program.

After the selection process, we have a minimum of two pre-departure meetings in the semester preceding the overseas course. In the first pre-departure meeting, at which we also invite parents, we concentrate on logistical information. We review the class schedule with the students and discuss passports, VISA's, airline tickets, and general health and the wellness issues students should be aware of prior to traveling to a different country. In addition, we discuss customs of the host country and basic etiquette by which we expect students to abide.

Although health and wellness issues are covered mainly in the first pre-departure meeting, at both pre-departure meetings we highlight and remind students of issues related to sex, alcohol and drug use. Our Office of Study Abroad covers issues related to sex, drug and alcohol use, and provides a variety of supporting literature related to these topics. While it may seem unnecessary to discuss these topics, we have found it invaluable to remind students that these issues are of grave importance to their health and well being, as well as being important to the success of the program. Students MUST also be reminded that in the event they are found breaking the law in the host country, we, as instructors, have little recourse or authority to assist them.

Being straightforward about our expectations of students is crucial. Reminding them that this is a full-fledged course requiring the active participation of every student is important. Although students will experience the culture and beauty of the host country, the first and foremost reason for being in this course is for educational gains. It is at that time that we encourage those students who do not feel they are able to work and participate under these expectations to remove themselves from the program. We also remind students that if we, as instructors, feel that their behavior on the course is detrimental to the program as a whole, we reserve the right to remove them from the program and send them back to the United States at any time.

Our second pre-departure meeting serves two functions: First, to check to see that students are moving along with acquiring passports, VISA's, and airline tickets, and second, to distribute the first assignments for the class. (These assignments are discussed in detail in the next section.) During this meeting, we also have a formal lecture period to discuss basic principles of wildlife management so that all participants have the same core background. Because we get students from a variety of science backgrounds, (biology, zoology, fisheries and wildlife), we found that this second meeting and formal lecture were beneficial. Valuable time in the host-country was not taken up covering basic topics of wildlife management. Students were also ready to "dive in" to their in-country assignments immediately after arriving in Kenya.

THE COURSE IN-COUNTRY

At this point, all of the details have been covered that are relevant to getting you ready to travel. Although left to the last section of this document, the course material is obviously one of, if not the most important feature of *African Wildlife Ecology and Management in Kenya*. What students should take away with them at the end of the course are highlighted next.

By the end of the course students should be able to:
- discuss the dynamic nature of Kenya's ecosystems and the human-wildlife conflicts which exist within them
- plan and develop wildlife management plans to achieve multiple use objectives for Kenya's wildlife resources
- explain how habitat components and characteristics impact populations of selected species in Kenya
- describe various population analytical approaches and apply them to monitor population trends of selected wildlife species
- describe various types of human impacts and their effects on wildlife habitat, populations, and local economies
- discuss approaches to maintain Kenya's biological diversity.

To meet these objectives, the course was structured around visits to four National Parks and one National Reserve (see Table 1 for schedule). Financial constraints on the students and time constraints on the faculty necessitate offering the class as an abbreviated course of approximately three weeks in duration. Because this is an intense six-credit course, we opted to restrict our visits to fewer areas for extended periods of time. We believe that this provides the student with a more in-depth understanding of the conservation and management issues because more time can be spent investigating issues and pondering ideas. Additionally, by restricting the course to a few selected parks we can minimize travel time and maximize educational opportunities. The order in which the parks and reserve are visited was selected to expose the students to increasingly more complex conservation issues and a variety of ecosystems.

Within the travel schedule, every day maintains a schedule of its own. Some mornings and afternoons are reserved for lectures or particular cultural events (e.g., a visit to the Birikini Women's Cooperative Group) or trips to selected areas in the park (e.g., the Rhino Sanctuary in Tsavo West).

During mornings and afternoons when a lecture or other event is not scheduled, the group participates in "game drives." Vans in which we travel become rolling classrooms. Each van holds four to eight students, an instructor and usually a Kenya

Wildlife Service (KWS) researcher or warden. During game drives students collect data they need to complete their assignments. Instructors and accompanying guest serve as guides of the areas visited. Presentation is fairly informal which allows for easy dialogue between the students and faculty. It is the responsibility of the students to engage in discussion and pose questions to the "guides" to gather the needed information to enhance their projects.

Evenings are reserved for guest speakers, lectures, and free time for students to write in their journals and/or work on group assignments. All daily schedules are flexible and adjustments for inclement weather and broken down vehicles are invariably required. Because a typical day lasts from sunrise until 10:00 or 11:00 p.m., free time is scheduled at regular intervals as part of the agenda. This free time is usually in lieu of an afternoon game drive. This gives students some down-time to socialize and relax. We do, however, schedule an optional game drive during this afternoon free time period.

Table 1. Itinerary for 1998 Overseas Study Trip

May 15 - 16	Travel: Detroit - Nairobi
May 17	Nairobi National Park
May 18 - 21	Tsavo East National Park
May 22 - 24	Tsavo West National Park
Tsavo East Management Plan Presentations	
Student Journals Due	
May 25 - 28	Lake Nakuru National Park
Lake Nakuru Research Proposal Presentations	
May 29 - June 2	Maasai Mara National Reserve
Maasai Mara Management Plan Presentations	
June 3	Nairobi
Shopping at the Central Market	
Course Review/ Student Evaluations	
Student Journals Due	
June 4 - 5	Travel: Nairobi - Detroit

Assignments and the grading policy are detailed in the syllabus, discussed during orientation meetings and included in the course packet. Grades in the course are determined by performance on seven assignments. Prior to leaving for Kenya, each student is required to prepare two one-page review papers (each worth 5% of the final grade). The first paper is a *Species Habitat Description* that requires the student to become the class "expert" on a selected wildlife species by becoming familiar with the habitat requirements of that species. The second paper is an *Africa/Kenya Topic Paper* and requires the student to become the class "expert" on a social, economic or conservation issue (i.e., *Overview of Kenya's Demographics, Ecotourism in Kenya, Maasai Culture, The Role of Zoos in Conservation*). Students are allowed to pick there own species and topic from a list prepared by the instructors. All review papers must be submitted to the instructors at least one week prior to departure and are all included in the course packet. Failure to submit either paper forfeits a student's right to participate in the course.

Throughout the course, students are required to keep a journal of their observations, experiences and thoughts (worth 10% of the final grade). Journals are collected twice during the course and are read by the instructors. Ten percent of the course grade is based upon participation. Students are expected to participate in all class discussions and discussions with invited speakers (i.e., area wardens, research biologists).

The three primary assignments are done in-country and are structured to increase in complexity in concert with the knowledge students are accumulating. Each of these assignments is tied to the issues at a particular park or reserve and each is done as a group project. Student groups are assigned by the instructors and group membership is changed for each assignment. For each assignment, each group must submit a written report and present an oral report of their findings to the class and guests (i.e., the area or park warden). All group members must participate in the oral presentation by giving a portion of the report.

All of the in-country assignments are groups assignments and each member of the group receives the same grade for the assignment. One of our primary reasons for having group and not individual assignments is the time available for grading. Once we are in-country there is very little "free time" available for class preparation and grading. It would be physically impossible to grade three individual assignments from each of 16 - 20 students. More importantly, however, we believe that having to work in groups enhances the student's experience. Group membership is assigned by the instructors to ensure a mix of academic majors and skill levels. Students bring different academic and social skills to the course. The group learning environment allows students with stronger skills in one area to assist those with less experience. As with on-campus courses, some students enjoy working in groups and others detest being dependent upon anyone else for their grade. We believe that the group assignments also help foster the camaraderie needed for a successful course.

On their first full day in Kenya, students visit Nairobi National Park to become familiar with some of the wildlife, habitat types and Kenya's conservation history, particularly relative to controlling poaching. This also provides an excellent and much needed opportunity for the students (and instructors) to get some of the initial awe and excitement "out of their systems."

At Tsavo East National Park in southeastern Kenya each group of four students is required to prepare a species-specific management plan (worth 20% of the final grade). For the Tsavo East assignment, students are only responsible for a

habitat and population management plan for their assigned species - they are under no obligation to consider any other species including humans. The students have about five days to complete the assignment. They do not have access to computers or a library. Because we must pack light, students are essentially limited to a calculator, human resources, data they collect in the field, and their course packet.

The lack of technical support and severe time restriction causes considerable stress in some students. All written reports must by necessity be hand written and visual aids for oral presentations are limited to colored magic markers and large sheets of paper. Despite repeated assurance by the instructors that while we expect high quality work, we do not expect the same level of performance that would be required back on campus for semester-long projects, few students believe this. We must be prepared to spend considerable time with each group helping them deal with the lack of technology and time.

Following a short visit to Tsavo West National Park, the second major assignment is given upon arrival at Lake Nakuru National Park. Lake Nakuru National Park is a relatively small park that is completely fenced, presenting a variety of unique management problems. Lake Nakuru National Park is completely bordered by farms and the town of Nakuru. For this assignment (25% of the total grade) each group must prepare and present a research proposal that focuses on a problem facing the entire Lake Nakuru ecosystem. Each proposal must include a statement of research objectives, methods of analysis, management implications, and a budget. Instructors grade the oral and written presentations, but KWS personnel are invited to the oral presentations and are asked to rank the proposals in terms of relevance, interest and "likelihood of funding".

The final assignment (25% of the final grade) is given at the Maasai Mara National Reserve and requires the students to incorporate the entirety of information they have received in the course. They must draw upon the lecture material presented by us, material presented by guest lecturers, informal discussions with KWS wardens and researchers and their own experiences. This assignment requires each group to develop a comprehensive management plan considering attributes of Maasai Mara's wildlife populations and habitat and socioeconomic values of the ecosystem. In short, they must consider all of the animals, all of the habitats, the tourists, and the local peoples.

Due to a lack of reference material in-country, we developed a course packet that serves as the student's primary written reference for the course. It is made available to the students prior to departure for Kenya and is required reading. It contains:

- the syllabus and travel itinerary
- a detailed packing list of what to bring and what to leave behind
- notes on collecting data and recording observations
- lists of the avian and mammalian species most likely to be observed
- descriptions of all of the course assignments
- copies of each student's *Species Habitat Description* and *Africa/Kenya Topic* papers
- readings (book chapters, thesis summaries, papers from the primary literature).

Grades are given on a straight percentage scale. The class is structured as an in-country experience and as such, all assignments are completed before we leave Kenya. Students usually receive their grades on the flight out of Kenya. The advantages of this are that we do not have to track down students in the United States for assignments and it provides students with immediate feedback. The 18 hour flight provides ample time to discuss grades.

CONCLUDING REMARKS

While we coordinate many of our efforts for developing an overseas study program with our Office of Study Abroad, we believe that similar courses can be developed and implemented in the absence of a main Study Abroad Office. For our program, we primarily rely on our Office of Study Abroad to produce brochures, accept applications, maintain student records, and wire funds. The remainder of coordination efforts are handled through the lead instructors of the course.

As a final note on the course - be prepared to return exhausted. We have found that taking a group of students to a foreign country is a uniquely rewarding experience. However, conducting an overseas study course must be viewed as a labor of love. When we are in-country, we are essentially with the students every waking hour. It is difficult to find time to grade assignments, much less steal a little free time to simply relax. We must assume the role of teacher, tour guide and parent. Being responsible for a group of adventurous young adults for three weeks in a foreign country is extremely challenging. However, there are few times when a teacher has the opportunity to witness a student realize that his/her life has been forever changed by what they have experienced. An overseas study course provides such opportunities.

STUDENT AUTHORING, EDITING AND ELECTRONIC PUBLISHING

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ABSTRACT: Millions of term papers have been written by college seniors who will be writing reports and publications as part of their professional responsibilities soon after graduation. While most term papers are graded and returned to student authors, a former student shared the observation that "nothing less than an 'A' is acceptable on the job." Writing assignments can be made more meaningful by giving student authors responsibility for their writing similar to those professionals have; their work will be edited, read and used by others. Student papers were first published on the Department's Cooperative Learning Center (CLC) local area network in 1991, after development of the Educators Software Package (ESP) for preparing hypertext information systems. Since then, over 2000 files have been published by CLC students in several courses. An immediate improvement in the quality of writing is observed when students know that the criterion for excellence is "acceptable for publication," and their papers will be read by students for years to come. Editorial guidelines remind students that disciplined scientific writing is different from creative writing. Student editorial boards monitor the progress of successive drafts, and data document improvement in writing as a result of the comments of student editors. The student-authored information systems, complimented by professionally-authored files, are accessed through course, subject, and species menus. Search functions enable students to find information on our CLC network that others have written, and links to libraries and the World-Wide Web provide access to other publications. While the information on our CLC network is of significant value to the students, the greater long-term value lies in the development of professional responsibilities for writing and editing. Rather than writing a term paper and taking what they get for a grade, our students write and rewrite until their paper is accepted for publication. Student editors, graduate assistants, and course professors help the students reach that goal, and when it is reached, everyone benefits, including students in the future.

INTRODUCTION

Millions of term papers have been assigned by professors, written by college students, read and graded by their professor or a teaching assistant, and then returned to the student author. Many of these students will be writing reports and publications for their job supervisors as part of their professional responsibilities soon after graduation. While it is customary to return term papers to the student authors with a grade in the range of "A to F," a former student commented that, on the job, "nothing less than an 'A' is acceptable."

Professors can make writing assignments more meaningful by giving student authors responsibility for their writing similar to those of professionals; their work will be edited, read and used by others. Professional-level writing should be the goal of all students when they are both learning to write and writing to learn. Writing should be an "authentic and natural activity" (Plevine 1982).

Professors need to be patient with student authors; success should be measured in long-term cumulative benefits rather than in immediate success or failure (Etheridge 1995). Professional researchers edit each others work before it is accepted for publication, and authors must follow a journal's publishing guidelines. Thus scientific writing should be thought of as a life-long learning experience by students and professionals alike.

This paper describes student authoring and editing in the Cooperative Learning Center (CLC) in the Department of Natural Resources at Cornell University, and the organization of the electronic information systems for student publishing on the local area network in the CLC. Student papers were first published on the CLC network in
1991 after T.N. Moen developed hypertext information system software called the Educators Software Package (ESP). Since then, over 2000 files have been published on our CLC network by students in several wildlife-related courses. S.R. Hall, the senior editor spring term 1997, has quantified and graphed the number of editorial comments on successive drafts.

He has also asked several former student authors and editors to share the effects of authoring, editing, and publishing on their writing skills, interactions with peers and professors, and their perceived implications for their future professional careers.

STUDENT AUTHORING

It is interesting to consider the number of hours college students invest in writing term papers relative to the number of hours readers invest in reading them. The reading audience is likely to be limited to a professor or a teaching assistant. One might estimate that writing and editing a term paper takes at least one hour per page, and reading about two minutes. The primary outcome of the reading is likely to be the grade, and the secondary outcome is the knowledge gained by the student. We suggest that knowledge gained and shared should be the primary outcome, and the grade secondary.

Students seem willing to take their chances when writing traditional term papers, deciding when a paper is done and accepting the grade assigned. In our setting, we have observed an immediate improvement in the quality of writing when students know that publication is the goal. Students realize that they are writing for "real audiences," an idea that warranted an entire issue of the Connecticut English Journal 15 years ago (Shugert 1983).

Writing should result in new knowledge acquired by the author; and sharing the written material with others multiplies the benefits of the author's efforts. While the grade should be secondary, its importance is not minimized. Rather, writing for real audiences makes the grade even more important because content that will be shared will be held to professional-level writing standards. We believe that our student authoring, editing, and publishing system promotes editorial improvements until student papers are acceptable for publication at a professional writing level. If they are not, what guarantee do we have that the first paper a new graduate writes in a new job will be professional-level writing?

Knowing that papers will be read by students for years to come is an important motivating factor for student authors. Improvement is immediate, and the cooperative learning environment in the CLC provides support and encouragement. We also benefit from having a course continuum in wildlife ecology and management (Table 1), which is a vertical integration of freshmen through graduate students in teams that work together toward common goals, similar to the vertical integration of career professionals where veterans and new employees are expected to work together (Fazzari and Moen 1996). Learning groups of 4-6 students are formed where students work together in goal-setting and project planning to meet team goals while individuals assume responsibility for their own research and writing. The student authoring and editing process in this interactive learning environment begins with project selection.

Project Selection

Undergraduate teaching assistants and senior management students help the students identify ideas for research projects, with the help of Professor Moen and graduate students. Students review published information resources on our CLC network and access the library databases for publications in journals and books. A final project idea is then submitted to undergraduate teaching assistants for approval.

Table 1. Students in the Wildlife Ecology and Management Course Continuum at Cornell University enroll in concept and application courses, and then work together in learning groups with students from each course.

NTRES 104 Natural History Information Management Concepts (1 credit)
NTRES 105 Natural History Information Management Applications (1-9 credits)
NTRES 105-1 Natural History of Plants
NTRES 105-2 Natural History of Animals
NTRES 105-3 Decision Aids for Laboratory and Field Identification
NTRES 204 Natural Resources Modeling Concepts (1 credit)
NTRES 205 Natural Resources Modeling Applications (1-9 credits)
NTRES 205-1 Biophysical Modeling in Natural Resources
NTRES 205-2 Simulation Modeling in Natural Resources
NTRES 205-3 Population Modeling in Natural Resources
NTRES 304 Wildlife Ecology Concepts (1 credit)
NTRES 305 Wildlife Ecology Applications (1-9 credits)
NTRES 305-1 Wildlife Behavior
NTRES 305-2 Wildlife Physiology
NTRES 305-3 Wildlife Nutrition
NTRES 305-4 Wildlife Energetics
NTRES 404 Wildlife Populations Ecology Concepts (1 credit)
NTRES 405 Wildlife Populations Ecology Applications (1-9 credits)
NTRES 405-1 Wildlife Population Estimating Techniques
NTRES 405-2 Wildlife Population Simulation Models
NTRES 405-3 Wildlife Population Reconstruction Models
NTRES 410 Wildlife Management Concepts and Applications (3 credits)
NTRES 498 Teaching in Natural Resources (1-3 credits)

Research Proposals

After selecting a project, a research proposal is prepared following guidelines in the Written and Oral Communications Information System (Moen 1998). Guidelines are given for writing titles, hypotheses, and objectives, and suggestions are given for describing methods, equipment, and data analyses. Proposals are written by each student and shared with the other students in the learning group before being submitted to undergraduate teaching assistants for editorial comments and approval. After the proposal is approved, students do library, laboratory, and field research, coordinating work within the learning group as they focus on a theme while demonstrating

relationships among natural history, organismal biology, ecology, and management concepts.

Publication

Each of the students in a learning group writes at least one manuscript to be submitted for publication in information system on our CLC network, including review papers based on library research and original research in the laboratory and field. Students are encouraged to outline their manuscript drafts before they begin writing, using the outlining option in word processing software. This concept is introduced to students in the Natural History Information Management course in the continuum (Table 1), and students in other courses in the CLC (Moen *et al*. 1996) who have not had the information management course learn about outlining software with the help of other students. Students then write their manuscripts and share them within the learning group. After responding to comments and suggestions of their peers, student authors submit their manuscripts to the student editorial board as the first step toward publication on the CLC network. The editorial procedures which follow are discussed next.

STUDENT EDITING

Traditional term papers have been a valuable part of higher education for a long time, even if they have only been read and graded rather than edited and improved. Now, however, students can work together more closely to bring term papers up to higher professional standards because of changes in student attitudes toward peer editing and revision that are directly related to the use of word processing software (Wright 1988). In our experience, students almost always respond positively to peer editing.

The idea for peer authoring and editing is not new. Reviews of collaborative learning by Gaillet (1992a, 1992b) indicate that peer editing in the classroom was promoted by Professor George Jardine at the University of Glasgow in the period 1774-1826. Recent publications promote authoring and peer editing as part of English composition classrooms (e.g. Dale 1997), but we suggest that it is especially logical for students to author and edit in science courses, because sharing research results through publications is standard procedure in the sciences.

When student authors know that other students will edit their writing for both style and content, they will consider and usually incorporate the editorial suggestions of the student editors, and discuss questions of content with them. Student editors may even have a better understanding of content than professors have. For example, Professor Moen, the senior author of this paper, completed a plant physiology course in 1964. A student who completes a plant physiology course fall term 1997 will likely be able to help a student who is writing on that subject spring term 1998 more than Professor Moen can. Because ecology is broad and complex, professors are setting a good example when they call on the knowledge of their students when evaluating student writing.

Teachers usually find a number of mistakes in student writing and it is often difficult to write helpful, perceptive comments on student papers (Grant and Shapiro 1987). Grant and Shapiro point out how teachers must decide what roles to play in their comments, such as coach, judge, or doctor. In order to help students become their own best readers, they also suggest that teachers should respond to student drafts in the way they respond to their colleagues' drafts—few judgments and directives, more questions and suggestions. We try to have students in the CLC approach editing in that professional way because it helps prepare them for professional careers where writing and editing will likely be expected of them.

While the student-authored information resources on our CLC Network are of significant value to current students, the greater long-term value lies in the development of professional attitudes toward writing and editing. Rather than writing a term paper and taking what they get for a grade, our students write and rewrite until their paper is acceptable for publication. Further, editing the writing of others helps students improve their own writing. Students become conscious of criteria and guidelines, and are reminded that disciplined scientific writing is different from creative writing. Interactions with a student editorial board help student authors improve their writing because, as one student pointed out "...it provided a step-by-step approach to reviewing my work and gave me a sense of cooperation from the editors with whom I worked." In a learning environment that permits intellectual flexibility and demands independent time management, another student noted that the editorial guidelines "...gave me structure when writing a scientific paper. The guidelines really helped give me a good idea how to set it up."

One of the advantages of student editing is that students tend to appreciate and to support each other's writing efforts. They tend to trust their peers (Pianko and Radzik 1980) and recognize common problems. The editing process in the CLC learning environment promotes cooperation with little perceived competition for grades assigned to papers among authors. Grades of "A" are not a limited resource; students earn that grade when their paper is acceptable for publication, our goal for all of the students in the CLC. As a result, one student felt that, "...other students gave more honest and helpful suggestions and edits, unlike other classes where peer editing was actually mired with competition."

Student Editorial Boards

Editing is a learned skill, and student editors need guidance when learning to be effective peer editors. Editorial guidelines are available in the Written and Oral Communications Information System (Moen 1998). We also hold an editing workshop at the beginning of the term to identify common

problems encountered in student writing and to call attention to the more unique ones that can be expected. The student editors learn things as simple as standard edit marks and as complex as the design of scientific papers. Edit marks can be made available with little discussion, while design considerations should be discussed in editing workshops. The student editors learn about professional journal guidelines (we use the Journal of Wildlife Management as our guide) and go over editorial comments on manuscripts that have been submitted for publication by professional scientists.

The student editors hold authoring and editing workshops for their learning groups early in the semester, calling attention to the importance of following editorial guidelines and the most common mistakes students make in this disciplined publishing setting. By identifying common writing problems, such as paragraph contents that do not build on the topic sentence, paragraphs that do not flow together, and captions that do not contain sufficient information, attention is focused on specifics that can be corrected early in the writing process. Such attention to detail carries over into the rest of their writing.

All of the undergraduate teaching assistants in the CLC are part of the student editorial board, and are responsible for both copy editing and content editing. While peer editors in the learning group should be sure that formatting guidelines have been followed, a student editor evaluates a submission for correct formatting first. If the guidelines have not been followed, the manuscript is returned to the student author. Manuscripts that are properly formatted are sent to student editors chosen for their knowledge of the subject for content editing, just as referees are chosen by professional journal editors.

Student editors monitor the progress of submissions, and provide feedback to student authors by E-mail and by returning written comments on the manuscript to students in their CLC mailboxes. When a student editor considers a manuscript ready for publication, it is submitted to Professor Moen with a recommendation for acceptance. Typically, student editors in the CLC review a manuscript two or three times before approving it. In this non-traditional environment that depends so much on the student editorial board, one student commented "…students fulfilled their editorial responsibilities very well."

Quantifying Student Improvement

Improvement in student-authored papers has been quantified by counting the number of editorial comments on successive drafts of 6 papers spring term 1997. Editorial comments were counted in three categories: copy, style, and content comments (Table 2).

Table 2. Examples of copy, style, and content editorial comments.

Copy	Style	Content
Spelling errors	Redundant statements	Factual incorrectness
Typographical errors	Awkward Statements	Information lacking
Spacing and formatting errors	More explanation needed	Illogical arguments
Words missing	Poor topic sentence, or none at all	Ecological significance not clear
Grammatical mistakes	Poor paragraph structure	Statistical analyses inappropriate
Punctuation errors	Poor word choice or phrasing	Captions not informative
Citation needed		
Incorrect table and figure references		

The number of editorial comments declined with successive drafts as authors incorporated the suggestions of student editors; there were about half as many comments on the second draft as there had been on the first draft (Figure 1). The numbers of editorial comments related to copy, style, and content categories are shown in Figure 2. Note that student editors identified copy editing problems more often than style or content problems, with improvements in all three editing categories as manuscripts were revised up to six times.

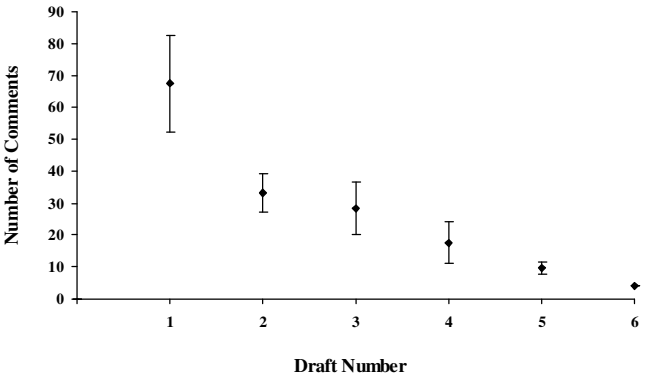

Figure 1. Average number of editorial comments made (± 1 SE) by student editors and Professor Moen on 6 successive drafts of papers approved for publication during the 1997 spring term.

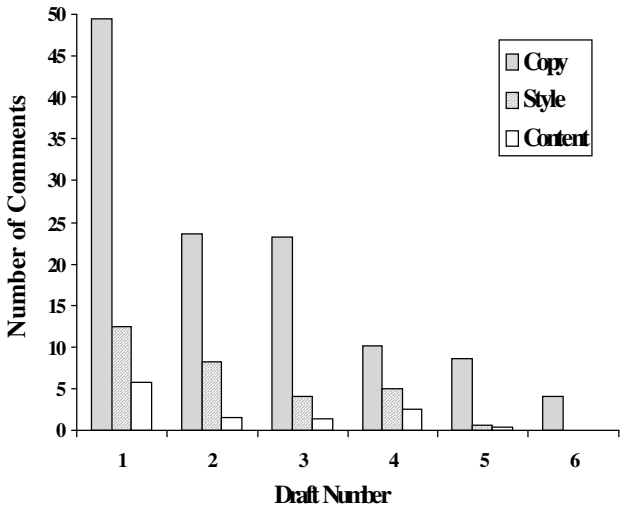

Figure 2. Number of copy, style, and content editorial comments (± 1 SE) by student editors and Professor Moen on 6 successive drafts of papers approved for publication during the 1997 spring term.

As student editors reviewed papers, the number of comments made declined because authors incorporated the comments and papers improved. However, on submission to Professor Moen, the Editor-in-Chief in the CLC, the number of comments increased again (Figure 3). The distribution of the number of comments made is bimodal; student editors identified many errors and professional-level editing identified several more that student editors had overlooked. Particular improvements were noted in topic sentences, making sentences clearer, using simpler words, and clarifying ideas.

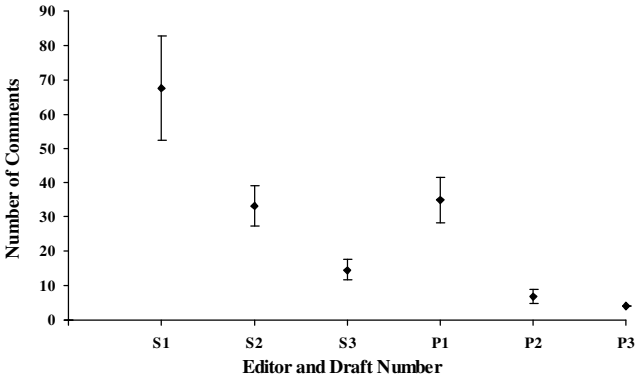

Figure 3. Number of editorial comments (± 1 SE) on drafts reviewed by student editors ("S" + draft number) and Professor Moen ("P" + draft number) on the 6 successive drafts. The number increased (P1) when Professor Moen edited the student papers because he suggested editorial changes that student editors had overlooked.

Ideally, student editors would reduce the number of copy editing comments that a faculty editor would have to make. Even though Professor Moen still found a number of copy editing problems after students had edited two or more drafts, the edited drafts were much better than the first draft of a typical term paper.

Challenges in the Editing Process

A new approach to writing in a rather different learning environment presents challenges to student authors. A range of prior research and writing experience should be expected when a group of new students assembles, and there is a range of writing abilities to draw on among student editors. It is important for professors to remember that students are learning how to write, learning how to edit, and learning how to read each others work critically. A range of student experience with research and writing should be considered normal in every class, with variations from year to year. Recognizing that, it is logical to provide new students not only with the technical help they need but with writing and editing models to follow. Writing models should include examples of professional writing and editing, perhaps from their professor's own experiences. Editing models should include the professor's editing of sample pages written by student editors in a "revision workshop."

One major challenge in the editing process is the amount of time that editing and rewriting requires; the time commitment by student authors and editors can be substantial for a 5-page paper. One student stated that "Time was a main issue. Authoring and especially editing took a lot of time in my schedule," and another said "The time it took for completion of my papers seemed like forever. I couldn't just finish...." For students with already challenging workloads, the time commitment to prepare a paper for publication could be overwhelming at times. One student compared writing traditional term papers with CLC papers: "Typically, other classes involve no editing. You write the paper, make some minor revisions, and turn it in. In the CLC I rewrote my paper more times than any other in my entire life. Each rewrite taught me something different, though, which made the whole process a valuable experience."

The need to establish personal timelines for project completion accompanies the time spent rewriting papers. One student said "The most challenging aspects of the process was being able to set my own deadlines rather than being told specific due dates." Another student commented "Since the class

has a more unstructured atmosphere, it took more discipline." The intellectual freedom granted to student authors can cause frustration at times; one student pointed out that "it is a lot easier to be told what to do than to have to think through the process and decide which is the best way to do it."

The regular student-student and student-teaching assistant interactions in the CLC result in an increased potential for conflict among students compared to traditional lecture and term paper settings. One student described the most challenging aspect of authoring and editing as "…rethinking and reworking parts of a paper I thought were good when comments indicated a need for improvement." Feelings can be hurt when one's writing is challenged, because words are a personal expression of an idea. Most students are not accustomed to receiving formal editorial criticisms from their peers and may not be prepared to deal with negative comments from them. This is part of the total learning experience, however; both authors and editors need to learn how to interact professionally.

Students who are new to this approach are encouraged when working with more experienced students who are enthusiastic about peer editing. Student-student interactions are one of the key factors for success in college (Astin 1992), and care should be taken that unskilled or uncommitted students are not grouped together (O'Donnell 1980). Matching more qualified students with less qualified ones can be good strategy if the more qualified ones serve as good models and help improve the qualifications of their coeditors. Everyone benefits from grouping students with varying qualifications: authors learn more about subject matter as they write and how to write better when they receive editing help, and editors learn about both subject matter and editing as they help other students.

Since student authors and editors have varying levels of writing and technical abilities, differences in editorial comments from different student editors are expected. These differences can confuse student authors accustomed to receiving inputs from one graduate teaching assistant or one professor. Our students commented..."Some teaching assistants have differing opinions, resulting in a lack of continuity in the editing" and "there were large differences in how people edited the papers." One student said "I noticed that if I did not have the right student editor look at my paper, I didn't get good feedback."

Student authors are convinced that the authoring, editing, and publishing process results in a superior finished product. Intensive peer editing "helps us learn from our mistakes" and "the quality of writing increases with each revision." Students shared additional comments such as "I think it is a great idea to get students used to the kind of writing we did…it feels really good to get something published…the teaching staff was always helpful, ready to listen, and really interested in what I was doing…I definitely have a better grasp of communicating my words and thoughts." The final student-edited manuscript has much more value to the author, editors, and other students than much longer traditional term papers do; we conclude that the time invested is well worth it. After reading dozens of papers that have been improved by having student authors and editors work together leads the senior author of this paper to conclude that most students are good writers. Complaints about their writing should be directed at the process rather than the product.

ELECTRONIC PUBLISHING

One of the most compelling reasons for promoting student authoring and editing is the potential to increase dialogue among students using hypertext-based information systems. Collaboration in writing should not be confined to authorship and peer editing, but should include dialogue with readers as well (Hunt 1992). Knowledge acquired by both students and teachers should be shared, and hypertext links make that feasible. Making meaningful information connections within classes and among successive years of student publishing by using hypertext links is so new that professors and students are still learning how to use it effectively.

Electronic Information System Design

Publishing on electronic information systems is different from publishing on paper. Files in an electronic information system need to be written with guidelines that assure uniformity among files. Page formats should be pleasing to see and easy to read. File length should be limited to a few screens, since broad subjects can be divided and divisions linked wherever related contents should be connected.

Files in the information systems on the CLC network are expected to contain appropriate multimedia components, with the text supplemented by graphs, tables, images, audio and video clips, and executable models (Boomer and Moen 1996, Runge and Moen 1996). Each of these additions to the main text or "alpha" file enhances the educational value of the file by engaging readers in more active involvement with the file subject. Electronic publishing involves much more than writing a traditional term paper.

Information System Menus

Each information system has a menu. New information systems are created with the ESP software by using a menu as the initial file. The software finds not only the files listed on the menu, but all other files linked to these menu files before compiling the information system. Sample menus from some of the information systems on the CLC network are found in Tables 3-5. These sample menus are very abbreviated as indicated by the ellipses (...) after most menu entries, and many of the files are accessed from a number of different menus.

Course-related menus. Course-related menus are based on course titles and numbers. Course menus are accessed by students at the beginning of a term in order to learn more about the course, plans for the semester, names of teaching assistants, and other pertinent course information.

Table 3. The course-related menu on the CLC Network.

NTRES 104 Natural History Information Management Concepts
NTRES 105 Natural History Information Management Applications...
NTRES 204 Natural Resources Modeling Concepts
NTRES 205 Natural Resources Modeling Applications...
NTRES 304 Wildlife Ecology Concepts
NTRES 305 Wildlife Ecology Applications…
NTRES 404 Wildlife Populations Ecology Concepts
NTRES 405 Wildlife Populations Ecology Applications...
NTRES 410 Wildlife Management Concepts and Applications...
NTRES 498 Teaching in Natural Resources...

Subject-related menus. Subject-related menus list typical subject areas such as anatomy, behavior, nutrition, physiology, etc. The entries do not represent specific courses in these subject areas, but identify all of the files on the CLC network that pertain to these broad subject areas.

Table 4. Abbreviated subject-related menu on the CLC Network

Anatomy and morphology...
Behavioral ecology...
Biometeorology...
Natural History...
Nutritional ecology...
Physiological ecology
The concept of biological time
Baseline metabolism
Body temperature rhythms, white-tailed deer
Chemical composition of milk, moose
Chemical composition of milk, white-tailed deer
Physiological thermoregulation
The concept of homeothermy
The thermal energy environment
The concept of critical thermal environment
Population ecology...

Species-related menus. Species-related menus provide students access to all of the published files on the CLC network that pertain to a particular species. Species menus are used by students in the Natural History Information Management course early in the semester when they are reviewing published information on different species and selecting a species of interest to them as the subject of a natural history file. Students in the modeling, ecology, and management courses do research and publish on selected aspects of species ecology and management.

Table 5. Abbreviated species-related menu on the CLC Network.

Canidae
Natural history, gray fox (*Urocyon cineroargenteus*)...
Natural history, coyote (*Canis latrans*)...
Cervidae
Natural history, white-tailed deer (*Odocoileus virginianus*)
Body composition, white-tailed deer
Body temperature rhythms, white-tailed deer
Food habits, white-tailed deer
Heart rate responses of white-tailed deer to snowmobiles
Milk production, white-tailed deer
Weight rhythms, white-tailed deer

Using the Cooperative Learning Center Network

New students begin using the CLC Network immediately, accessing student-authored information first. This impresses on them the importance of previous student's work and of their own work in their first term. We discuss appropriate file subjects and file length, describe the concept of hypertext and information relationships, and introduce the Written and Oral Communication Information System (Moen 1998) where they find suggestions, guidelines, ideas, templates, and more. They also access libraries and the World-Wide Web, learn how to search effectively, and how to select relevant information from the large amount available.

Students in any one of the courses in our course continuum (see Table 1) have access to the concepts from all of the courses in the continuum. Students in the course on natural history information management, for example, are expected to access the modeling, species ecology, population ecology, and management course concepts, giving them a broad picture of wildlife ecology and management as well as a larger context for their own work.

Using the World-Wide Web

The World-Wide Web (WWW) , with its powerful searches and hypertext capabilities, has added a whole new meaning to the term "information delivery" in higher education. In the past, large amounts of information were delivered by lecture because it was an efficient way for professors to summarize the results of many hours of library work and years of education for their students. Lectures are still effective, but the role of lectures has changed. Now, lectures can focus more on

concepts that should be discussed rather than on information delivery, since the more straightforward facts can be delivered electronically. Professors can deliver course information electronically that was delivered by lecture in the past, and well-written professional files serve as models for students to follow.

The computers in the CLC are linked to the libraries at Cornell and to the WWW. How important is it for college professors to help students learn how to review not only traditional publications but also information resources on the WWW? An elementary school in Minnesota uses the Internet as a collaborative tool, an information resource, and a medium for student publishing because it is imperative that educators use the WWW (Collins and Collins 1996). Students in a rural elementary school in Ohio have published over 1,500 original books and poems since 1990 (Massey 1995). Current elementary school students using WWW resources and publishing will expect to use such up-to-date resources and creative learning activities in college.

Expanding Publishing Opportunities for Students

The potential for expanding student and faculty publishing opportunities is almost beyond imagination. Students in wildlife ecology and management at Cornell have been publishing on our local area network since 1991. Now we are developing a CLC Web Page that will be the access point to these publications spring term, 1998. Students enrolled in the wildlife ecology and management continuum courses will be able to access Professor Moen's Main Concept Book and other files from any computer.

The potential for global distribution of student and faculty writing will inevitably bring changes to higher education. Information is equally accessible to professors and students, and the line between student and teacher is less marked now than ever before. Perelman (1992) applies the term hyperlearning to "...a wide-open community of practice, where learning is by doing..." and "...the roles of apprentice and expert are continually shifting with the demands of the problem at hand..." The lines between universities, geographical locations, programs... are all fading. Imagine the potential for cooperation among Universities at the program level, and for cooperation of students and faculty working on similar research problems. The vision for a "community of learners" described by Perelman (1992) may be realized sooner than we think. College students should not be considered empty vessels to be filled, but colleagues on a quest for knowledge in a setting that relies much more on lateral transfer than on vertical transmission of knowledge.

CONCLUDING REMARKS

Students enjoy writing and learning in any subject more when they are given encouragement and support. Recognizing the value of student-authored work by publishing on a local area network promotes interest and a feeling of accomplishment among students. In the Cooperative Learning Center at Cornell University, we are learning how to promote cooperation and collaboration among students, and how to design an authoring and editing environment that will be challenging and rewarding to students. We are convinced that will, not wealth (Perelman 1992) is the key to success in this endeavor (Moen and Decker 1996).

Knowing that students will read what other students have written, both professors and students need to be more conscious of correct content. Fewer pages with correct content are better than more pages with questionable content. Shorter files connected by hypertext to related files are better than longer ones that stand alone. Writing assignments should be shorter if quality and the amount of learning is inversely proportional to length.

An important feature of a learning group in the CLC is its vertical integration . . . freshmen through graduate students learn together, and each person makes significant contributions to the group, demonstrating the true characteristic of "hyperlearning" (Perelman 1992) as they share their ideas and expertise. In order to do this effectively, each student must assume responsibility for his or her own learning because no professor, or even a large number of graduate teaching assistants, can or should watch over the students to see that they "do their work." A student who graduated two years ago wrote: "Although it can sometimes be difficult to work as a member of a team, it is commonplace in the professional world. There, projects and ideas are often undertaken by members of a team and if not, they are certainly under scrutiny by co-workers and employers."

Student learning, not teaching, is the focus in the Cooperative Learning Center in the Department of Natural Resources at Cornell University. Student authors, student editors, student readers, graduate assistants, and professors are all part of an education team that should strive to make the transition from student to professional as complete as possible, and life-long learning a reality. When we follow the guideline that what we do in our Cooperative Learning Center must be authentic relative to professional work, we are confident that our attempts are on track, and any failures we experience are due to our own inexperience and the impossibility of being the perfect teacher for every student.

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LENDING LANDSCAPE PERSPECTIVE TO NATURAL RESOURCES EDUCATION

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ABSTRACT: One of the more challenging aspects of natural resources education is to impart a landscape perspective to students in the course of professional instruction. This is one of the more subtle but important aspects of ecosystem-oriented forestry. The old adage that a picture is worth a thousand words pertains to this context, as does "water, water everywhere but not a drop to drink." There is abundant technological potential embodied in the several satellite remote sensors continually adding to an already vast warehouse of image data, but casting this digital image raw material in a form for ready viewing by students has heretofore required technically sophisticated infrastructure and run afoul of copyright restrictions on sharing of such data. Recent developments in compressing image data for viewing and redistribution can resolve much of this difficulty. A "PHASE" compression of satellite data reduces it to a fraction of its media requirement, frees it from copyright restrictions, and makes it compatible with web downloadable no-cost viewers. Landsat thematic mapper data for the entire state of Pennsylvania have been compresssed in this manner to fit on a single CD-ROM and still leave room for a host of other data. An individual diskette will accommodate a chunk of landscape large enough to provide a backdrop for most settings in natural resources education. The PHASE software is shareware, and a little help from local remote sensing specialists should be sufficient for getting started.

INTRODUCTION

Natural resources education has tended to be locality oriented as opposed to vicinity oriented. In forestry, for example, silviculture and management usually focus on the stand as the unit of analysis and operation. For aquatics the stream reach, pond, lake or wetland is the unit of discourse for analysis and operation. For wildlife a patch of cover as a habitat component is often the unit of attention and prescription. On the other hand, we extoll the virtues of forests, wetlands, etc. in stabilizing and ameliorating environments more generally. Given a reasonably high level of environmental awareness among the general public, we shouldn't be surprised if the latter messages are taken to heart with consequent public concern for what transpires in the more naturalistic components of their environs where they lack direct land tenure. Our locality-oriented training, however, leaves neophyte natural resource professionals rather ill-prepared for objective public exchange regarding the likely implications of natural resource interventions at a specific place relative to other localities in the vicinity. Even many natural resource professionals with more experience in the field are little better prepared in this regard.

Cognizance of vicinity effects is implicit in the idea of ecosystem-oriented forest management, and is likewise central to landscape ecology (Forman and Godron, 1986). If a forester may not wish to subscribe to all of the formalisms and tenets of landscape ecology, the essentials of vicinity influence by forest can be considered in terms of stands and "standscapes." Landscapes (and standscapes) typically have the character of mosaics (Forman, 1995) in which there is greater or lesser degree of differentiation between and within the elements of the mosaic. The more similar the surrounding elements are to a stand, the greater will be the propensity for first-order effects such as fire and insects to propagate from the stand through the vicinity. The more dissimilar the elements in the vicinity, the more different kinds of potential spatial interactions must be considered along with distance decay curves for such influences. The problem is that vicinity issues remain obscure in the minds of students when considered in the abstract. It thus becomes critical to be able to present patterns of real landscapes in a visual manner to provide instructional context. Ability to depict the landscape following an intervention would also be helpful.

While considering one particular standscape will not sufficiently prepare students to deal with vicinity effects generally, having had explicit exposure to the process will help sensitize them to need for anticipating and mitigating influences of management actions that may extend beyond the target stand. Primary concern here is with technology for extracting landscape renditions from multiband satellite image data in a manner that makes visual presentations for vicinity context broadly and economically available. A mode of building upon this technology for depicting prospective management interventions is also considered.

LANDSCAPE VIEWS AS IMAGE-MAPS FROM PHASE-COMPRESSED IMAGE DATA

Regularly updated multiband satellite data having resolution of 20-30 meters over most of the globe have existed for a number of years. Therefore, technology for acquiring earth image data from orbit has not been the constraining factor. However, society has not been reaping the full measure of benefits from this technological investment for several reasons. First is that acquiring a copy of recent satellite based image data has been costly, to the tune of something on the order of $6K per scene. Second is that preparatory computer processing, analysis, and image generation has required hardware and software capability beyond the ordinary and also expensive. Third is that the level of technical sophistication required to work with the hardware and software has been relatively high. Fourth is that satellite data are generally copyrighted with a prohibition on redistribution except for derivative products that do not permit restoration of the original image data files. Thus printed images can be distributed, but not original data on which printed images are often based. But printing is fairly expensive both to do and reproduce. Finally, a large media requirement for multiband image data has required special storage facilities for use on any given computer installation.

Several recent breakthroughs have combined to make routine creation, usage, and even mass distribution of landscape image-mapping capability both feasible and economical. First is an exponential increase in both processing speed and disk storage capacity of personal class computers, which enables handling of image datasets that formerly required special computer configurations. Second is rapid evolution and decreasing cost of writable CD-ROM technology and accelerated readers. Third is some opening of the GIS and image data software arena in conjunction with the Internet and WorldWide Web that makes reasonably sophisticated software for viewing downloadable without charge. Fourth is a method of image data compression that not only reduces dataload but also transcends conventional copyrights on the original image data, to which attention now turns.

Most landscapes exhibit pattern when viewed from above, as when looking out the window of a rising aircraft. Such pattern, in turn, implies that there are areas of evident uniformity juxtaposed with areas having notable contrast. The areas of uniformity and contrast may or may not have definite geometric shape and repetition, since those are added qualities of some patterns. Since digital image data acquired from satellite sensors usually covers and often surpasses the spectral sensitivity of our vision, one can assume that pattern information is implicit to the data for landscapes where we experience visual perception of pattern from above.

The spatial layout for digital image data is a grid of cells, with the cells being called pixels which is short for picture elements. Pixels situated in more uniform areas must therefore have a pronounced degree of similarity relative to those for contrasting areas. In statistics, the extraction of unspecified similarities/dissimilarities is accomplished via a host of disparate mathematical heuristics that are generically called cluster analysis. Since implicit pattern in image data also implies redundancy, it is reasonable to expect that suitably conceived clustering should provide a basis for compression of image data. Clusters should thus correspond to (unnamed) cover types.

By way of some further background, clustering has long played a role in analysis of multiband image data. Its primary use has been in thematic mapping by the so-called "unsupervised analysis" approach. This entails first clustering, and then empirical investigation of cluster instances to determine how each cluster should be designated on the map. A rather modest number of clusters is usually sought in this context so that the empirical investigation involved in labeling does not become overly burdensome.

Kelly and White (1993) advocated considerably more clusters, and developed software for computer-aided labeling so as not to increase the overall workload excessively. The proliferation of clusters led them to call this "hyperclustering." Noting substantial expression of lanscape pattern in their hyperclusters led to the present development of a special hyperclustering methodology for image data compression which is specifically geared to capturing salient landscape features. This landscape oriented clustering has been dubbed PHASE, which stands for Pixel Hyperclusters Approximating Spatial Ensembles (Myers et al., 1997). PHASE formulation extracts as many clusters as can be handled by the chosen viewer software, up to the 255 maximum that byte binary image data formats will accommodate. Cluster mean values are used to approximate image data for the respective clusters. The software for PHASE formulation and analysis is treated as shareware (Myers, 1997). Since the within-cluster variability is expressed only statistically, distributing a PHASE formulation does not infringe on copyright for the original image data. A PHASE formulation has the further advantage that it can be used in GIS as a pseudocolor digital map.

PHASE compression obviously cannot take place without an image dataset to serve as raw material, and image data is still costly. Given one purchased copy, however, PHASE compression can provide landscape views to a number of others that is limited only by cooperative spirit and financing of distribution. There is a stipulation that the PHASE software not be sold for profit, but PHASE compressions are value-added products that can be a basis for commerce. The cost of procuring original data can be spread by group purchase, or financial inducement for PHASE formulation can be offered to a laboratory that has procured image data for other purposes.

A biodiversity research effort in Pennsylvania had access to satellite data for the entire state, and one goal of the research was to make spatially explicit information available to the

public. A computer vendor provided supplemental funding to assist in producing CD-ROMs containing PHASE compressions for general distribution. A single CD-ROM not only accommodated PHASE compressions for the whole state, but a variety of other GIS data like roads, hydrology, and county boundaries as well. Since a PHASE formulation compacts an earth view in several image bands down to a byte, this compact disk is called a Terrabyte CD. The Terrabyte CD is configured for viewing and analysis via the commercial ArcView GIS by Environmental Systems Research Institute (ESRI) of Redlands, CA. Among its many other potential uses, the Terrabyte CD offers the computer vendor a good promotional for running GIS systems on its line of computers. Several other partners also contributed buy-in and in-kind support to this production effort.

In a spirit of open GIS, ESRI has also recently made its new ArcExplorer GIS viewing facility available for downloading on the Web at the www.esri.com/arcexplorer address. ArcExplorer handles GeoTIFF image-map files. Plans are in place to reformat the Terrabyte files from grid coverages to GeoTIFF on another CD-ROM so that they become accessible to organizations such as public schools that cannot normally mount substantial GIS capability.

Another possibility for viewing in the absence of a regular GIS lies in the MultiSpec software that the LARS group at Purdue University makes available under NASA sponsorship for downloading via the Web at the http://dynamo.ecn.purdue.edu/~biehl/MultiSpec/ address. The MultiSpec viewer accommodates PHASE files as a thematic form, with a current limit of 230 clusters. It should also be mentioned that the PHASE software provides for partitioning and reassembly of image files to allow transport when high capacity removable media are not available.

MODELING LANDSCAPE VIEWS UNDER PROSPECTIVE MANAGEMENT SCENARIOS

The PHASE approach would also enable a relatively simple and straightforward adaptation of cellular (raster) GIS for modeling overhead views of landscapes under alternative management scenarios. This possibility arises from PHASE generation of several different color renderings for a landscape.

Some investigation of a PHASE landscape view in the manner of unsupervised classification analysis should serve to determine cluster identification number for a sample of each land cover type under study. The PHASE files can then be consulted to determine the corresponding color scheme for each of the land types. The next step would be to set up a parcel identification grid for the landscape under study. Each parcel could then be assigned to a land cover type in accordance with the prospective management, and a lookup table used to colorize the respective parcels accordingly.

Such modeled landscape views could go a long way toward lending spatial perspective to linear programming exercises as typically conducted in forest management classes. They would be especially valuable for considering the effects of management strategies on habitat integrity and connectivity. When used in conjunction with topographic maps or digital terrain models, they would likewise help to reveal the visual impacts of management on landscapes.

PHASE formulations further support adaptations of most analyses that are conventionally conducted on multiband digital image datasets. PHASE compression also has the effect of inducing explicit spatial structure, whereas spatial structure is only implicit in the original image data. The explicit spatial structure can be analyzed directly with the FRAGSTATS software of McGarigal and Marks (1995), which would not be possible for the original data without doing an intermediate classification.

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NATURAL RESOURCE EDUCATION: GETTING FOREST PRODUCTS WORKERS INTO THE FLOW

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ABSTRACT: The forest products industry employs over 1.4 million people in the U.S.; it ranks among the top ten manufacturing employers in 46 states. Surprisingly, a recent survey of U.S. forest products workers revealed substantial ignorance and misperceptions about forests and forestry issues. Despite this, few educational programs are targeted at this audience. The Oregon Forest Resources Institute has teamed up with Oregon State University's Forestry Media Center to fill this gap with Project FLOW (Forestry Learning Opportunities for Workers).

Phase one of this project, completed in summer 1997, analyzed the current status of forestry educational opportunities for forest workers in Oregon: existing educational activities, opportunities for new programs, and obstacles to implementing new programs. A mail-in survey, sent to human resource officers or chief executives of 590 forest products businesses in Oregon, indicated that it was important for forest workers to have reliable information about forestry topics. However, fewer than half those responding said that their company currently distributes educational materials or provides on-the-job learning opportunities. Principal obstacles cited were lack of time during the workday, lack of staff, and lack of relevant and effective educational materials.

Phase two of this project will use the survey data, as well as information collected from focus groups, site visits and telephone conversations with key stakeholders, to develop and pilot-test learning materials in various formats. We anticipate that materials developed through this project will have wide application throughout the United States – and that better-informed workers are likely to become better individual decision makers and more effective ambassadors for sound forest management.

INTRODUCTION

Public questionnaires commonly indicate widespread misinformation about natural resources. Surprisingly, many workers in the forest products industry share these misperceptions, even though their work puts them much closer to the subject than the average citizen. For example, 56% of forest products workers estimated the percentage of paper that is recycled in the U.S. to be one-half or less of what it actually is (Bowyer 1995).

The forest products industry employs over 1.4 American workers, placing it among the top ten manufacturing employers in 46 of 50 states (Bowyer 1995). In Oregon, it employs about 52,000 workers (OLMIS 1997). Although many educational materials on forestry topics are available, few seem to be targeted specifically at this audience.

The Oregon Forest Resources Institute (OFRI) is a state agency charged with communicating reliable forestry information to all Oregonians. OFRI recently identified forest products workers as one group who could benefit from their work. Their five-year strategic plan (OFRI 1996) stated that "providing [industry] employees with reliable information will help them better understand the condition and future of Oregon forests, and make them more comfortable communicating about… our forests."

The College of Forestry at Oregon State University (OSU) is widely regarded by Oregonians as the state's most trustworthy source of forestry information (Hibbitts 1997). About two-thirds of those polled said they placed a "great deal" or a "fair amount" of trust in OSU's forest scientists. No other group, except for state forestry officials, was trusted by more than one-third of those polled.

OFRI asked the Forestry Media Center staff to try to determine the best opportunities for improving natural resource education for forest products workers. Were educational materials aimed at the general public suitable for forest workers, or was there a need for new materials and methods developed specifically for the industry workforce?

We named this project Forestry Learning Opportunities for Workers, FLOW for short. Phase One of the project is a needs and opportunity assessment. Phase Two involves development of new materials, media, and methods, based on the findings developed in the first phase. This paper addresses Phase One, which was recently completed. Phase Two is not yet underway.

METHODS

We collected data using a variety of methods, including personal interviews, a written survey, telephone interviews, focus groups, and a site visit. This helped to ensure that we heard from a broad spectrum of the forest products community – including CEOs, human resource managers, public affairs and communications officers, plant supervisors, business managers, and line workers – as well as forestry educators from around the state.

Discussions With Forestry Educators

Before collecting any other data, we asked key OSU forestry extension personnel to describe current information delivery programs that might be appropriate for educational materials aimed at forest products workers. We also gleaned their ideas about potential content areas, and asked for a "reality check" on the goals of Project FLOW.

Two members of the Project FLOW team also attended a meeting of the Western Forestry Communicators (WFC), a group of trainers, educators, and human resource personnel in the forest industry – people who are responsible for disseminating company information to workers and/or the public. The FLOW team members described the project and received feedback about the opportunities and constraints of creating educational materials for forest workers. This gave us a preview of what to expect, and what hurdles we would possibly encounter along the way.

Industry Survey

To collect additional data on a larger scale, we mailed a written survey to nearly 600 Oregon forest products companies. Our survey targeted people responsible for overseeing or providing information to employees within their company (e.g. human resource managers, communication specialists, and CEOs). A list of approximately 800 forest products companies was generated from a CD-ROM database of Oregon manufacturers (Oregon Economic Development Department 1997). Standard industrial codes (SIC) were used to group the companies into four categories: 1) pulp and paper mills and paper product companies, 2) logging companies, 3) primary manufacturers (e.g. sawmills, veneer mills), and 4) secondary manufacturers (e.g. furniture and cabinet makers). Companies employing fewer than 10 people were eliminated, with the assumption that educational activities and materials would most likely be aimed at larger audiences. This reduced the number of companies surveyed to 590.

Survey questions addressed six basic concerns: importance attached to forestry education, the types of education currently offered, who it reaches, how information is conveyed, and where and when educational activities occur. To maximize feedback, the survey was designed so that respondents could merely check boxes or provide written responses if desired.

The surveys were mailed in May 1997, accompanied by a cover letter from OFRI, and a self-addressed stamped envelope. A follow-up reminder post card was mailed two weeks later.

Telephone Interviews

In order to "ground-check" results of the survey, the FLOW team initiated follow-up discussions with 25 respondents – about one-quarter of those who returned the surveys. We contacted respondents from all four sectors of the forest products industry, and from all over the state. We selected respondents who seemed supportive of Project FLOW goals, and those who included additional ideas and feedback on the surveys. Our aim was to ensure the clarity of the original survey questions, probe a bit deeper into the respondents' answers, get more details about current educational endeavors they were involved in within their companies, and discuss opportunities and constraints of Project FLOW.

Focus Groups

Three focus groups were organized in Portland, Corvallis, and Roseburg, to engage survey respondents in a face-to-face discussion. All survey respondents who indicated they an interest in attending a focus group were invited to attend.

Seven participants, representing all four categories of forest products companies, attended focus groups in Portland or Roseburg. Survey results and trigger questions from the FLOW team helped frame discussion. Participants shared examples of educational materials or events occurring in their organizations. Lastly, we presented a few scenarios of potential educational materials to gauge participants' reactions to different media, and to determine what elements or characteristics might be successful.

Site Visit

The FLOW team attempted to schedule several meetings with workers at representative companies, but due to busy sched-

ules at most facilities, we only managed to make one site visit, to a veneer mill in White City. We set up this event with the assistance of the acquisitions forester, who was particularly interested in our project. Because of the difficulty of assembling mill workers at one place and time (a mill can't be shut down during the work day), our only window of opportunity to visit with workers was during their half-hour lunch break. Notices advertising the event were placed in the workers' paychecks one week prior to our visit. Seven workers attended.

RESULTS

FLOW Survey Results

Response rate. Of 590 surveys mailed, 103 (17%) were returned. Considering that we followed conventional guidelines for mail surveys (Business Research Lab 1996), this was a disappointing return. The response rate varied widely by industry sector. Primary processors (sawmills, veneer mills, and paper mills) returned about 24% of their surveys, and logging operators returned about 22%. Returns from secondary processors were much lower, ranging from 13% for companies performing millwork to 5% for the manufactured housing industry.

Question 1: distribution of educational materials. Forty-two percent of the 103 respondents reported that their firm currently distributes educational materials about forests or forest management to its employees. This rate varied by company size. Nine of 14 companies (64%) with at least 1000 employees reported distributing forestry educational materials, while only 11 of 43 companies (26%) with fewer than 50 employees did so.

Question 2: on-the-job learning opportunities. Twenty-three percent of the 103 respondents reported that their firm offers on-the-job opportunities for employees to learn about forests and forest management issues. Again, company size affected these results. Eight of 14 large firms (57%) reported offering such opportunities; only 4 of 43 smaller companies (9%) did so.

Question 3: methods currently being used. For companies answering "yes" to either of the first two questions, the 3 teaching methods most commonly used included newsletters, brochures or fact sheets, and bulletin board postings. Methods least used were audio tapes, classroom presentations, and conferences or workshops.

Question 4: importance of forestry information and discussion skills for workers. Sixty-seven per cent of the 103 respondents reported that it was either "very important" or "somewhat important" for their workers to have reliable information about forestry and controversial forestry topics. Nineteen per cent said that it was "not too important," and 11% said that it was "not at all important." Results varied by sector. Nine of 10 softwood veneer manufacturers (90%) rated this item as "very" or "somewhat" important. So did 24 of 32 sawmills (75%), 15 of 21 logging operators (71%), and 5 of 9 paper mills and paper products manufacturers (56%). No furniture or cabinet makers rated it as "very important," and only 3 of 10 (30%) rated it as "somewhat important." One cabinetmaker who rated both items as "not too important" went on to say that "I fail to see the purpose of this survey. We use forest products, but we don't do forestry. Everyone who writes on paper uses forestry products."

Question 5: usefulness of existing materials and opportunities. Respondents rated brochures and fact sheets as the most useful formats for providing information about forestry and forest management issues, with a mean score of 2.05 on a 3 point scale. Newsletters were rated a close second (1.99), while posters, field tours and video programs shared third place (1.58). Computer-based learning was rated as least useful (0.81), followed by audio tutorial tapes (0.92).

Question 6: available technologies. Three-fourths of the 103 respondents said that VCRs were available on site for use in employee training. Two-thirds had computers, while one-third had Internet access. Only 3 respondents had satellite dishes.

Question 7: where forestry education takes place. The most common educational venue was safety meetings, cited by 23% of the 103 respondents. Other educational opportunities cited by respondents include: payroll stuffers, handouts, newsletters, and other printed materials (10%); company meetings (4%), general discussions (2%), presentations by lumber suppliers, and "on the job."

Question 8: obstacles to employee education. The biggest potential obstacle to creating and maintaining an effective employee education program was "lack of time during the workday." Seventy of 103 respondents (68%) described this as a "big problem." The next most important obstacle was "lack of staff to organize and implement programs;" 42 respondents (41%) described this as a "big problem." Third was "lack of relevant and effective educational materials," cited by 32 respondents (31%) as a "big problem." Other obstacles not specifically mentioned in the survey but cited by respondents include union contracts, lack of a suitable location, the topic being "not really relevant," "crews spread out" [geographically], and "employees want[ing] to use their spare time for personal needs."

Question 9: usefulness of potential products and activities. Asked about hypothetical educational activities or products that could be developed, respondents rated as most useful prepared newsletter stories, posters and displays, and video-based educational kits. Rated as least useful were computer-based information using the Internet, and self-study materials to be used on employees' own time. One respondent asked for "success stories, [because] the media focuses on the negative." Another stressed that newsletter stories should be "short and

simple." Yet another rated formal presentations and "train the trainer" events as useful, so long as they took place on the job site.

Question 10: communication skills development. Active listening and critical thinking were rated as the most important communication skills (they received weighted ratings of 3.41 and 3.38, respectively, on a 5 point scale). Facilitating educational events was rated as the least important (weighted rating 2.35). One respondent requested that an additional skill be added – teaching employees how to write letters to representatives. Another wrote that she was not interested in the program. A third respondent, while rating "good communication skills" as most important, took issue with the whole idea of communication skills training: "I wouldn't allow such a program. These categories are totally 'off the mark,' basically irrelevant to my business, & indicate psych[ological] behavior modification & influence."

Question 11: train-the-trainer. This idea received moderate endorsement from survey respondents, as long as it was convenient. More than a quarter of the respondents (30 out of 103) said that they would be very likely to attend an event designed to help organize or improve an employee education program, if it was held near their location, while 18 said they would not participate. These numbers were nearly reversed for an event held at OSU's College of Forestry: 13 said they were very likely to attend, while 30 would not participate. Only 6 respondents said they were very likely to view a satellite teleconference, while 36 said they would not participate.

Question 12: pilot testing new materials. Sixty of the 103 respondents (58%) indicated that they would be interested in pilot testing new forestry educational materials if they are developed. Interest among logging contractors was highest, with 17 of the 21 respondents in this category (81%) expressing interest. Nineteen of 32 sawmills (59%) responded positively, as did 4 of 10 softwood veneer plants (40%), and 2 of 10 furniture and cabinet makers (20%). All 4 paper mills were interested, but only 1 of 5 paper products manufacturers expressed interest, for an aggregate response from the paper industry of 56%.

Telephone Interview Results

Respondents generally reiterated opinions they had expressed in the written survey. Most information received in this step was anecdotal. Rather than attempt to summarize that information in this paper, we refer interested readers to our project report to OFRI (Hino et al. 1997).

Focus Group Results

The seven participants in the two focus groups were generally very supportive of project goals, but were unable to reach consensus about the methods required to reach those goals. Some unanticipated potential benefits from FLOW emerged during these discussions – improved morale and increased productivity for participating employees. On the other hand, some concern was expressed about companies' potential return on their investment in Project FLOW, and about how the project would fit in with company goals.

Site Visit Results

We briefly introduced Project FLOW to the seven workers present, then asked them what kinds of questions they get asked about forestry, what their current sources of forestry information are, and what types of additional information they would be interested in. It was difficult to confine the discussion to aspects of Project FLOW, as several workers used the meeting as an opportunity to sound off on other issues in the presence of "management." We did learn that most workers had access to *Evergreen* magazine, although they felt that it took too long to read each issue. *Evergreen* is published monthly by the Oregon non-profit Evergreen foundation, dedicated to restoring public confidence in forestry. It has a circulation of about 100,000.

DISCUSSION

In analyzing the vast amount of data received through the survey, telephone interviews, focus groups, and site visit, we realized that we had tapped into an incredibly complex issue. To organize our thoughts, and plan for future activities anticipated under phase two of the project, we used the data to answer the following twelve questions.

1. What Is The Current Situation Regarding Forestry Learning Opportunities for Workers?

Forestry education for the forestry workforce is already happening to a limited extent. Efforts are concentrated at larger companies within the primary processing sector (sawmills, veneer mills, paper mills). Methods used vary widely, but are generally passive (e.g. newspapers) rather than active (e.g. field tour), and generally do not involve employee release time. Notable exceptions include a large primary processing corporation that offers field tours on company time, and a secondary manufacturer that has periodic "lunch and learn" sessions in which employees take part in exchange for a free lunch.

A variety of well-made materials are available, although most are tailored to the general public rather than to the forestry workforce. Notable examples include *Evergreen* Magazine, videos from the Temperate Forest Foundation, and a Web site and printed materials from the American Forest and Paper Association. Most respondents were aware of at least some of these; many cited numerous other national, regional, and local providers of information.

Many companies, both large and small, produce company newsletters, and some produce videos and other materials.

While internally-produced materials may include information about forestry issues, their primary intent is usually to convey company-specific news and other information. Few companies have attempted to evaluate the effectiveness of employee education.

2. Does The Industry Think This Project Is A Good Idea?

We did not analyze non-response bias in our mail survey. Among the 17% of the industry representatives who responded to our survey, there is general agreement about the value of forest products workers learning more about forestry. Support is strongest among loggers and primary processors, and much weaker among secondary products manufacturers. This presents an interesting challenge: should we target those who seem most interested and may therefore be better informed, or should we target those who seem to feel less connected to the resource and may be more in need of accurate information?

3. Who Is The Best Audience To Target?

Our consensus was that we should focus on workers who are willing to invest some of their own time and effort to learn about forestry. We also felt that we should target line workers, because they are likely to have fewer learning opportunities than managers.

4. What Are The Incentives For Employees?

Potential rewards for workers to participate in forestry education are mostly intrinsic, intangible, and hard to measure. According to several respondents, one possible outcome for employees would be a more positive valuation of themselves, their company, their industry, and the contributions that each makes to society. Tangible incentives would come mostly from individual employers: recognition (such as positive feedback from supervisor, mention in a newsletter, a badge, a jacket, a lapel pin, a hat, etc.), paid time for taking part in education, or possibly career advancement.

5. What Are The Incentives For Employers?

Several potential outcomes, including higher employee morale, increased company loyalty, and greater community support, could contribute to companies' financial performance. However, all of these outcomes are difficult to measure, and a causal linkage with forestry education would be hard to prove.

6. What Are The Potential Impacts?

According to Jim Bowyer (1995), the principal benefit of a better-informed forestry workforce is the diffusion of information to the general public, ultimately leading to better decisions about how natural resources are managed. Other potential benefits include the ability to counter negative information in the press, and an improvement in the public's perception of what some have characterized as a "low-paying, dangerous, dirty business to be in."

7. When And Where Is Learning Likely To Occur?

Information overload. Information is already being presented to employees on the job in a variety of settings and using a variety of media, but there is already too much information that must be conveyed - training, safety rules, information on benefits, etc. In most workplaces, there simply is no more time available for learning about forestry issues on the job - it is categorized by managers as "nice to know" rather than "need to know." Competition is fierce, and it is difficult to prove that the costs of downtime or release time for forestry education are justified by any tangible benefits to the company.

Safety meetings. Many companies use these as a vehicle for occasional forestry education. Several respondents warned that this practice could dilute the effectiveness of the meetings' primary purpose (improving workplace safety) and should not be encouraged.

Overtime. Asking employees to put in extra hours for forestry education is probably not feasible. Union contracts may require overtime pay, and most workers want to get home as soon as possible.

Internal newsletters. As discussed earlier, most forestry education is via passive methods such as company newsletters. Some companies report that the effectiveness of these methods is improved with discussions at "tailgate parties" – informal employee meetings.

Break times. Most learning opportunities are likely to take place on employees' time. One promising way to capitalize on this opportunity is the "lunch and learn" where employees are exposed to new information during their lunch break, and the incentive to attend is free food.

Slack times. Some logging workers are faced with seasonal downturns in work, related to winter weather or spring bark slippage. There may be some opportunities to present workers with organized learning activities during these slumps.

Home. Highly motivated employees, probably fewer than 10% of the workforce, might take materials home with them if they are made interesting and attractive, can be easily understood, and require little time to absorb. Participation could be increased if suitable incentives are provided.

8. What Are The Advantages And Disadvantages Of Specific Media And Methods?

Newsletters/brochures/fact sheets. Print materials are relatively easy to produce and distribute. When well written, they provide an easy way for employees to get information and to pass it on to friends and family. However, even the best newsletters

will reach only a certain percentage of their intended readership. It takes a lot of skill and money to make educational materials as attractive as the printed advertising and information that people are bombarded with on a daily basis. Many workers will ignore materials that require more than a few minutes' attention. Other obstacles include the need to accommodate varying levels of literacy and education, different learning styles, and even language barriers brought on by an increasingly multicultural workforce.

Posters. A poster can be taken in at a glance, and can convey a simple message in a highly visual way. However, posters were regarded by respondents as being far less interesting than TV, and less effective at promoting critical thought or discussion.

Video. Many people prefer this medium for information as well as entertainment. Video is chiefly useful for changing attitudes rather than conveying a large amount of factual information. The biggest problem with video in this context is providing workplace viewing opportunities. A few highly motivated employees may take videos home for viewing. Other drawbacks include video's relatively high production cost for the amount of information conveyed, and its linear nature.

Web-based information. The World Wide Web is currently enjoying a meteoric rise in popularity. It has the advantage of presenting information as vividly as 4-color glossy print at a far lower cost; it can also be easily updated. However, only a few managers presently have access at work, and most workers will probably never have an opportunity to access the Web while on the job. Growing numbers of workers with Web access at home could easily access a forestry information Web site if they chose to do so – the problem, as with other media, is in competing for limited time and attention against all their other interests. A Web site could reach most workers indirectly, is by providing raw material (e.g. statistics, analysis, and news articles) for company newsletters in a cost-effective manner.Field tours. Experience is the best teacher. Field tours can provide a vivid learning experience for participants, and can be tailored to local issues and interests. But they cost more per participant than most other methods. Most companies seem unwilling to provide release time, so other incentives must be identified for workers who participate.

Classroom instruction. This time-honored setting for learning can provide for a greater degree of interaction and variety than most of the passive methods catalogued here. However, many workers end up in jobs that don't require advanced education precisely because they disdain the classroom. While some workers do continue their education at night school, the reward is usually a degree leading to a better job. Instruction in forestry issues would be unlikely to be popular, unless release time or other incentives were provided.

9. What Are Potential Content Areas?

Many workers have pressing concerns about current forest management practices. Why are some trees left standing after a harvest? Why are some trees left lying on the ground? Is there any good reason to continue clearcutting? Does clearcutting lead to landslides? Do log exports equate to loss of domestic jobs? Why are some fires left to burn? Often these questions relate to specific examples in the workers' neighborhoods. Managers expressed interest in increasing their workers' knowledge of the complete cycle of natural resource production and use: silviculture, harvesting methods, processing, consumption, and recycling.

10. Should Communication Skills Be Part Of FLOW?

The consensus seems to be that although communication skills are important, they would add further complexity to an already difficult project. Some feel that communication skills training on the scale feasible under FLOW is unlikely to have a significant impact. Many respondents expressed unwillingness to communicate with members of the public who are antagonistic to forestry.

11. What Are The Characteristics Of Effective Materials?

Entertaining. This is a "buyer's market." Forestry workers, like everyone else, get their news from newspapers, magazines, and television, and are continually bombarded with a huge amount of sophisticated communication in the form of advertising. Using video as an example, people will compare everything they see on the screen with the fare available on television or at the local video rental house. Straightforward presentation of facts is not likely to attract and retain a wide audience. Each topic needs to be treated creatively, incorporating entertainment with information.

Short and simple. Forestry workers have limited free time. Faced with a large magazine or a long video, most people will put them aside. Respondents to this survey criticized existing materials for being too long or too complex. The best way to simplify material is to rely on visuals (photographs and artwork) more than on text. Graphs can be effective for some people, but may be seen as too complex by others.

Controlled by learner. Most people want interactivity — the ability to control the content, flow, and pace of information. Simple interactivity can be achieved with well-organized print materials. A video program on a tape is not interactive because it is seen by everyone at the same pace and in the same order, but if combined on a CD-ROM with questions and other prompts, or if used in a classroom setting with a skilled instructor, it can become interactive.

12. What Are The Major Obstacles To FLOW?

Time. Undoubtedly, as we learned from our respondents, the largest obstacle is lack of time during the workday. Everyone in modern society suffers from information overload. New information will be accepted only if it has a proven value - if it can be tied to some tangible benefit.

Subject complexity. There are thousands of topics that could be addressed. Different topics will be of greater or lesser interest to different audience segments.

Workforce diversity. This makes the "one size fits all" approach unlikely to succeed. A variety of materials, utilizing different media, are needed to reach the entire workforce. Alternatively, it may be best to target only certain segments of this vast audience.

Company buy-in. Many companies will only support and facilitate the distribution of materials that they see as contributing directly to their mission. They want materials to explicitly feature their company and their activities.

CONCLUSIONS

We presented the findings from Phase One of Project FLOW to the OFRI board in August 1997 (Hino et al. 1997). By November 1997, the OFRI board had asked the Forestry Media Center to go ahead with development of three pilot projects: a video, a Web site, and a set of field tours. We decided to try several different methods, because we feel that different messages and media will work in different situations.

Because FLOW will be a long-term process, we feel that it is important to have some success early on. Initial materials and methods will target line workers in primary processing facilities; future efforts will address harder-to-reach audiences such as loggers and secondary manufacturing workers.

A variety of methods and materials will need to be developed, and the Forestry Media Center will only have a role in some of them. Our logical niche is centered on the development of non-print media, and on the dissemination of messages that stem from scientific research at OSU.

FLOW's chances of success will be increased by enlisting the participation of forestry industry associations. Managers involved in such groups are more likely to support FLOW goals, and have the ability to influence adoption of FLOW materials and methods at their facilities.

We learned a number of valuable lessons from Phase One of FLOW. Some of our preconceptions regarding forestry education for forest workers were affirmed; others were contradicted. We expect to gather more feedback once materials and methods developed during Phase Two are in use; this information will undoubtedly shape and improve future efforts. Project FLOW team members are hopeful that some of our experiences will be of value to other natural resource educators.

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BACK TO BASICS - ARE TRADITIONAL TEACHING METHODS OBSOLETE?

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ABSTRACT: A survey requesting students to assess components of effective learning was presented in four forestry courses - one at each undergraduate academic level. A total of 120 students received the survey and 118 returned it. Results clearly indicate that students rank instructor attitude and subject matter as the most significant factors to effective learning. Course style and format were much less important, although students have a clear preference for any format that provides hands-on experiences. While most students are familiar with some forms of teaching technology, they only rated it as somewhat effective to the learning process.

INTRODUCTION

As many colleges and universities reexamine their instruction missions, issues of academic excellence and scholarship in the classroom are raised. This naturally leads to discussions of measuring teaching quality and, at least at our University, the issue of the use of innovative techniques and technological teaching tools as one measure of teaching excellence. In many cases, use of technology in the classroom is essential - new technological tools are available to foresters and other natural resource professionals that must be incorporated for instruction to be up-to-date, computer labs allow for the solving of more complex problems, and technology can speed information retrieval. Whether or not these new technologies and methods encourage excellence in teaching or are meaningful measures of quality teaching remains, to us, an open question. Many forestry courses deal with basic information that must be mastered before tackling more complex problems and both authors have fond memories of instructors who could hold a class spellbound using nothing more complicated than a chalkboard. Our objective was to find out from our students what was important to them in defining quality instruction and to ascertain the degree to which they use technology in the classroom and its perceived effect on their ability to learn. Students are the target audience because the single most important evaluation of teaching quality at the University of Kentucky comes from student course evaluations and the factor used in annual merit and promotion decisions is the student rating of overall teaching quality.

METHODS

An "Education in Natural Resources Survey" was developed to solicit information from our students. The survey was presented to our freshman introduction class, a sophomore level soils class, a junior level measurements class, and a senior level timber management class. These latter three classes are composed almost exclusively of forestry majors, while the freshman course is open to anyone and contains a substantial number of non-majors and non-freshman. The combined enrollment of the four classes was 195 students. The surveys were handed out in each class, unannounced, on the same day. Since there is always some absenteeism and since some students were enrolled in more than one of these classes, our total sample population was 120. From these individuals, 118 surveys were filled out and returned. The survey included open-ended questions concerning factors of positive and negative learning experiences, direct questions concerning technology use and its effectiveness on learning, and direct questions concerning the effectiveness of various class structures. Students were asked to incorporate all of their college experiences into their answers. A copy of the survey can be found in Table 1.

RESULTS AND DISCUSSION

A summary of the results for each survey question is presented in bold text on the survey form in Table 1. Questions 1 and 2 asked students to list the three things that make an excellent learning experience and three things that detract from a learning experience. Since these were open-ended questions, the data had to be categorized, resulting in 19 categories for Question 1 and 18 for Question 2. The five most frequently listed categories, with the percentage of students who listed them are included for each question. For both questions, these five listed categories account for more than 50 percent of the response frequencies. It is interesting to note that for both questions, these categories include factors that can be controlled by the instructors as well as factors that are completely outside their control. The most important factors of a positive learning experience concerned the instructor's

attitude and willingness to help outside of classes, the student interest in and perceived relevance of the material, and the ability to get hands-on experience. Similarly, the most frequently cited negative factors included the instructor's lack of organization and perceived negative attitude. The quantity and difficulty of the work were listed, but less frequently than instructor attributes and scheduled class time. It is interesting to note that while interest in the subject matter was listed as a strong positive factor in learning, lack of interest in the subject matter did not diminish the effectiveness of learning.

Questions 3 and 4 concerned the types of technology students had been exposed to and its perceived effectiveness on their ability to learn. Responses were ranked on a 1-5 scale with 1 being much easier and 5 being more difficult. Results indicate students routinely use some forms of technology. The majority use PC labs, E-mail, and the Internet or WWW. Noticeably fewer reported using on-line library reference services. What this might imply is, perhaps, a topic for further investigation. The vast majority reported that technology made learning somewhat easier. Whether this is due to the limits of the technology or the familiarity of students with technology is also a topic for further investigation. In other words, university computer labs cannot always afford to have the latest equipment, and current students have, for the most part, grown up with the technology. They are less awed by it and, perhaps, have less appreciation of its power as few have memories of performing the same tasks by more laborious methods before technology was available. Negative comments included difficulty with the technology itself as well as difficulty with its accessibility. This last point may also warrant further investigation as technology that is out of date (which many university computer labs are given the speed of technological updates), difficult to use or has limited accessibility may be more of a hindrance to learning than a help.

One of the reasons often quoted by our faculty for developing and employing innovative teaching methodologies is a perceived dissatisfaction with the effectiveness of the traditional lecture method, especially for certain types of material. To a degree, our survey supported this. In the fifth question we asked students to rate the effectiveness of various class styles (lecture, lab, etc.) in helping them learn new material. While relatively few students rated any style as ineffective or highly ineffective, some definite preferences were observed. The majority of students rated lectures as effective, but few rated them as highly effective. In fact, more students rated them as neutral. Labs, however, were another matter. Eighty percent of the students rated them as highly effective or effective, with an almost even distribution between these two categories. This is consistent with the responses to Question 1 where hands-on field work was reported as beneficial to learning. Students seemed to rank discussions/ recitations somewhere between lectures and labs in the highly effective category. This is not a class style employed very often in our forestry curriculum, so most students are exposed to this teaching style in other courses (usually prerequisites) across campus. Independent study was ranked rather evenly between highly effective, effective, and neutral. This is a learning mechanism many of our students are not exposed to and, indeed, there were fewer responses to this part of the question. Also, some students take independent study courses out of genuine interest while others simply use them to add hours to satisfy graduation requirements. Internships are another learning device many of our students do not get exposed to as shown by the large number who reported no opinion. Students who had experience with internships, however, overwhelmingly ranked them as highly effective. This was not surprising given the students' expressed desire for hands-on experience. The response to seminars was also not surprising given the students' general lack of familiarity with them (note the no opinion count). Most found them to be neutral or effective, and few found them highly effective. Undergraduates are not normally exposed to graduate-style seminar courses, and seminars offered in our department, while open to everyone, are generally research oriented presentations by faculty and graduate students. Some undergraduates do routinely attend, but most do not have the scientific background yet to fully appreciate the content or its placement in the broad scheme of the field.

Question 5 is, perhaps, somewhat simplistic and specific conclusions should be drawn with some caution. One issue this question did not address, but which would be interesting to discover, is the interaction between a student's rating of class styles and their experiences with specific courses taught using these styles. Both authors have experienced good and bad lecturers and effective and ineffective discussion courses. In seeking ways to effectively present the technical subject matter in our courses, we find ourselves employing a variety of techniques and styles. Additionally, the success of discussions and seminars depend heavily on the preparedness of the student as well as the instructor. The effectiveness of a particular class style, then, would be dependent on the style itself, the student, the suitability of the material for presentation using that style, and the expertise of the instructor with both the material and the style. We suspect that these are all closely linked and a truly in-depth study would have to have some mechanism for evaluating these interactions.

Questions 6 and 7 asked students to consider both the highly effective and highly ineffective courses they have had and to indicate the source of the effectiveness or ineffectiveness from the options given. These options were format/style, instructor/ subject matter or both. The responses to both questions were extremely similar. In highly effective courses, 55 percent of the students credited the instructor/subject matter for the effectiveness, 17 percent credited the format/style, and 31 percent said both. In highly ineffective courses, 60 percent of the students blamed the instructor/subject matter for the ineffectiveness, 18 percent blamed the format/style and 22 percent blamed both.

The reported importance of the instructor and material on course effectiveness is consistent with the results observed for Questions 1 and 2. The lesser importance attached to format and style is consistent with the responses to Question 5.

The last three questions provided some demographic information. As expected, the majority of students were either forestry or natural resource majors. Despite the fact that one of the courses surveyed was a freshmen level course, very few of the students responding were freshman (Question 9). Several explanations for this exist. The freshman level course is open to anyone and is linked with the University's general requirements. It therefore attracts a wide diversity of students. Secondly, a significant number of forestry majors do not begin as freshman. Many transfer from community colleges or other programs and are classified as juniors and seniors (based on credit hours) even while taking freshman and sophomore forestry courses. This also helps explain Question 10, which indicates that the majority of students have "C" or better averages. Students who fall below this point are dropped. Since most of the respondents are upper division students, they have already crossed this academic hurdle.

CONCLUSIONS

Despite the increasing emphasis on pedagogy and methodology, instructor attitude, enthusiasm, and organization and subject matter are still the most important factors in determining the student's perception of the effectiveness or ineffectiveness of a course. Course format and style, while not trivial, are rated by students as far less important to their ability to effectively learn. What was clearly important was students' desire to get hands-on experience while in college. Similarly, technology is important and has its place, but also has its limitations in enhancing learning. Most students in this survey felt that it made learning somewhat easier. Traditional methods can and do still work.

This study took place in only one department, and a technical professional program at that. If the results observed here are true of students across the University of Kentucky as a whole, then there are some implications for strategies to improve undergraduate education. Technology should be incorporated to the degree necessary to convey current material and, once incorporated, should be readily accessible to students. The major emphasis should be place on recruiting and rewarding capable instructors dedicated to their profession and the welfare of students. The fact that student's mentioned instructor attitude, much more frequently than perceived instructor competence, in the survey may mean that the greatest crisis in higher education may be how we treat our students. Perhaps it is time to reexamine the original mission of the Land Grant College.

A final caveat in interpreting these results is worth mentioning. The survey dealt entirely with student perceptions of what was an effective or ineffective instructor, course style, or technology. The obvious limitation is that students seldom have a clear idea of what they need to know. They may rate an instructor or course as ineffective because it truly was ineffective or because they did not care for the instructor, did not care for the material, or were unwilling to work with sufficient diligence. This survey was not designed to filter any of this out. Perhaps a better test would be to survey graduates who have been on the job 3 - 5 years as to what constituted effective learning experiences and compare it to the results of this survey. This, too, is a topic for further investigation.

Table 1. Survey issued with response summaries in bold text.

Education in Natural Resources Survey

Students: This survey of your classroom experiences is NOT part of your evaluation for the course you are currently attending. Please be assured that all answers will be held in confidence and your identity will remain anonymous. Please answer these questions based on the entirety of your university experience from all the courses you have taken. When you have finished the survey, fold it in half and return it to the instructor. We appreciate your time and careful consideration of these questions.

1. Please list three things that make a course an excellent learning experience for you. (n=118)

Instructor attitude/enthusiasm 14.8%
Interesting material/subject matter 13.6%
Hands on learning/field work 10.1%
Instructor explains material/available outside class 8.3%
Relevant to real world 7.7%

2. Please list three things that reduce or diminish the effectiveness of learning in a course. (n=114)

Unorganized 15.9%
Early or late classes 13.6%
Instructor attitude 10.0%
Too much work 8.0%
Too complex work 7.6%

3. What kinds of technology have been used by instructors of classes you have had in the past?
(Check all that apply). **(n=118)**

PC labs **(82)**
Multimedia presentations **(58)**
Internet or WWW **(87)**
Commercial software **(27)**
Electronic mail **(83)**
Educational software **(52)**
Online library reference services **(38)**
Other **(12)** (please list) **Laser survey gun, GPS, GIS, electronic homework**

4. Has the use of that technology, in your opinion, made it easier or more difficult to learn new material? (Please circle one)

14 **62** **29** **8** **4**

Much easier/ Somewhat easier/ Neither / Somewhat more difficult/More difficult

Mean = 2.368 Std. Dev. = 0.906 N = 117

5. Please evaluate each of the class styles below for their general effectiveness in helping you learn new material

Course type	HE	E	N	IE	HIE	NO
Lecture	13	78	17	6	3	1
Lab	45	49	12	2	0	8
Discussion/Recitation	30	58	19	4	1	2
Independent/Individual Study	24	27	29	7	0	8
Internships	41	17	10	2	0	43
Seminar	7	29	29	7	2	39

HE--Highly Effective E--Effective N--Neutral I--Ineffective
HIE--Highly Ineffective NO--No opinion

6. For classes you have had that you consider highly **effective**, was the effectiveness due to the course format and/or style or was it primarily due to the instructor and/or subject matter?

Format/Style	**19**
Instructor/Subject Matter	**61**
Both	**31**

7. For classes you have had that you considered highly **ineffective**, was the effectiveness due to the course format and/ or style or was it primarily due to the instructor and/or subject matter?

Format/Style	**17**
Instructor/Subject Matter	**58**
Both	**21**

8. Please circle your major:

FORESTRY **(61)** NAT RES **(17)** AG **(5)** OTHER **(35)**

9. Are you a (circle one):

FRESHMAN SOPHOMORE JUNIOR SENIOR GRAD
(14) **(21)** **(35)** **(44)** **(3)**

10. Please circle the range which corresponds to your GPA:

0.0 - 0.9 / 1.0 - 1.9 / 2.0 - 2.5 / 2.6 - 3.0 / 3.1 - 3..5 / 3.6 - 4.0
(0) **(1)** **(13)** **(50)** **(31)** **(20)**

PROMOTING THE SCHOLARSHIP OF TEACHING: RESULTS OF A WORKSHOP ON ENHANCING EDUCATION IN WILDLIFE CONSERVATION

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ABSTRACT: We describe the justification, format, and assessment of a workshop "Enhancing Education in Wildlife Ecology, Conservation, Management: An Exchange of Ideas" facilitated at The Wildlife Society's Fourth Annual Conference. The workshop was designed to meet the professional development needs of college and university wildlife educators. Over 80 participants from academic and agency backgrounds attended a keynote address and breakout sessions to discuss pedagogical techniques and approaches to teaching specific wildlife course content. Breakout sessions on active learning in large classrooms, constructed controversies, and using writing in the classroom were identified by most participants as most important. The diverse backgrounds of session participants affected the nature of discussions in course-content focused sessions. Participants routinely expressed satisfication about the opportunity to exchange ideas about teaching methods with colleagues.

INTRODUCTION

Among the stated objectives of The Wildlife Society (TWS) is to "seek the highest standards in all activities of the wildlife profession" (TWS 1989). The Society, through its high-quality journals, professional conferences, and support for continuing education, has enhanced the development of wildlife management and research professionals since its inception. For most wildlife professional working in colleges and universities, however, research or management (service) activities constitute a small proportion of their official responsibilities. TWS programs addressing the professional development of wildlife educators have been slow to develop relative to those for researchers. The College and University Wildlife Education Working Group was formed in 1993 to promote the professional development of wildlife educators. Our goals are to "improve communication among members regarding issues [related to] undergraduate and graduate education" and "to improve the quality of education for students thereby strengthening the professional foundations of wildlife managers... resulting in better stewardship of wildlife resources" (TWS 1995)

The membership of the College and University Wildlife Education Working Group has identified as its most significant need the opportunity to exchange ideas regarding the pedagogy and discipline-specific content associated with educating future wildlife professionals. To foster this exchange the Working Group publishes a quarterly newsletter with book reviews and essays on topics related to teaching scholarship, established a ListServe site, and provided members with information on who is teaching what to whom to allow individual connections. These efforts have been successful to the extent that information about teaching pedagogy and course-specific content is available to members. But the membership has continued to express its desire for direct dialogue about teaching and education issues, explicitly identifying topics related to various approaches to teaching for discussion. Many have stated that they have numerous opportunities to discuss research issues with colleagues at their respective institutions and at a variety of professional meetings, but that there has been only minimal exchange of ideas about the dominant time investment in their careers: teaching. Although there clearly is no reason that such discussions can not happen among colleagues within or among colleges and universities, it is evident that the traditions for such exchange have not been established. We suspect that this is yet another symptom of the poor acceptance of teaching as a form of scholarship (Boyer 1990).

In 1996, we proposed the first college and university teaching-focused workshop for The Wildlife Society's annual conference. It was our intent that the workshop provide a milieu for formal and informal exchange of ideas about

teaching wildlife conservation in colleges and universities. This paper describes the format of the workshop, characterizes the background of its participants, identifies the strengths and weaknesses of our approach, and summarizes the feedback from participants about the workshop. We hope this information is useful to others planning similar workshops in the future.

DEVELOPING THE WORKSHOP

Although articles on challenges in education appear in journals associated with natural resource management societies (e.g., Ledford 1996), few are written on pedagogy or approaches to teach subjects in our disciplines (i.e., what works in the classroom and what doesn't). Because TWS is devoted to the education of wildlife professionals, we believed that perhaps academics and agency personnel with outreach responsibilities might be interested in participating in a workshop based on how to improve teaching and learning in the classroom.

To facilitate the development of this workshop, we prepared a proposal that was initially presented to the TWS College and University Wildlife Education Working Group (CUEWG) and later to the Program Committee for the 1997 Annual TWS Conference. The theme of the proposal was to develop a workshop that would initiate a conversation among wildlife professionals on the scholarship of teaching. Therefore, the focus of the workshop was to discuss how can we teach (with less emphasis on what we teach) to enhance learning.

The proposal was presented to the membership of CUEWG one year prior to when we wanted to conduct it. The objectives of presenting the proposal to our peers was to get input on the subject matter, format, and if it was conducted would people, at least CUEWG members, participate. The membership was very supportive of developing and conducting the workshop. Most the discussion among members centered on if the entire workshop should focus on pedagogy or if some time should be devoted to what people are teaching under various subjects in the area of wildlife conservation. Interest in having a component of the workshop address what was being taught in different subject areas was due to the rate of which wildlife management has changed in recent years. Several subject areas were discussed, however, members decided to focus on what peers were teaching in the areas of ecosystem management and conservation biology, population dynamics and management, and human dimensions of wildlife management.

The three pedagogical breakout session topics selected by the CUEWG were active learning in large classrooms, using writing in large classes, and constructive controversies (Campa et. al 1996, Johnson and Johnson 1992, Johnson et al. 1996) and case studies. At the CUEWG planning meeting we received input on breakout session topics from approximately 25 wildlife biologists that included college and university faculty and department administrators, agency biologists, and graduate students.

The final workshop agenda presented to the 1997 Conference Program Committee consisted of 4 components: a keynote speaker address (35 minutes), three concurrent breakout discussion sessions on pedagogical topics (each 1 hour and 20 minutes), three later concurrent breakout sessions on subject area topics (each 1 hour and 20 minutes), and summary/ evaluation session (20) minutes. For the keynote speaker, we wanted to invite a nationally known academic, outside of the area of wildlife conservation, who had extensive experience applying and experimenting with cooperative learning. Our justification for selecting an educator outside of our discipline was to insure that the presenter focused on discussion pedagogical topics and challenges for teaching students rather than discussing the teaching of subjects related to wildlife conservation. We think this was a critical component for challenging workshop participants to start thinking about not what they teach, but how they teach prior to attending the first breakout sessions. All wildlife professionals are well educated in the principles of the discipline, but how many of us who teach in the academy or in workshops have equal depth in how to teach? For our keynote speaker, we invited Dr. Karl Smith, a civil engineer at the University of Minnesota. Dr. Smith presented an active presentation on, "Teaching Tomorrow's and Today's Students."

Our goals for the two sets of breakout sessions were: to facilitate discussion among participants so that they would leave with information and/or techniques that they could use in their classrooms or workshops, and to model how classes could be conducted using cooperative learning techniques such as the bookends technique (Johnson et al. 1991). Therefore, in each of the six breakout sessions there were periods of presenting introductory material on the specific topic of each session, having participants respond to interpretive questions (M. Salemi, University of North Carolina, Chapel Hill, pers. commun.) presented by session facilitators and discussing responses to those questions. Prior to the workshop, we briefed breakout group facilitators on the goals of the sessions.

Using active learning techniques in large classes takes some risk and extensive planning to conduct meaningful activities that will facilitate learning. A goal of one of the breakout sessions was to share ideas on how to create a more active learning environment in large classes. Participants in this session learned about what active learning pedagogy is, discussed what techniques others were using and in what type of class format (e.g., laboratories, lectures, problem-sets, simulations), and had an opportunity to develop an active learning strategy for one of their own courses. The session ended with participants writing a one-minute essay on how they wanted to implement active learning strategies in their course(s). The essays were collected, along with self-

addressed envelopes, and were mailed back to the participants prior to the beginning of the next semester.

Because wildlife conservation has a rich history of complex management issues, educators often discuss past or current issues in the classroom to demonstrate how professionals historically dealt with issues and to give students an opportunity to see how management concepts and principles are applied to address a current management problem. Teaching with case studies and/or constructive controversies can create or enhance motivation for learning and emulate the type of work environment students will be challenged with as professionals (i.e., how to respond to stakeholders with a diversity of values). Therefore, a goal of another breakout session was to model how case studies and constructive controversies can be used in classrooms. For example, participants in this session were surveyed about the types of issues or controversies that they discuss in classes and workshops and who were the associated stakeholder groups. The facilitator then modeled how they could teach their issues using the constructive controversy format with informal, formal, or base groups to facilitate a more active learning environment. Participants then discussed some of the benefits and considerations to be kept in mind when using this form of cooperative learning.

The process of writing has been widely demonstrated to promote critical thinking and enhance learning of subject area concepts (e.g., Bean 1996, Emig 1977, Langer and Applebee 1987, Moore 1994,). Writing as an active learning tool helps students to organize thoughts, synthesize and analyze information, and evaluate alternatives. In addition, enhancing communication skills is essential in wildlife management especially for communicating with stakeholders about why resources are managed as they are and for disseminating scientific information to peers. Writing skills are improved only with practice. Therefore, to help educators deal with this challenge, the third pedagogical breakout session addressed using writing in the classroom. In this session, the facilitator began by having participants write a one-minute essay (Angelo 1991a,b) on "How do you use writing?" This writing assignment was followed by a mini-presentation on "Writing to Think and Learn." Participants then discussed topics such as suggestions for designing writing assignments and grading such assignments.

Each facilitator of the wildlife conservation breakout sessions was asked to bring copies of course outlines and/or handouts they use in classes. These handouts were used in some sessions to facilitate discussions on what subjects were being taught in various courses, how management concepts and principles were taught, and when particular courses were taught in different curricula. In addition, these handout materials were made available so that participants could use them as references for teaching similar courses at their respective institutions. Each of the three wildlife conservation breakout sessions were attended by college and university faculty and department chairs, agency personnel, and undergraduate and graduate students.

Following the wildlife conservation breakout sessions participants reconvened for a short summary of the workshop outcomes and were asked to respond to several questions as a qualitative evaluation of the workshop. During the summary, we challenged educators (and future educators) to continuously think about the way they teach. Teaching can be approached much the same way we conduct field or laboratory research: we ask questions, determine how to address the question, collect data, and then evaluate the data to see what worked and what did not. Just as we take risks in our research to enhance learning, we need to do the same with teaching. In addition, during the summary we reflected on how breakout sessions were conducted; could classes be taught the same way? Facilitators initially presenting material or asking questions, followed by periods of discussion, reflection, or problem solving. Using this approach in the classroom may be a first step to facilitate more active and a higher levels of learning.

ASSESSING THE WORKSHOP

Attendance at the workshop exceeded our expectations. Over all sessions about 85 people participated. Minimum attendance for a specific breakout session was 14 and several reached capacity of 20 participants. The membership of CUEWG is almost exclusively faculty from 4-year colleges and universities, but the workshop attracted participants from a broader range of TWS membership. Most surprising to us was the significant number of international participants (at least 5), graduate students (15-20), and federal and state agency personnel (ca. 15) in attendance. Although we did not systematically survey these groups regarding reasons for their attendance, informal interactions and comments on formal evaluations suggested some reasons for their participation.

International colleagues expressed notable interest hearing how American universities approached discipline-specific topics (e.g., conservation biology) and how American curricula were structured (this apparently was the result of discussions outside of the formal workshop process). Graduate students (primarily, but not exclusively Ph.D. candidates) indicated a desire to gain exposure to innovative teaching methods, learn how other universities structured courses and curricula, and to discuss course content and design as they envisioned developing their own courses in the near future. They also expressed the sentiment that participation in such a workshop would look good on a curriculum vitae and that the workshop milieu gave them the opportunity to network with possible future employers. Several agency personnel indicated a primary interest in learning what colleges and universities were teaching regarding specific concepts (e.g., ecosystem management). Others, particularly those that worked for agencies in public

education roles, were interested in discussing mechanisms for the delivery of information to clients. In informal surveys, faculty routinely expressed satisfication with the opportunity to talk with peers about their teaching, to hear what others were doing in the classroom, and to establish contacts for further interaction.

Each of the authors facilitated a breakout session on a pedagogical issue and a subject area issue. It was our impression that the sessions on pedagogical issues produced more animated discussion, that was more focused, and yielded more valuable outcomes for a larger proportion of the participants. This may have been the result of the diverse audience participating in the workshop. In the pedagogical breakout sessions, experience in using the teaching techniques was not necessary for participation in discussions. Students offered comments on their experience in classrooms using active learning strategies or their feelings about new approaches. Agency personnel commented on their efforts to engage clients in a variety of wildlife-associated activities. All participants asked questions of the facilitators and other participants about their experiences with the various pedagogical approaches. Faculty teaching different course material shared common experiences with a pedagogy or discussed application of techniques across subject area boundaries. Discussions in the pedagogy sessions were spirited, far-ranging, and showed no signs of waning when time expired.

The subject-area breakout sessions were more variable in the intensity of interaction. In one, only 1 participant and the 2 facilitators had experience teaching the material (ecosystem management and conservation biology), and in the others, participants with content-specific teaching experience were in the minority. Many participants were keenly interested in hearing about such topics as what concepts were being taught, how specific principles were being presented, and what exercises were used to engage students in learning the material. But, discussions encompassed smaller segments of these breakout sessions than the more general pedagogy-focused ones. Nonetheless, faculty participants in content-oriented discussions expressed considerable excitement about the opportunity to exchange ideas.

The formal evaluations of the workshop tended to bear out our qualitative impressions. We asked participants to respond to 3 questions: What is the most important thing you learned; What are you willing to try to implement; and What topics would you like more information on? Although specifics were varied, clear patterns of what was most effective emerge from these data. Although each of the 6 breakout sessions was identified by participants in providing the "most important thing learned," 65% of the participants responding to this questions (n = 20) cited a pedagogical technique as being most important. Issues related to problem-based learning, cooperative learning, and interactive teaching were the most commonly noted components under "most important." Additionally, 81% (n = 21) indicated the willingness to implement a specific pedagogical technique in their courses. Given that not all respondents were faculty, these numbers may underestimate the significance of the value of the pedagogy focused interactions. Participants most frequently identified case studies, problem-based learning, and interactive exercises as likely to be implemented.

Respondents identified several issues about which further discussion or information was desired. Curriculum issues (undergraduate and graduate) were the most commonly referenced by participants (6 of 12 responses). Five responses referenced general or specific pedagogical issues (e.g., group project evaluations, teaching diverse student constituencies). Only 1 of the 12 identified a specific, content-oriented topic.

We do not interpret the formal and informal evaluations to suggest that subject area sessions are inappropriate for future workshops. Soliciting pre-workshop registration for sessions may be useful in anticipating the audience for specific sessions and redesigning the structure to fit the audience composition. For example, breakout sessions on teaching population ecology attended by university faculty could be facilitated to promote exchange of ideas; whereas a session likely to be attended by graduate students could be designed to showcase syllabi, software for laboratory exercises, and discussions of what key concepts should be addressed in an undergraduate course.

Informal feedback from participants, and non-workshop attendees who heard about the sessions at the conference, indicated a substantial demand for future workshops. Our experience suggests that workshops with a substantial component on innovative pedagogy will meet a significant need among wildlife conservation educators. In our case, discussions of pedagogical issues took off and required limited facilitation. Sessions devoted to subject areas within the discipline are valuable, but may need more careful structuring to be fully effective. Most importantly, teaching workshops will contribute meaningfully to building networks among educators, including perspective faculty and educators outside of academia.

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AUDIO TAPES VS. INTERACTIVE COMPUTER SOFTWARE FOR STUDYING BIRD SONGS: THE VALUE OF ACTIVE LEARNING

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ABSTRACT: We tested the use of audio tapes versus interactive computer software for learning of bird songs by undergraduate students at the University of Missouri. Overall final grades did not differ between semesters when audio tapes or computer software were used to study bird songs. Mean song quiz scores were higher (21.63 vs. 19.48; 25 maximum, P = 0.04) and mean quiz score variances lower (0.49 vs. 0.75, P = 0.007) when students had access to interactive computer software than when they used audio tapes to study bird songs. Key factors affecting improved student performance seemed to be higher student interactions and peer teaching activity, self-testing options, and ease of access to specific quiz material provided by interactive computer software.

INTRODUCTION

Identifying bird species from auditory cues is essential to most avian population research, population monitoring, and conservation efforts. Avian ecologists use song or call note identification to establish presence, determine relative abundance, or quantify density of birds during breeding, migratory, and winter residency periods (Verner 1985). Whereas some individuals show amazing ability to learn birds songs and calls, recognizing hundreds of species (Forsyth 1994), most people find learning bird songs tedious and difficult. Until recently most students of bird song used phonograph records or audio tapes for study, but the advent of CD-ROM has resulted in a variety of computer software to aid in learning bird songs. We used data from our Ornithology course at the University of Missouri to test whether the use of CD-interactive software improved student performance on bird song quizzes versus their performance using audio tapes.

METHODS

In our Ornithology course at the University of Missouri we require students to learn 70 common bird songs. From 1985 to 1995 we made available to students audio tapes for study of the required songs and quizzed them on subsets of songs throughout the semester. We compiled study tapes of the required songs from several commercially available phonograph or tape sources. We made available photo slides sets matched to the song tapes in our teaching laboratory which was open daily from approximately 0700 to 1800 hours Monday to Friday. However, most students made copies of our tape or purchased their own and studied tapes outside of the classroom. Here we present data from the last 5 semesters (during years from 1989 through 1995) when tape availability, song quiz structure, etc. were identical to 1996-1997 when interactive software for bird song study was used.

In 1996 we obtained a computer with CD-ROM and audio playback capability for dedicated use by Ornithology students. We made various computer software available to students in 1996 and 1997 for study of the same songs required in prior years. Two primary interactive computer packages were used by students. We made available National Audubon Society's Interactive CD-ROM Guide to North American Birds©. This software shows visual images of a bird species while playing the song. We also installed on the computer the program Bird Song Master©. This software, without visuals, plays the Peterson Field Guide Compact Disc for Bird Songs®. It also allowed us to create files of the only the required songs in the same order previously used with audio tapes. This was not an option with the Audubon CD-ROM software. Bird Song Master had random quizzing options for the students to use for self-testing. Students had access to the interactive software on the same schedule as in prior years. Some students in 1996 and 1997 continued to use audio tapes for study outside of class, but the great majority used the computer during, and especially outside of regularly scheduled class times.

Song quiz format was consistent across years of our study. The complete list of required songs was broken down into 5 subsets of 12-16 songs. Although all songs are available for study throughout the semester, bi-weekly song quizzes covered only 1 subset of songs. Quizzes consisted of 5 songs, randomly chosen from a subset. We played the 5 quiz songs in order and then repeated the sequence once. Each song was worth 1 point, therefore the total song quiz points each semesters totaled 25 points. Total course points available varied slightly among years of our study, but song quiz points were a small proportion of the total in all years (ca. 4%).

Because of the high quality visuals associated with the songs on the National Audubon CD Guide and the seeming affinity of current students for computer graphics we expected predominant use that software. We further hypothesized, as we had in making photo slides available with the audio tapes, that seeing an image of the bird while listening to its song would reinforce learning. We expected students to use the Bird Song Master software primarily for its quiz function. Our general hypothesis was that use of interactive computer software would improve song quiz scores from that measured in prior years when audio tapes were used.

RESULTS

Although there has been a trend toward increasing class size in recent years, mean size did not differ between the years that audio tapes where used versus years when computer software was employed ($t = 1.01$, 5 df, $P = 0.17$; Table 1). Because any differences in song quiz results could be confounded by variation in overall student academic ability among years, we tested mean class grade point average based on final course grades. There was no difference in mean final course grade point averages (mid C range, ca. 2.5) between our experimental groups ($t = 0.53$, 5 df, $P = 0.31$; Table 1).

Mean song quiz scores were >2 points (ca. 11%) higher when interactive computer software was used than when audio tapes were used for study ($t = 2.20$, 5 df, $P = 0.04$; Table 1). Variation in student performance within years was less when computer software was studies than when audio tapes were used ($t = 3.76$, 5 df, $P = 0.007$; Table 1).

Table 1. Class size, mean course grade point averages, mean song quiz scores, and mean song quiz variances during years using audio tapes and CD interactive software for studying bird songs at the University of Missouri, 1989-1997.

Audio Tape				
Year	Class Size	GPA[a]	Song Quiz Score	Song Quiz Variance
1989	38	2.68	19.63	0.60
1991	40	2.63	20.75	0.81
1992	46	2.54	17.95	0.73
1994	55	2.18	18.39	0.84
1995	51	2.53	20.67	0.79
Mean	46	2.51	19.48	0.75
± SE	3.2	0.09	0.57	0.04

CD-Software				
Year	Class Size	GPA	Song Quiz Score	Song Quiz Variance
1996	50	2.28	21.95	0.47
1997	53	2.57	21.30	0.50
Mean	51.5	2.43	21.63	0.49
± SE	1.5	0.15	0.33	0.02

[a] Based on A = 4, B = 3, C = 2, D = 1, F = 0.

DISCUSSION

As hypothesized, the use of interactive computer software enhanced student learning of bird songs. However, our qualitative observations suggested how students used the software was not as we had expected. Although student use of the software combining visuals of the birds while playing the song was high initially in both semesters, use seemed to shift substantially to the software without visuals. It seems that the software that allowed creation of subsets of the required songs and the self-testing option available with the Bird Song Master program were attractive to students.

We observed another factor in the use of either of the interactive software that may have had a substantial impact on student learning. Students using the computer often worked together in small groups. They quizzed each other, competed with the self-test option, and coached each other on song identification. We strongly suspect that this peer-teaching may have had more impact on student learning than the specifics of the computer packages. The computer hardware and software seemed to enhance the likelihood of peer interactions about the material.

Listening to audio tapes is an inherently passive learning mode that has been repeatedly demonstrated not to enhance

learning and retention (e.g., Chickering and Gamson 1987). Although the computer software for studying bird songs that we made available to students could be used with a minimum of active learning involvement, students seemed to use the programs in an active learning style. Peer-teaching has been recognized as a particularly powerful pedagogy for student learning (Goodlad and Hirst 1989, Topping 1988).

Although our study focused narrowly on learning to recognize auditory signals, the learning atmosphere created by the use of the interactive computer software could be extended to a variety of learning situations. We believe that computer based instruction that incorporates ease of access to specific study material (i.e., the subfile creation option in the Bird Song Master program), self-testing options, and that promotes peer interaction and teaching will have the greatest impact on student learning.

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INTERSTATE EDUCATIONAL PROGRAMS: ARE WE READY?

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ABSTRACT: During the past 15 years, Utah State University and other institutions have vigorously investigated the possibility of sharing educational resources across state lines. This concept, while very important to higher education's future, has not been fully realized . The most obvious barriers have been lack of financial resources and working models. This paper outlines models and procedures that could benefit institutions in the development of cooperative degrees.

INTRODUCTION

Higher education in the United States has been very stable. However, during the past 10 years it has come under attack on many political fronts. These attacks have questioned tenure, faculty workload, outcome assessment, and access. The last time the appropriateness of higher education was questioned so thoroughly was 136 years ago when higher education was opened to the "common people" through the Land-Grant College Act. All issues, including access, were not addressed in the year of 1862 nor will the higher education issues of today be answered in 1998. However, if we in higher education don't address the issues equally as well as the Land-Grant College movement did, I would predict that we will stand by and watch as another type of higher education replaces the system that is so very dear to our hearts. If we dig in our heels, saying the only way to get a quality education is to attend one of our campuses as a full-time student and be evaluated, mentored, and placed as we have done for the past 100 years, and as the Ivy League institutions did in the 1800's, we too may shrink to few in number.

The purpose of this paper is not to provide answers to all the issues facing higher education but to address the issue of access and its relationship to dwindling state and federal resources provided to state institutions of higher education.

Student "access" is a term that recognizes the same problem that existed in 1862. At that time the access issue was that only the "rich and elite" were afforded the opportunity to attend college. Today, while "common people" attend college, we have come to understand that higher education must be available to most individuals at convenient times and places throughout their "life spans."

Our nation's future depends in large part on our ability to educate virtually our total population. Thomas Jefferson maintained that, "Man is basically good-- he is educable. He can be responsible, make his own decisions, run his own government and decide the major issues affecting his life." An educated nation can and should maintain a high quality of economic and social life for its people.

Providing access to more people at convenient times and places is a very troubling issue for those of us in higher education because we know all too well that we are educating more people with fewer resources each year. This must have been the feeling of the early land-grant administrators who had almost no resources and were mandated to enroll all who could benefit from education.

FINANCIAL STRESSES ON HIGHER EDUCATION

For the past 15 years, social and economic conditions in most states have caused state legislatures to rethink funding mechanisms for higher education. Higher education institutions have watched their legislative support dwindle from 20% of the overall state budgets to, in some cases, as low as 4½% of total state appropriations. This shift has been caused notably by a decaying infrastructure, such as roads and state buildings. Many universities have a substantial backlog of deferred repairs.

Over the next four years, for example, Utah will spend $1.6 billion to overhaul the I-15 freeway system, the primary north-south artery through the state. Also of concern to higher education is the drastic increase in funding for social programs that are either receiving less federal funding or exhibit a drastic increase in need. Examples include a substantial increase in the number of correctional facilities being built and social service assistance for individuals and families at or below the poverty level. Utah is projecting a 9% increase per year in its inmate population, which will dictate a combined 9.28% increase in correction budgets. This increase

will allow 400 new beds per year at an annual construction cost of $24 million and an annual operational cost of $8.8 million.

Facing such dramatic increases, it has been common for state legislatures to fund incremental salary increases only or, in some cases, provide higher education institutions with no increased funding, encouraging instead that they downsize to provide salary increases. For the past 13 years, Utah institutions have not received any increase in operating and maintenance budgets; therefore, a higher percentage of an institution's budget goes to salaries each year. The result has been that students must pay higher fees to support activities previously covered by state appropriations. It is not uncommon for some students to pay fees that are half again the amount of their tuition.

The student fee dilemma, coupled with no increases in operating and maintenance budgets, have made many institution administrators look hard at eliminating low-enrollment undergraduate and graduate programs. This past fall, Utah State University was re-accredited by the Northwest Accrediting Association. One of the committee recommendations was to carefully examine the future of several low-enrollment graduate programs. On the surface, this recommendation seems very logical. However, as budgets are analyzed, it is soon recognized that cutting a low- enrollment graduate program will save few education and general fund dollars because external research grant dollars are not only paying the cost of research but also the cost of maintaining these graduate programs. This same scenario could be posed for the new and emerging sub-disciplines such as biotechnology. These new areas not only require a great deal of start-up funding, but enrollments initially are typically very small. Therefore, often the low-enrollment programs and the new and emerging programs lack a critical mass of students, critical mass of faculty, and adequate funding for operations.

INTERSTATE COOPERATIVE EDUCATIONAL PROGRAMS

In 1987, the Western Council of Administrative Heads of Agriculture (WCAHA) commissioned a study to determine the feasibility of sharing educational programs in teaching, research, and Extension across state lines. Factors sparking this investigation included enrollment decreases, no increases in operating budgets, and the traditional desire of colleges of agriculture in the land-grant system to be "all things to all people". WCAHA hoped that through advanced telecommunications systems and other models, programs could be shared across state lines, making it possible for colleges of agriculture to downsize or eliminate some programs and still provide all agricultural disciplines to state residents. This study was confined to two disciplines, dairy and sheep, and found an annual cost savings of $4.5 million for the dairy program and $1 million for the sheep and wool program across 13 western states.

The western regional effort was further developed with the founding of A*DEC, which now ties 50 land-grant universities together via telecommunications technology. Over the past 10 years, these and other institutions have successfully shared many educational programs. Based on this experience, the following represents beneficial reasons to share programs among states:

Research

- Facilitate replicated research and Extension demonstrations among participating states.
- Conduct research seminars to encourage faculty to develop joint research proposals.
- Link commodity groups and scientists to discuss research problems and priorities.
- Provide a forum for university and private sector scientists to design future research projects.

Extension

- Provide a medium for interstate discussions and diagnosis of production problems.
- Allow immediate access to all states for the transmission of emergency information.
- Provide an economical and efficient mechanism for regular interaction among state Extension specialists and program leaders in the development of interstate Extension programs.
- Furnish an easy way for one state to provide Extension expertise to other states on an as-needed basis.

Teaching

- Effectively increase class size as students from various universities are taught by one faculty member.
- Offer courses annually that are now offered only every other year.
- Stop discontinuing degree programs simply because of low enrollments.
- Teach classes using professors actively engaged in research in specific disciplines.
- Offer graduate students the benefit of inter-university graduate committees.
- Enhance course work through special seminars and guest presenters from various universities and scientists from private industry.
- Give students a broader perspective of the discipline by involving students and faculty from other states.
- Enable students desiring degrees in disciplines not offered at their "home institution" to receive instruction through a cooperative program.
- Organize and fund new degree programs on an interstate basis rather than have each state provide for itself.

While the above benefits are very real, the lack of discretionary funds at the academic unit level has negatively impacted the end results. There are also other barriers that need to be overcome to make cooperative education programs possible. They include:

- Accreditation/governing board approval
- Common course content and vision of subject matter to be included in educational degree programs
- Common calendars (semesters vs. quarters)
- Common class schedules
- Common tuition (out-of-state vs. in-state)
- Common application/registration/financial aid procedures
- Access to library/computer resources
- Access to laboratory facilities and proctors for laboratory experiences
- Payment of program costs (tuition funded vs. institution subsidized)
- Access to telecommunication equipment
- Marketing of educational programs across state lines
- Traditional on-campus vs. off-campus delivery
- On-campus students' reluctance to participate in telecommunicated courses

SENIOR YEAR ENHANCEMENT MODEL

The Senior Year Enhancement Model could be used most effectively when an institution does not offer a degree important to only a few individuals per year. An example for Utah is the BS degree in Poultry Science. USU gave up this degree four years ago because there was an average of three students per class. Though the class size was low, the poultry industry is very important to Utah's economy. Therefore, USU proposed to the Western Region Colleges of Agriculture the Senior Year Enhancement Model which would allow USU poultry students to major in Animal Science for three years at the Logan campus, then physically transfer to an institution such as Oregon State University to receive poultry courses specific to the Poultry Science Degree. In return USU would make its Dairy Science Degree available to other western states.

This model has attracted only a limited number of students to these "regional programs." Interviews with students indicate they are generally unwilling to move to regional sites. Even with the home institution tuition rates, other barriers loom large, including the cost of moving, summer work on family operations, finding new part-time employment, financial aid changes, and many personal considerations. The model has further been complicated in that cost effective regional telecommunications systems have not been available. In addition, there has not been enough use of the systems to develop models which will compensate for hands-on laboratory experiences. However, some institutions and industries indicate site proctors can be very effective in extending the laboratory experience to distance sites.

LOW ENROLLMENT SHARED DEGREE PROGRAM

The Low Enrollment Shared Degree Program selected as a model is the BS degree in agricultural education. This degree was selected because it represents a low-enrollment discipline throughout the western United States but has a high demand for high school agricultural teachers. While this model have not been tested, it may act as a catalyst to encourage institutions to form cooperative degree programs.

The model begins by examining the demand for graduates. The 1996 Western Region Agricultural Teachers Supply and Demand Report shows 199 graduates vs. 279-346 teaching positions available. There were an estimated 80-147 teachers needed more than those being supplied.

It was determined that a critical mass of faculty for any given program should be seven, with 21 being the critical mass of students for that same program. Therefore, the Western region states were divided into five subregions, which gave each subregion at least the minimum number of students and faculty necessary for a quality educational program.

The proposed model was developed for subregion III, which includes Wyoming, Nevada, Utah, and Colorado. Each of the states in this model would be assigned a particular discipline within this comprehensive degree. The University of Nevada-Reno could be assigned those courses relating to water, soil and range management; Colorado State University--animal science; University of Wyoming--agribusiness and computer applications; and Utah State University--agricultural systems and teaching methods, with each institution providing its own general education and some science-related courses. It should be noted that the Agricultural Education Model has not been negotiated with the states listed. Once the model is developed it may include different states and different subject matter assignments.

Should this degree program or a similar interstate program be developed, the following guiding principles should be used:

- All educational institution partners must provide courses and students to the program. Since it is difficult if not impossible to send tuition and fees between institutions, it is important that all institutions provide an equal share of instructional resources.
- All institutions must dual list all courses. Institutions are not likely to participate in a cooperative degree program if the institutions cannot maintain their own students. Therefore, each institution must accept each other's institutional credit and faculty within the consortium. This will allow each institution to maintain its own student body.

- All institutions must provide student services for their students. Important student services such as application, registration, financial aid, library, and computer services must be provided by the home institution. Otherwise students get "caught" in the system and will quickly become discouraged.

Under this model, the only resources being shared are the courses themselves. If an institution understands that it will not lose student credit hours to another institution and will receive 75% of the course work free by providing 25% of the course work free to three other institutions, there will be no competition and theoretically great incentives for faculty to become involved.

TUITION AND FEES MODEL

This model was developed to provide a mechanism allowing all institutions to retain their own students, their own tuition and fees, and provide student services to their own students.

Tuition

Historically, tuition has been set by higher education institutions and their governing boards, based on institutional research costs of instruction models. State legislatures have determined the amount of subsidy allowed for in-state tuition and generally mandated that out-of-state students pay the full cost of instruction. Out-of-state students' full cost of instruction is generally three to four times that of the subsidized in-state student tuition.

Fees

Traditionally, fees have covered costs other than instruction, such as student activities and health services. However, most institutions and student bodies have elected to add student fees to tuition as a means of enhancing the educational experience, since higher education budgets have not provided adequate funding for educational support, such as computer laboratories and library resources. More recently, continuing education units have attached a "program fee" to pay additional costs of delivering programs to non-traditional students at times and locations conducive to their needs.

Proposed Tuition For Multi-Institutional Degree Programs

The Western Governors University (WU) concept suggests that state boundaries should not be a barrier to sharing resources. There are many efficiencies related to allowing greater educational access to more students with fewer higher education institutions or enlargements to current institutions. This concept, while very valid, creates a necessity for higher education institutions to rethink the traditional tuition rate for extending educational programs beyond state lines and collaborating with out-of-state institutions in the delivery of programs.

A guiding principle in higher education is to develop and deliver educational programs important to state residents. Therefore, the principle suggests that any institution delivering programs for a multi-state delivery should first determine that there is a need within its own state. Hence, if only those states participating in a multi-state cooperative degree actually offered courses, each state could charge its own in-state tuition and enough fees to pay for its portion of the delivery costs. This scenario would build a "win-win" situation for each state, since each state would charge its students (those from within that state) in-state tuition and claim the student credit hours generated by the in-state students. Each state would then be responsible for the student services required by its own students.

This type of relationship would start with representatives from the continuing education units and the academic departments for a particular discipline, meeting and developing a cooperative degree program. Academic representatives would first agree on a core curriculum and assign the teaching evenly over the institutions involved in the delivery of the degree program. All courses in a given cooperative curriculum would be assigned course titles and numbers by each institution. This configuration would allow each institution to offer its own courses to its own students, with its students paying in-state tuition and a program fee, based on delivery costs within each state.

States that wish to participate in cooperative degree programs, but cannot offer educational resources to those programs, will contract with the sponsoring institutions to deliver the degree programs into their respective states. It is recommended that the tuition and fees for the non-instructional states be based on an average of the tuition and fees of the institutions providing the instruction. The tuition and fees from the non-instructional states will be divided equally among the instructional institutions. In this case, the instructing institutions will also be responsible for student services for students in non-instructional states. This tuition and fee relationship is possible because the instruction institutions will have paid all direct delivery costs within their states; therefore, out-of-state tuition need not be charged to students from non-instructional states. However, first priority must be given to students living in instructional states.

This same model could be used for in-state institutions sponsoring cooperative degrees. In this instance, each instructional institution would charge its own tuition and fees to its own students. In may be necessary, however, for an average tuition and fee schedule to be adopted to prevent "institutional shopping" should the tuition and fees vary widely among institutions.

It is possible that the percentage of institutional effort may vary among institutions in either the interstate or intrastate models. If this occurs, the institutions will prorate the income from tuition and fees based on the percentage of effort provided by each institution. Since costs of instruction vary greatly, depending on production and transmission costs and faculty salaries, it is important to have equal partners to limit tuition and fees crossing state lines.

DEVELOPMENT OF A COOPERATIVE DEGREE

The following steps have been used in the development of a model degree program with eight different Idaho and Utah institutions. While telecommunications equipment analysis is still ongoing, the projected start date for this degree program will be fall semester 1998.

Individuals Involved

- Faculty

  Each institution provided one faculty member representing the degree discipline. The charge to these faculty was to develop a common set of courses needed for the particular degree program. They determined subject matter content and sequenced the courses.
- Continuing Education Directors

  The continuing education deans or directors developed a finance model to ensure success of the program. Continuing Education Units needed to be involved because they generally have discretionary income through tuition and fees to finance degree programs, particularly if there is an off-campus clientele.
- Institution Technology Representative

  The institution technology representatives determine common technology within the participating institutions and the feasibility of scheduling and using these technologies.

Once the curriculum has been determined, sequenced, and technology scheduled, marketing and persuading students to receive their education through this non-traditional medium becomes critical. It is important that a brochure be developed which outlines the positive nature of receiving a degree from academics specializing in a particular component of the curriculum. Marketing the program to the entire department faculty is also critical. Cooperative degrees tend to threaten faculty if they think they will lose their "pet courses;"therefore, they must be reassured that no student credit hours will be lost to the department and there will be more time that can be devoted to research and Extension activities.

Since interstate cooperative degree programs are still relatively new, it may be advantageous for only two or three institutions to work on a cooperative degree at a time. It will be less complicated and lessons learned can guide the formulation of more complicated future cooperative degree programs.

Recently continuing education deans and directors from 10 institutions met and discussed the development of cooperative degrees. Their list of potential degrees include:

Pharmacy
MBA/Prerequisite Courses
MS Engineering Management
MS Technical Management
P.D./EdD
P.D./EdD Leadership of Higher Education
MS School Psychology
MS Assistive Technology
MS/BS Environmental Science
MS/BS Special Education
BS/MS Speech and Hearing Communicative Disorders
BS/MS Computer Science
MS Instructional Technology
MPA, BS Nursing
MS Food Services and Dietetics
JD National American Law
Library Studies
MS Journalism
MS/P.d. Adult Education
BS/MS Criminal Justice
MS Applied Math
MS Physics
BS Secondary Education
MS Non-thesis Chemistry

The development of the list of the degrees is an important first step. The most important second step is to meet with faculty and telecommunications/system directors to determine the feasibility of the joint degree programs.

We must be pro-active and have the courage to investigate new methodologies and approaches to delivery of higher education programs. If we fail to do so, there are many other institutions waiting in the wings to fill the void.

WRITING ACROSS THE CURRICULUM EFFORTS AT NORTHERN ARIZONA UNIVERSITY'S SCHOOL OF FORESTRY

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ABSTRACT: The objective of Writing across the Curriculum (WAC) in the School of Forestry is to build critical thinking and writing skills throughout the duration of a student's program. The program, as it has evolved over the last four years, has resulted in more writing assignments in classes where previously little had been required, a movement from descriptive to analytical writing by the students, and finally, a demonstrable improvement in student writing abilities. Success has been due primarily to four key features: (1) a revision of the Forestry Professional Program prerequisites, (2) revising the Forestry curriculum both to increase the amount of writing required as well as a logical progression in the types of assignments, (3) faculty development seminars and assistance provided by the English Department's Composition program, including tutoring students and providing them workshops, and (4) an assessment of faculty and student attitudes towards writing.

Student and faculty attitudes towards writing and opinions about effective strategies to improve writing were assessed through the use of surveys. The results showed that while there was broad support for writing among faculty and students, the amount of writing assigned was fairly minimal (particularly in the lower-division courses), and that while students, on average, felt their writing was successful, faculty though that it was not. The two strategies that were considered most effective were student revision after faculty comment and peer revision among students. Because evaluating and grading was viewed by the faculty as the primary factor limiting their assignment of writing, a standardized grading score sheet ("rubric") was developed.

The net result of the writing across the curriculum program in the School of Forestry is that faculty are assigning more writing, providing opportunities for revision after their comments, and standardizing evaluation and grading criteria. Our strongest partner in this effort has been the English Department and its Composition program in particular. The results of our collaboration have demonstrated—albeit not statistically significant—an improvement in our students' writing abilities.

INTRODUCTION

Writing is rated by employers, faculty, and even students, as one of the most important skills needed for effective natural resource managers. In the Fall of 1993 it became apparent that many of our students were ill-prepared after completing the professional program. At the same time faculty began to recognize that students' writing abilities were hampering our teaching capabilities. Experience with Writing Across the Curriculum (WAC) over the last thirty years has shown that students learn to write best when writing is (1) introduced as part of the academic discipline, and (2) used as an essential learning tool (Spagna, 1997).

The objective of Writing across the Curriculum in the School of Forestry is to build critical thinking and writing skills throughout the duration of a student's program. The program, as it has evolved over the last four years, has resulted in more writing assignments in classes and a demonstrable improvement in student writing abilities. The success of the WAC program is due primarily to the dedication of the faculty, but four key features supplied the support which enabled the faculty to be successful. These are: (1) a revision of the Forestry Professional Program prerequisites, (2) revising the Forestry curriculum both to increase the amount of writing required as well as a logical progression in the types of assignments, (3) faculty development seminars and assistance provided by the English Department's Composition Program, including tutoring students and providing them workshops, and (4) an assessment of faculty and student attitudes towards writing. The way in which these four components acted to support faculty efforts to improve writing will be discussed after the professional forestry program is described.

WRITING IN THE FORESTRY PROFESSIONAL PROGRAM

The School of Forestry at Northern Arizona University offers a three semester, upper division program that leads to a professional degree (B.S.F.) in Forestry (see Figure 1). The professional program is preceded by a set of prerequisite courses, of which only three (9 credits) are lower division Forestry courses. Two composition courses (6 credits total) are included as prerequisites, one at the freshman level and one at the sophomore. Forestry 101, which is now taught in both the fall and spring semesters, does not presently emphasize writing for two reasons: (1) sections are large, up to 120 students; and (2) there is no guarantee—particularly in the fall semester—that students have had any college-level composition courses (see Figure 1). Because of the size of the section, writing is limited to one paragraph (at most); and while identification of students with writing problems is possible, there is not a high priority in encouraging them to seek assistance. While the number of students in Forestry 211 (Forest Measurements) is also high, generally around 60 - 70, they are required to prepare a two to three page laboratory report every week. This report is reviewed both by the faculty member (for technical merit) and by a Forestry graduate assistant (for composition). The assignment must be re-written until the writing portion attains an 80% grade. Students with severe writing handicaps are encouraged to seek assistance from either Forestry's writing tutor or the University's Writing Assistance Center. One short paper is required in Forestry 212 (Silvics).

Most instruction in the Forestry Professional Program occurs in three semesters of integrated classwork, beginning in the fall of a student's junior year and concluding in the fall of their senior year. Each semester is essentially a 16 credit course, divided into modules (concurrent in the first two semesters and sequential in the third) usually taught by more than one professor. Semester A focuses on the ecological and physical aspects of forestry; Semester B on management science, forest planning, and policy; while Semester C is a capstone project.

Semester A typically contains from 25 to 40 students (including some graduate students taking it to fulfill prerequisites). Writing assignments in Semester A vary among the faculty members who teach there. Approximately half the modules within the semester require writing. Typically, when writing is assigned, students are expected to prepare their papers in standard scientific form (i.e., introduction, objectives, methods, results and discussion). Generally, 25 to 30 students move on to take Semester B, where writing intensity dramatically increases. Presently, there are four concurrent tracks (somewhat similar to individual courses) during the semester. One track (focusing on history, policy and recreation) has been designed to emphasize writing, and because students are required to obtain at least a C in all four tracks to progress to Semester C, the writing-intensive track ideally provides an incentive for students to improve their writing during Semester B. Unfortunately, every year two or so students decide the effort is not worthwhile and change their majors, which is not an optimal resolution to writing problems. The sequence of writing assignments in Semester B starts with one to two paragraphs in the first week (used as an assessment tool), progresses to two page essays by mid-semester, and requires two five page reports at the end of the semester. Re-writing is used to overcome the student perceptions that writing is a one-shot task.

The prerequisite courses, and the initial two semesters of the professional program, are intended to prepare students for the profession by having them write a management plan—similar to what they would do as foresters—in Semester C. The plan is a comprehensive document that is set up to guide the management of specific land areas. It includes an introduction, description of the area, results of the resource inventories, and analysis of various management scenarios. Students prepare an individual plan, aside from the inventory and the initial three chapters which are done in groups of four. Past history has shown that, because of time constraints, very little editing and re-writing is done by students prior to submitting their plans; unfortunately, it is not uncommon for students to merely "data-dump" rather than thoroughly analyze the project.

Faculty demands in Semester C to wade through masses of poorly written—and often poorly analyzed—management reports (25 students times 100+ pages times each report evaluated by a minimum of two faculty members) caused widespread despair at the end of every fall semester. At the same time, the limitations of the traditional curriculum were being challenged by some faculty. This resulted in two curriculum changes, the first involving a switch in the English composition prerequisites, and the second being a thorough revision of the Semester A and B curriculum, with writing being one crucial criterion.

COMPOSITION PREREQUISITES

The Forestry faculty's initial reaction after recognizing that student writing abilities were inadequate was to blame the English Department since, after all, we required 9 credits (three courses) of English courses prior to entry into the professional program. If students came to us unprepared in their Junior year after they had taken these courses, then the problem must lie with those courses. With this in mind, the Forestry curriculum committee decided to revisit our writing prerequisites to ensure that they met our needs. What we discovered was not quite so simple; nor were we free of blame! The problem was actually two-fold. First, we discovered by examining transcripts that many students had not taken the required prerequisites, yet had been admitted into the Forestry Professional Program. But in some cases, the writing prerequisites were not taken by a student until after they had completed the three semester program, were never taken, or advisors were

allowing inappropriate courses to be substituted. This problem—which has largely been overcome—was resolved by informing both students and their advisors that the composition requirements would be strictly enforced as well as revising the advising form to more clearly indicate which courses could be substituted.

The second concern was whether the prerequisite composition courses were, in fact, meeting our needs. To determine this, we obtained and examined the syllabi for the then prerequisite courses, English 101 and English 102 (a two semester freshman composition series, 3 credits each), and English 302 (technical writing, 3 credits). What we found when we evaluated the Technical Writing course was that not much writing was required, and that the type of writing (cover letters and resumes) was not adequate for our needs, nor did the writing strategies used (plenty of headings and lots of white space) teach the types of analytical techniques that we felt were needed. The net result, in our opinion, was that students were misled (no one received less than a B in this course) into believing that they were adequately prepared to write technical papers.

We were fortunate that the Composition program had recently developed two new courses, English 105 (Critical Reading and Writing, 4 credits) and English 205 (Writer's Workshop, 2 credits). When we examined their syllabi, and after discussions with Dr. Geoff Chase, then head of the Composition program, the curriculum committee decided to adopt English 105 and English 205 as prerequisites. The rationale for this decision was that the amount of writing, its intensity, and the skills required to succeed in these classes would better prepare students for entry into the Forestry professional program.

Unfortunately, there is not a semester-by-semester correlation between the English prerequisites and lower division Forestry courses, at least until Forestry 211 when we are assured that students will have had, or be concurrently registered in, English 105 (see Figure 1). By the beginning of Forestry 212 we know that students will have completed English 105, and have finished or be concurrently registered in English 205. And before gaining admission to the professional program, in Semester A, students are required to have completed of their writing prerequisites.

FORESTRY CURRICULUM REVISION

The discussions with the English faculty about writing led to an increased awareness of the concepts behind Writing Across the Curriculum that were stated in the introduction: that writing—and the teaching of writing—has to be an integral part of the discipline, and that the process of writing could—and should—be an essential learning tool. Until recently, most writing intensive assignments did not occur until at least the second semester of the junior year. With the new composition prerequisites, and a heightened sensitivity by the faculty, intensive writing is now being required in the first semester of the sophomore year. Our curriculum does not yet fully and perfectly structure these assignments, too often they begin afresh with each course and semester. But linkages across Forestry courses, and between the English prerequisites and Forestry courses can be developed.

The large class sizes in the existing structure of Forestry 101 (Introduction to Forestry) create a multitude of problems: the classes are impersonal, assignments and exams must be simplified due to grading difficulties, and as a result building skills during the crucial freshman year is difficult. Of primary concern to the Forestry faculty is the problem that many students fail to continue with the program (of the approximately 200 students taking the course each year, only about 75 take the next course in the sequence). In an effort to address these problems, proposals to separate the course into smaller sections of about 25 students have been advanced. These smaller sections would allow more writing, the ability to link assignments with the composition courses, and hopefully attract and retain more students.

The challenge to maintain and increase the writing required in Forestry 211 and 212 is also related to the size of the classes and the inconsistency in the composition courses that a student might have taken. Students in Forestry 211 can be expected to at a minimum be registered for English 105. Therefore, students can be expected to either have, or be developing, the skills necessary to respond to the laboratory report assignments. In addition, the requirement that students get at least 80% of the points assigned to writing in the laboratory reports means that they have an incentive to improve their writing. This is consistent with reports from the writing tutor that she is receiving requests for assistance from these students. Forestry 212 is problematic because sophomore standing is not required to register. It is conceivable that students have had no composition courses if they take Forestry 212 the second semester of their freshman year; and because English 105 is not available to first semester freshman, co-registration with this composition course and Forestry 212 is the best that can be expected. For sophomores, it is possible that they have taken English 105, and possibly even English 205 when they take this course.

Semester A continues the writing process and style from Forestry 211 by focusing on preparation of laboratory reports. However, in contrast to Forestry 211, the faculty expectations in Semester A are that the reports will be more focused, specifically linking the objectives of the laboratory to the methods used for the analysis, then clearly differentiating between the results and the discussions and conclusions that can be inferred from the results. Thus, the level of sophistication in the laboratory reports grows (as size is enlarged from two pages), while analysis rather than description is emphasized.

Semester B faculty have made a concerted effort to both increase the amount of writing, as well as to build skills through-

out the semester. Journals are used in one module as a way to develop ideas and arguments for student papers (and as a replacement for quizzes) (Bean, 1996). In-class writing exercises, combined with peer discussion of writing, has been used to provide immediate feedback to students. For longer papers, students are generally allowed to improve their grades if they revise their original submittals after receiving comments from faculty.

In Semester C the major curricular change has been to increase the amount of revision that students are expected to include in their management plans. Traditionally, all chapters of the management plans were individually prepared. This last year, the first four chapter (problem formulation, area description, inventory methods, and analysis procedures) were written by groups of three students. Groups were given the opportunity for revision for the first three of these chapters, with substantial improvements noted from those groups who took advantage of this. Students self-selected themselves into groups for the implementation portion of the management plans. In this case, peer comment and revision was used between pairs of groups. While the overall quality of the plans still suffered from their traditional deficiencies, the parts where revision was incorporated were noticeably better.

FACULTY DEVELOPMENT

Ultimately, the writing knowledge and skills that students bring into our courses is bounded by the Forestry faculty's ability continue building both conceptual and technical skills. Faculty incorporation of writing has been shown to be affected by perceived difficulties in, preparing assignments, assessing the quality of student responses, and the sheer demands that grading places on the instructor in large classes. We found that one good way to support faculty is to build bridges with university's English Department. Our collaboration with the English Department started when we were reviewing our prerequisites, and blossomed into a full-fledged partnership. Three principal components characterize this partnership.

First, the School of Forestry funds an English Department graduate assistant. Over the last three years, four different graduate assistants have provided writing workshops and tutoring for Forestry students (this is a coveted assignment for these students, both because we traditionally provide an office, but also because the graduate assistants recognize its value for their future job prospects). The tutors (or "coaches" as we call them) are available to assist or review faculty writing assignments. Through consultation with the professors, they advise students and have provided faculty members with grading assistance. The workshops provided to students are sequenced to build the writing skills needed for Forestry 211 (fall) and Semester B (spring). The availability of the writing workshops compensates for differences in incoming student writing skills, and allows faculty to focus on development of concepts rather than the mechanics of writing.

The second area of collaboration involved the English Department providing three "brown bag" lunch seminars designed to meet Forestry faculty needs. These seminars were variously given by the Chair of the English Department, the Head of the University Writing Center, and/or the coordinator for Writing Across the Curriculum in the Forestry School. The first seminar discussed how students respond to writing assignments, the second on how to effectively evaluate and grade writing assignments, while the third how to prepare effective writing assignments. The knowledge gained by the Forestry faculty from these seminars has been widely applied in their classes.

The third area of collaboration between the Forestry School and the English Department involved an assessment of student and faculty opinions about writing, the efficacy of our course prerequisites, and development of grading scorecards ("rubrics"). These tasks were undertaken through a one-year appointment of a Writing Across the Curriculum coordinator (a previous writing coach), who worked with a Linguistics professor and another English graduate student. Opinions about writing were developed through a survey of both students and professors (Spagna, 1997) (the results of these surveys are discussed in the next section). An assessment of the efficacy of the composition prerequisites was done by comparing student scores on a writing assignment with the grades the student received in any composition courses and the student's ACT/SAT scores (also reported in the next section). The grading rubric for writing assignments was developed as a way to ensure consistency and ease the grading burden for evaluating writing (Shearin et al., 1997). A copy of the rubric is provided in Appendix A.

WRITING ASSESSMENTS

Student and faculty attitudes towards writing have been shown to have a significant effect on the success of writing across the curriculum programs (Spagna, 1997 citing Anson, 1988, Charney, 1995, Daly, 1985, Pajares and Johnson, 1994). Positive attitudes towards writing are reflected both in a willingness on the part of faculty to incorporate writing into their classes, as well as a willingness on the part of students to respond to these assignments. But we were also concerned about whether a student's previous experience, both in high school and in pre-requisite classes, also affected their writing ability. A two-part writing assessment project was conducted in an attempt to first determine student and faculty attitudes towards writing, and secondly, to determine whether a student's performance on writing assignments could be predicted based on prior coursework and scores on standardized tests (Spagna, 1997).

Survey of Student and Faculty Attitudes Towards Writing

The first assessment to determine faculty and student attitudes towards writing was done through written surveys (Spagna,

1997). Eighteen faculty members and 23 Forestry seniors provided the sample for this analysis. Faculty and students were asked to respond to twenty-four questions related to their attitude towards writing which were taken directly from statements made during interviews. A total attitudinal score for each respondent was constructed from an individual's response to these questions (Spagna, 1997). A second set of four questions were asked of both faculty and students about the usefulness of different types of assignments, effective strategies to respond to assignments, and how well students performed in nine different phases of the writing process. Finally, faculty were asked a third set of three additional questions about how frequently they assigned different types of writing in lower-division and upper division courses, and what factors limited the amount of writing that they assigned.

The responses to Spagna's (1997) attitudinal scale questions show that both faculty and students have positive attitudes towards writing, although the faculties' (3.24 out of 4) is higher than the students' (2.85 out of 4).[2] There is no real divergence between faculty and students opinions that writing is an essential part of a good college education, although faculty are more strongly of the opinion that foresters need to write well. Both groups strongly agree that learning to write well is a life-long process, and both groups feel that writing will be an important part of forestry graduates' futures. Where students and faculty diverge in their attitudes about writing is when it comes to its effectiveness as a learning tool. Faculty are much more likely than students to think that writing helps students grasp concepts. Faculty perceive that writing was a more effective way to determine whether students had benefited from reading compared to quizzes over the same material.

Spagna's (1997) analysis of the usefulness and success of different types of writing and writing strategies highlighted similarities and differences in opinions between students and faculty. Faculty think their writing assignments are not terribly successful in improving basic writing skills or in encouraging critical thinking. They do, however, think they are successful in modeling professional tasks and reviewing material from class. Of the five strategies employed by faculty to help students with their writing (peer review of drafts, revision after instructor comments, Writing Coach consultations, University Writing Center consultations, and student self-evaluation), revision after comment and Writing Coach consultations are most commonly used. Faculty think that the revision process is most useful, and do not think much of student self-evaluations. Students generally rely on revisions after faculty comment and peer review of drafts as their preferred mechanisms. Students occasionally go to the Writing Coach, but hardly ever to the University Writing Center. By far the most successful strategy, from the students' perspective, is responding to faculty comments, and secondarily, peer review.

Responses to Spagna's (1997) survey show significant differences between student and faculty perceptions of student performance on nine different stages of writing. Table 1 provides the comparison for these stages. In general, faculty believe that students performed poorly (less than 2.5 on the 4 point scale) on seven of nine writing stages. The only areas where faculty think that students perform successfully or better are in understanding assignments and addressing the appropriate audience. In all categories, in comparison to the faculty, students feel that their performance is successful, sometimes by an average of one point on a four-point scale (i.e. from an average of poor to an average rating of successful). The difference between mean ratings is greatest in the areas of support concepts with information, using clear and concise language, and correctly using and documenting quotations.

Spagna (1997) found that faculty considered writing assignments to serve three very important purposes: they model writing tasks used in the profession, they help to improve students' basic skills, and they encourage critical thinking. But faculty attitudes towards writing are not reflected in their assignments. Spagna's survey shows that very few writing assignments occur in lower division courses, and when they do, they are primarily short-answer essay exam questions. Three out of four lower division Forestry courses assign laboratory reports, two assign personal narratives, and analytical papers are assigned in one course, but only once a semester. No lower division courses assign literature reviews or research papers. As discussed previously, writing intensifies in the upper division Forestry courses. The frequency of short answer essay exams drops, and writing is typically replaced by personal narratives, analytical papers and research papers. Literature reviews are still infrequent, and the number of any given type of writing assignment is generally limited to one or two a semester. So while the faculty sees the value in writing assignments, their implementation of this vision is limited. Class size is the most common reason given by faculty for limiting writing assignments.

Indicators of Student Writing Performance

A second assessment attempted to determine whether writing success can be predicted based on student ACT/SAT verbal scores, overall grade point average, and/or on the prerequisite courses taken (Spagna, 1997). Student success was measured in two ways: (1) student scores on all writing assignments taken during Semesters A and B in 1996 (two different cohorts equaling 59 students) were tallied; and (2) a specific assignment (a two to three page essay) assigned in Semester B during 1996 and 1997 (totaling 43 students) was scored by two readers (Spagna and Shearin) using the rubric that is provided in Appendix A (absent the content section). We were specifically interested in knowing whether students who had taken the new second-semester composition course (English 205, Writers' Workshop) rated higher than students who had taken the previous prerequisite course (English 302, Technical Writing).

Spagna (1997) analyzed whether the prerequisite courses had any positive effect on student writing abilities based on their scores on an essay assignment. The mean writing score for this essay was 9.38 out of a possible total of 15 points, a less than stellar performance on the part of most students. For those who had taken English 205 (the new prerequisite), the mean score was 10.12. For those who had taken English 302 (the previous prerequisite), the mean score was 8.90, while the mean score for students who had not taken all their prerequisite composition courses was also 8.90. While it is apparent that students, on average, who had taken English 205 performed better on this writing assignment (means of 10.12 compared to 8.90 for the other two groups), Spagna (1997) found through an ANOVA test that there was no statistically significant difference. She obtained a similar result when students' performance on a broad range of writing assignments in Semesters A and B were examined. Students in Semester A (1996) who had taken English 205 had a mean score of 84% compared to 81% for students who had not taken it. Similarly, in Semester B (1996), students who had taken English 205 had a mean score of 83% compared to 77% for those who had not taken it (Spagna, 1997). So while English 205 apparently results in higher scores on writing assignments, as yet there is no statistical support for this hypothesis. It appears that—based on a limited sample of both writing and students—there is no strong correlation between a students' general preparatory work, attitude, and overall academic performance with their writing ability.

DISCUSSION AND CONCLUSIONS

The School of Forestry at Northern Arizona University has made substantial progress over the last three years to address the writing needs of its students. The emphasis placed on writing in specific courses has lead to an increased awareness on the part of students that writing is, and will be, an important part of their professional lives. Faculty, as determined through the survey and by their participation in writing seminars, are also aware and excited about the importance of writing in the University and the professional program. Specifically, faculty feel that writing should model the types of tasks that professionals will be required to do, writing should encourage critical thinking, and finally, writing tasks should be assigned—and designed—to improve writing skills. But to accomplish these objectives requires a revision in the types of writing most often assigned to Forestry undergraduates: short answer exam responses and descriptive laboratory reports. Forestry professionals are required to ascertain the nature of a problem, determine what previous knowledge exists to assist in their analysis, and then synthesize this in a manner that informs and justifies their decisions. The types of writing assignments that do this are literature reviews, comparative essays, and analytical papers. But the processes and exercises used to develop these skills, and specifically these types of writing, according to the Forestry faculty survey are not frequently assigned.

The challenge for writing across the curriculum then becomes how to induce professors to actively incorporate writing into their courses, and students to actively work to improve there skills. The work done for this project has shown that there are a number of techniques that have potential to translate writing awareness into writing actions. First, and perhaps foremost, more writing needs to be assigned in lower division courses. To do this, (1) the size of the sections for these courses must be reduced so that the grading burden is manageable, and (2) the types of writing can be mirrored to those covered in English prerequisites and students advised (or required) to co-register for these classes. In this way, there would exist a feedback and reinforcement between the skills building learned in the composition classes and the content- and conceptual-based knowledge that can occur in Forestry lower division courses.

There are a number of strategies to reduce the grading burden on faculty. First, there are many activities that involve writing that do not incur large grading requirements. Journals kept by students to record their reflections on assigned readings and develop themes for papers are a comparatively efficient way to provide students with feedback. They can replace quizzes or short answer exam questions with little additional effort, and they have the benefit of counteracting student strategies to just memorize answers. In-class writing exercises that respond to prompts based on readings or class topics can be immediately discussed. If scoring is needed, they can be handed in and easily graded on a "plus, check, minus" system. Finally, we have seen the benefit in devising a grading "rubric" to make our criterion both clearer to students and quicker on faculty to assess.

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[1]The discussion of the assessment of student and faculty attitudes towards writing was based on a study conducted for the School by Spagna (1997), and the grading rubric by Shearing, Spagna and Jamieson (1997). Their assistance is gratefully appreciated, however all conclusions based on their work are the author's.

[2]My interpretation of the responses to the attitudinal questions differs from Spagna's (1997). Spagna believes that the questions cannot stand independently, but instead can be considered only as interdependent pieces of an overall attitudinal scale. I, on the other hand, think that there is useful information contained in responses to specific questions.

APPENDIX A

GRADING RUBRIC FOR WRITING EVALUATION
(Shearin et al., 1997)

Use: This rubric has four categories: content, logical development, mechanical style, and grammar. Depending upon the type of assignment and the level of the course, the four categories may be weighted differently. The content area for each course, or possibly even assignment, should be specific to the expectations of the faculty member.

Content

Content area instructors should define criteria for this area using a 5 - 1 scale.

Logical Development

- A 5 in this category has a thesis, presented near the start of the paper, that adequately reflects the assignment. Each paragraph has one major idea. All main ideas are relatable to the thesis. All main ideas are supported by well-explained and in-depth examples or evidence. Connections between paragraphs are clear. The situation is introduced, and terms defined where necessary.
- A 4 is generally well-developed but could be better.
- A 3 is readable but inconsistently organized and/or underdeveloped.
- A 2 has development problems that obscure meaning.
- A 1 has no evidence of the features of the 5 score of this category.

Mechanical Style

- A 5 in this category exhibits a clear awareness of audience. It uses appropriate vocabulary, sentence structure, and punctuation. Spelling is correct. Language is clear and concise. Where appropriate, sources, tables figures, and maps are used clearly and accurately.
- A 4 has generally good mechanical style, but it could be better.
- A 3 is readable but exhibits an inconsistent awareness of audience. Contains some inappropriate use of the features of this category.
- A 2 has such inappropriate use of features of this category that either author seems completely unaware of audience or meaning is obscured.
- A 1 has no evidence of the features of the 5 score of this category.

Grammar

- A 5 in this category demonstrates consistently correct subject/verb agreement. It also has correct sentence structure and word choice, consistency in person, tense, and number, and clear pronoun references.
- A 4 has generally good grammar, but it could be better.
- A 3 is readable, but it has noticeable grammatical errors.
- A 2 has grammatical problems that make meaning difficult to decipher.
- A 1 has no evidence of the features of the 5 score of this category.

THE UPPER MIDWEST REGIONAL CAPSTONE AWARD PROGRAM

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ABSTRACT: Five Upper Midwest universities—Iowa State University, Michigan State University, Michigan Technological University, the University of Wisconsin-Madison, and the University of Wisconsin-Stevens Point—all offer a capstone course or capstone sequence for senior students in forestry that results in a written paper or project report. The five universities have collaborated with private industry and public agencies to develop an award program for these capstone reports.

In this paper we describe the capstone courses taught by each of the universities and their project requirements. We summarize experience gained on the administrative and judging requirements and procedures, including those relating to costs and funding, during the first year of the competition. We also discuss the benefits of the program to students, faculty and the participating industries and agencies

INTRODUCTION

Employers representing a wide range of fields in both the private and public sector uniformly stress the need for new employees to have good skills in the areas of problem solving and critical thinking, communication and teamwork. These essential elements have been recognized for some time, and the reasons for incorporating them into an "integrated resource management" course were well stated in the *Journal of Forestry* roughly twenty-five years ago (Bentley, 1975; Lavin, 1975; Hagenstein, 1975; Gould, 1975; Beuter, 1975). Most forestry programs have some type of capstone experience in their curricula, and capstones are also incorporated into the curricula of other natural resource disciplines (Willis and Scalet, 1995). Several of these were described in journals (Straka, 1993) and in the proceedings of the forestry education conference held in Syracuse in 1994.

In the fall semester of 1996, the authors were sharing experiences about their respective capstone courses and the quality of the reports produced by the students. From that discussion emerged the idea of initiating an award program to recognize the best reports and the teams that produced them. It also seemed appropriate to include other universities in the immediate region so they were contacted to learn if they had capstone courses and whether they wished to participate. Iowa State University, Michigan State University, Michigan Technological University, the University of Wisconsin-Madison, and the University of Wisconsin-Stevens Point all have capstones and agreed to be included in the program. The University of Minnesota does not have such a course and is thus not participating in the awards program. While there was no attempt to exclude any other regional universities, it was decided early on to keep the program relatively small so that it might be manageable.

Capstone Courses at the Five Universities

What follows is a brief description of the various capstone courses that exist among the five universities. Iowa State University's Forestry 454—Forest Resource Case Studies, was initiated in 1975. It is a 3-credit course and is the oldest continuously taught capstone course among the schools participating in the award program. Since it has been described in detail elsewhere (Countryman, 1994, Countryman and Thomson, 1979), it will only be noted here that the course provides students with a portfolio of case study projects that have been submitted by foresters and others throughout Iowa. This portfolio provides a broad set of potential projects. While many focus on land and resource management planning, others relate to such things as problems involved in forest products manufacturing.

At Michigan Tech, the capstone consists of a three-term sequence of 2-credit courses (FW 481, 482 and 483—Integrated Forest Resource Management I, II, and III) that begins in the fall quarter and continues throughout the academic year. The first course focuses principally on resource inventory and the second on development of alternative management scenarios. The third course continues with development and analysis of efficient land allocations in response to each scenario and evaluation of landscape-level implications of each land allocation using a

geographic information system. Students work in teams of 3-5 and are assigned 80-160 acre tracts of forestland for study. Teams prepare reports based on the material covered and applied to their study property for each course. This has the advantage that the final report at the end of the year is cumulative and can incorporate improvements and correct deficiencies noted by instructors on earlier versions.

Michigan State uses the 3-credit Natural Resources Planning and Policy course (FW-FOR-PRR-RD 466) as the capstone for its forestry and wildlife majors, but enrollment is open to students in related natural resource disciplines such as fisheries, parks and recreation and resource development. The course is taught during the spring term and focuses on ecosystem-based planning and policy issues through development of a multiple-use plan and case studies. Teams usually include five students who work together to prepare a plan for a large property (10,000+ acres).

The designated capstone course at UW-Madison is Integrated Resource Management, which is currently in the process of being assigned a permanent course number. While most Forest Science majors take this course, an alternative capstone experience consisting of a Senior Thesis, is available to students who meet the requirements for admission to the Graduate School. The capstone course is 3 credits and is similar to those at other institutions in that students work in teams of 3-5 to inventory, analyze and prepare a management plan for a specific property which varies in area from 200-2,000 acres. The course is taught during the fall semester. Teams are required to conduct resource inventories, develop and analyze management alternatives and prepare and submit written plans. In addition, teams present their plans orally in a public forum where the audience consists of faculty, students, and outside professionals and landowners.

UW-Stevens Point (UW-SP) has been using its Integrated Resource Management Seminar (NRES 490) as the capstone. It, too, involves student teams and focuses on interdisciplinary natural resource planning of a small and large tract of land. NRES has been a 1-credit course but UW-SP is currently in the process of increasing the credits to two. This expanded format will provide time for a richer capstone experience and a more in-depth planning project.

Administration of the Upper Midwest Capstone Awards Program.

Responsibility for administering the program rotates in alphabetical order among the member universities of the Upper Midwest Capstone Awards Program on a two-year basis. During the time that a University runs the program, it is responsible for recruiting the industrial sponsors of the program, selecting judges and coordinating the judging of the capstone reports.

The judging panel is comprised of seven members. Three represent the industries that have funded the program for the year, two represent public agencies, and two represent universities in the program. Each judge serves for two years and the terms are staggered so that at least three judges remain from the previous year in order to provide continuity and "institutional memory." In order to smooth the transition from one university to the next, during the year prior to the change in one administrative responsibility, one judge is selected from the university that will next administer the program. Michigan Tech administered the program in 1997 and 1998 and Jeff Stier, representing the University of Wisconsin-Madison, served on the panel of judges. The University of Wisconsin-Madison will administer the program from 1998 to 2000.

Three industry sponsors are asked to support the program for two years by providing $250 per year for the awards and also to provide a judge for two years. The sponsorships are also staggered so that continuity is maintained. Michigan Tech's Pete Cattelino, the advancement officer for the School of Forestry and Wood Products, made the initial contacts with industry representatives on behalf of the Upper Midwest Capstone Awards Program.

Each fall term of the academic year, the program administrator recruits new judges and industry sponsors and disseminates the announcement of the award program (Appendix A). They also send a reminder letter to each of the institutions participating in the program including any new information that is necessary. Throughout the academic year each University runs its capstone course or sequence as it has always done. Faculty then select a maximum of two papers or reports to represent their school and submit them for judging. In May seven copies of each report (one for each of the judges) and a brief cover sheet describing the objective(s) of the report is sent to the program coordinator. The coordinator packages sets of the reports and mails them to the judges. Judges rank the papers and write comments which are then forwarded to the coordinator by the third week of June. The coordinator tabulates rankings, collates comments and faxes this information to the judges by the end of June. In early July the judges and the coordinator hold a conference call to discuss the papers and select the top two papers. The coordinator is responsible for mailing the award checks to the students.

The program is relatively inexpensive to conduct. The awards total $750 per year (3 industry sponsors provide $250 each). The administering university spends about $400 per year on administrative costs, primarily on mailing the reports to the judges and on the conference call. Since administration is rotated among the five schools, each university only pays these costs for two years within a ten-year cycle.

Experience the First Year

The award program was held for the first time in the 1996-97 academic year. Four of the five schools participating in the program submitted capstone reports. UW-Stevens Point did not because, as described above, their capstone course is currently undergoing reformulation. Each school was permitted to submit two reports but Michigan State submitted just one; hence the coordinator was faced with disseminating copies of seven reports to each of the seven judges. Despite some tricky logistics, the process went smoothly, and judging was completed in July, 1997.

The panel of judges was charged with selecting a first and second place winner. Prior to the conference call among the judges, each judge ranked the reports and these rankings were shared anonymously by the coordinator with the other judges. How hard was the judging? Well, it certainly wasn't easy. There is always an element of "apples and oranges" in such an exercise and this one was no exception. In addition to the capstone courses having slightly different objectives and emphases, teams ranged in size from 3 to 5 students and the properties on which they worked from 80-18,000 acres. Yet, despite these differences and the diversity within the panel of seven judges, there was strong, although not unanimous agreement about which report was viewed as the best. The first place award of $500 went to a 5-person team from Iowa State.

There was less agreement, however, about the relative rankings of the remaining reports. The various judges brought different perspectives and considerable discussion and negotiation was needed to select the second place winner. In the end the judges found two reports to be of similar quality and declared a tie for second place between a team from Michigan State and one from Michigan Tech. The two teams split the $250 cash award. This significantly reduced the cash award per team member but the judges felt it was most important to recognize the efforts of the students and that the amount of money students received was less critical to the success of the program.

After the judging was completed, the judges suggested changes that they believed might help make the process easier in subsequent years. These have been incorporated into the guidelines for the competition. Most of these changes reflected attempts to standardize understanding of the context within which the reports are generated. For example, judges thought that it would be helpful to know what proportion of the course grade was determined by the capstone report, how many credits the course(s) were, and how many and what kind of data were provided to the teams versus their having to generate original data. Initially, the guidelines for the competition called for reports to be judged according to the objectives and grading criteria for each of the respective capstone courses. However, given the diversity among the five schools, the committee elected to develop explicit evaluation criteria for purposes of the competition.

What Benefits Do Participants See from the Award Program?

Faculty at the participating institutions see it as a way to help motivate students to do their best work and as a means of gaining some degree of recognition for their best students. Faculty whose students produce winning reports can also take satisfaction from their teaching efforts and all faculty can gain a better understanding of what their colleagues around the region are doing. The program thus functions as a mini-forum for exchanging ideas about what does and doesn't work and why different schools have organized their capstone experiences in the ways they have.

Some students are motivated to try for both the recognition and the cash the awards bring. While the amount of the award is not very substantial when split among members of the winning teams, students are always short of funds and some respond positively to economic incentives. Others tend to be more interested in the competitive challenge than in the potential financial payoff. And yet others recognize that winning such an award can be a very positive thing to include on one's resume when searching for that first employment opportunity. Students are quick to realize that the public agency and industry judges are apt to remember the names of the authors of what they considered the best reports, and that this could be an advantage when competing with others for job opportunities.

The forestry professionals who judge the reports get to "take a peek" into the academic world, and to gain an understanding of what is being taught at the various forestry schools and how. The are also able to determine, at least to an extent, how well students assimilate and develop the knowledge and skills that will be so important in the professional world. Several industry judges also distribute the reports among their own employees
with two purposes in mind. First, the additional readers improve the quality of the judging. Second, many firms now provide forest management assistance to NIPF landowners and the high quality of the reports has helped the companies improve their own landowner reports.

The award program provides the public agency judges, and perhaps more importantly, the companies sponsoring the awards, an opportunity to identify some of the best and brightest students, students who will soon be entering the workforce. Hence, participation in the program can be viewed as a way to identify potential future employees. However, lest we paint too mercenary a picture, we do want to note that industry sponsorship has been very easy to gain and the company representatives have been genuinely and enthusiastically interested in encouraging and recognizing excellence among students.

SUMMARY AND CONCLUSIONS

While it is always dangerous to generalize from a sample size of one, our experience with the first year of the award program has been very positive. Industry and public agency professionals were delighted to be asked to participate and did so enthusiastically. Funding has been no problem. While there was great diversity among the reports and the panel of judges, the judging went relatively smoothly and subsequent refinement of the evaluation criteria should make it somewhat easier in the future. Since the program was not initiated until late 1996, students at some schools were well into or had already completed their capstone projects and the award program probably had little effect on motivating those teams. However, this year students were made aware of the program at the beginning of the fall semester and it did seem to encourage them to work harder on their reports.

Considering the ease with which the award program was developed and administered, we would encourage schools in other regions to consider initiating a similar program. We would suggest, however, that schools might want to control some of the variability among capstone reports by working with other schools that have similar characteristics in terms of land ownership patterns, forest types and capstone requirements. If other regional award programs were to become established, some day there might even be a national award program, perhaps coordinated by the Society of American Foresters or one of its working groups. As Arlo Guthrie suggests in "Alice's Restaurant," if we can get a critical mass of three or more programs established, we just might have the beginning of a movement!

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Appendix A: Announcement for the 1997-98 Upper Midwest Capstone Award Program

AWARD PROGRAM FOR SENIOR CAPSTONE COURSES AND SEQUENCES

Purpose:

To recognize excellence among senior forestry students in the Upper Midwest (Iowa, Michigan and Wisconsin) by evaluating their integrated knowledge as presented in senior capstone course or sequence projects. Awards will be presented to the two best student capstone reports.

Description:

Iowa State, Michigan State, Michigan Tech, UW-Madison and UW-Stevens Point all have capstone course or sequences that require senior students to synthesize their knowledge of natural resources while solving a forestry problem. in part this has been driven by a desire of forest industry and public agency critiques of forestry education. This award will recognize student excellence in capstone courses and sequences.

Each university will submit a maximum of two papers to the judging committee as well as a summary of the objective of each paper. At the end of the academic year a committee of three industry representatives, one from each sponsoring company, two university faculty, rotating among the universities, and two public agency representatives will select the first and second place reports. Judging will be based on the overall quality of the report as well as the match to the stated objective of the paper. The first place report will receive a $500 award and the second place report will receive a $250 award.

Funding for these awards is provided by:

Lake Superior Land Company
101 Red Jacket Road
Calumet, MI 49913

Biewer Sawmill, Inc.
6251 West Gerwoude
McBain, MI 49657

Kretz Lumber Company
P. O. Box 160
Antigo, WI 54409

COMPUTER-AIDED INSTRUCTION IN DENDROLOGY: PREPARATION FOR DISTANCE LEARNING

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ABSTRACT: Many state legislatures are increasing public access to higher education by establishing more two-year institutions with lower tuition and fees than four-year institutions. This will likely increase the number of students enrolling in two-year institutions and later transferring to four-year institutions. Transfer students presently comprise more than 30% of the University of Arkansas at Monticello's (UAM) undergraduate forestry majors. These students arrive commonly deficient in six required freshman and sophomore forestry courses and facing four years at UAM to complete their baccalaureate degree. Prospective transfer students need access to freshman- and sophomore-level forestry courses. Forestry majors need tutorials aiding the development of skills and knowledge in plant morphology, identification, nomenclature and silvics. At UAM, dendrology is taught using a combination of computer-based and traditional classroom methods, thereby extending educational experiences to a broader range of learning styles than traditional instruction alone. When combined with distance learning technologies, this approach can potentially reach prospective transfer students. Resolution of course deficiencies reduces problems for transfer students and academic advisors, and homogenizes levels of preparedness leading to higher quality instruction, student understanding and academic success. This paper introduces a series of PC-based tutorials and a format for electronic discussion groups in dendrology intended as part of a package for both resident and distant students. The user-friendly tutorials provide easy access to approximately 120 species of native and exotic woody trees, shrubs and vines of the upper Coastal Plain of the Western Gulf Region. The self examination segment of the software allows students to pretest their skill and knowledge in the morphology, identification, and nomenclature of forest species as part of their preparation for actual examinations. The electronic discussion groups helps students learn from each other while catering to diverse learning styles and study schedules. This approach to dendrology is nontraditional and appeals to students either literate or illiterate in computer usage without reduced participation in traditional classroom experiences.

INTRODUCTION

Many state legislatures are restructuring higher education and increasing public access by establishing more two-year institutions and reducing charges for tuition and fees at these institutions. For example in Arkansas, there are 30 state-supported two- and four-year institutions (plus other private institutions) serving the higher education needs of approximately three million people. Currently, two-year institutions charge approximate $30 per semeter hour for tuition and fees. This compares to $65 at four-year institutions. By law, state-supported four-year institutions must accept the transfer credits from the two-year institutions. Thus, two-year institutions are playing an important role in the completion of general education and early major requirements. Careful selection of courses during the first two years of study is especially critical for transfers into highly structured curricula such as forestry. This reduces student trauma and improves academic performance, quality of the graduate and eventual professional success.

The UAM forestry curriculum is highly structured, requiring discipline to complete general education requirements, a core of major requirements, supportive requirements, an eight-week summer camp and 12 hours of free electives for graduation in four years and one summer. Majors normally enroll in six core forestry courses, Introduction to Forestry, Dendrology Laboratory I and II, Silvics, Forest Soils, and Forest Mensuration during the freshman and sophomore years. Dendrology Laboratory I and II, Silvics and Forest Mensuration are prerequisites for summer camp. Summer camp follows the sophomore year and provides field experiences and relevancy for upper-level concepts. All upper-level forestry courses build on these six courses and the summer camp experience. Furthermore, majors may use their 12 hours of free electives as a planned course of study, especially tailored to their individual interests.

PROBLEM

Transfer students commonly enroll in the UAM forestry curriculum with junior standing but deficient in six, core

freshman- and sophomore-level forestry courses. This scenario often means, first, transfer courses are in excess and/or do not match UAM general education requirements. These courses commonly fill free elective slots, undermining the student's ability to pursue individual interests. Second, the summer camp experience is postponed. Thus, students enter some upper-level courses without the relevancy honed by field experience. Third, in search of a full load, advisors enroll transfers in freshman- through junior-level, general education and professional courses. These circumstances (1) undermine the summer camp experience as a preparatory tool for advanced study, (2) dilute the contribution of free electives to the development of the student's unique interests, (3) contribute to diversely prepared students taking the same course, (4) complicate the delivery of quality classroom information by the instructor plus the synthesis and integration of information by the student and (5) adversely impact the quality of these graduates. At UAM, transfers represent approximately 30% of the total undergraduate forestry enrollment and this proportion is expected to increase.

Many of today's students have access to computer-related technologies at home and in school. These "Nintendo Kids" are often bright, well versed in computer-aided approaches to learning and working and do not necessarily respond to traditional techniques of instruction. Computer technologies as innovative teaching tools potentially provide a creative forum for reaching gifted young minds. As taught in many forestry schools, dendrology addresses aspects of plant morphology, identification, nomenclature, classification and silvics. The presentation of these subjects is well suited to computerization. Thus, the objective of this initiative was to develop computer-aided tutorials in plant morphology, classification, identification and nomenclature for use by resident and distant students in dendrology.

MATERIALS AND METHODS

ToolBook[1] 3.0 was loaded on a 155 MHz pentium IBM clone with 32 MB RAM, 2.0 GB hard drive and 32 bit real color video card. Tutorials based on Toolbook were developed in plant morphology plus identification and nomenclature. A dichotomous key and silvics tutorial are in progress. HyperText Markup Language (HTML) was used to develop a set of notes stored on the WWW (address http://www.uamont.edu). Undergraduate students developed all tutorials which include professional terms "hotlinked" to a dictionary and graphic images of the feature to be studied. In these learning aids, names follow those of Cronquist (Harlow et al. 1996).

Lecture Notes

HTML was used to develop a set of files containing lecture notes covering approximately 120 native and exotic woody trees, shrubs and vines of the upper Coastal Plain in the Western Gulf Region and introduced in Dendrology Laboratory I and II. Weekly laboratory exercises are stored in separate files containing approximately 15 woody species selected from diverse habitats and forest communities. Students log on the instructor's home page on the WWW and select the lecture notes for the week of study or species desired. Tree size, leaf, twig, fruit/flower, and bark attributes are described for each species (Figure 1). Limited comments about unique properties of each species are also provided. Leaf, twig, fruit/flower and bark are "hotlinked" to color graphic images illustrating the attribute. This tutorial supplements traditional laboratory instruction by allowing students to review trees on sites many miles from campus and print a set of corresponding lecture notes at their convenience.

LAB 1- FRONT DOOR OF FORESTRY BUILDING

Species covered include:
green ash, sawtooth oak, weeping willow, eastern redbud, water oak, ginkgo, pecan hickory, cherrybark oak, red mulberry, white ash, common persimmon, eastern redcedar

page		
630	**green ash**	**Oleaceae**
	BRF	**Fraxinus pennsylvanica**

1. small to medium sized tree reaching 50' in height and 20" in dbh
2. **leaf**: opposite, pinnate, compound, 6" - 10" long; blades, elliptical or lanceolate to ovate - lanceolate; surfaces lustrous green above and below or paler beneath
3. **bark**: interlacing diamond shaped ridges in the bark; narrow fissures
4. **twig**: moderately stout with bud sitting on top of a U-shaped leaf scar
5. **fruit**: dioecious; a samara with slender seed; wings tapering midway along the seed
6. habitat: bottomland sites
7. wood sold as white ash; used for baseball bats, tennis racquets, hockey sticks, oars and other play-ground and sports equipment

etc.

Figure 1. An example of the HTML lecture notes for Dendrology Laboratory I and II. A computer file exists for each of 12 weekly exercises. Each file contains descriptions, complete with "hotwords" in bold type and linked to graphic images of the leaf, bark, twig, and fruit for approximately 15 species.

Plant Morphology

Taxonomy requires the development of a professional vocabulary and mastery of the application of these new terms

and concepts for woody plant identification. The characteristics of leaves, twigs and fruits are among the features used during woody plant identification. The objective of this tutorial is to help students learn the types and characteristics of leaves, twigs and fruits including but not limited to (1) leaf arrangements, types, margins, apices, bases, venation, shapes, and surfaces (Figure 2), (2) twigs, their buds and scales, plus lenticels, vascular bundles, spurs, pith, thorns and spines and (3) fruit types of both fleshy and dry simple fruits as well as multiple and aggregate compound fruits. The computer presents leaf, twig and fruit features for comparison and mastery leading to the development of visual recognition skills and vocabulary needed for consistent identification of woody plants.

Identification And Nomenclature

The purpose of this tutorial is to drill students on the identification and nomenclature (including spelling and capitalization) of species of the upper Coastal Plain in the Western Gulf Region. The data base for this tutorial consists of approximately 120 species. A separate game exists for each week, midterm and final laboratory experience. Students select the file for the week or species they wish to study. The computer presents a graphic of a feature (leaf, twig, flower/fruit, habit), a description of the feature and a question: "The Common Name Is?" or "The Scientific Name Is?" (Figure 3). Students read the description for an attribute and study the graphic. If necessary, students click on words "hotlinked" to a dictionary. Furthermore, students may select from other features (leaf, fruit/flower, twig) by clicking on the icon for that feature. After examining the desired feature(s), students enter a reply in the answer box. If the computer detects an error in the answer, editorial symbols are used to help students recognize and correct the mistake (Table 1). The computer allows three attempts, checking each for spelling and capitalization and tabulates a score based on the first attempt, similar to an exam. At the end students are provided a score as if an exam had occurred.

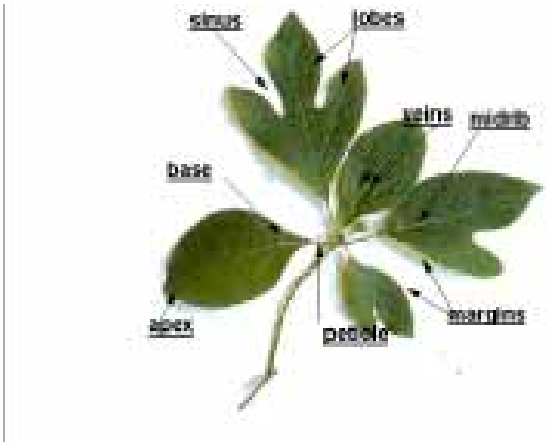

Figure 2. A graphic used to illustrate parts of a simple leaf.

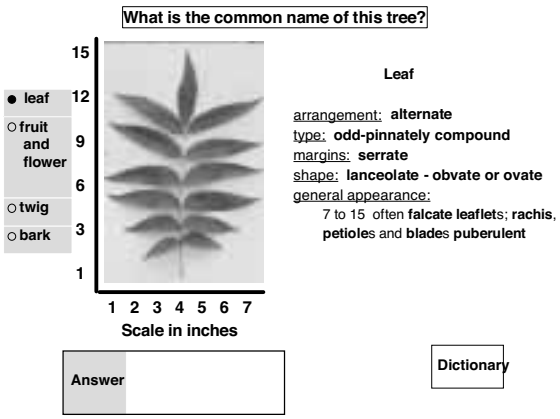

Figure 3. Water hickory (Carya aquatica (Michx. f.) Nutt.) as generated by the identification and nomenclature tutorial. Descriptions in bold are linked to a dictionary. Descriptions and graphic images of fruit and flower, twig, or bark are available by clicking on the icon.

Table 1. Editorial symbols used by the identification and nomenclature tutorial to aid students in correcting a misspelled response.

Symbols	Error Explanation
△	Word Missing Here
>	Missing Character After Here
<	Missing Character Before Here
X	Wrong Word
x	Extra Character
=	Wrong Character
~	Transposed Letters

Dichotomous Key

This tutorial illustrates and assists in the development of the vocabulary and logic needed to identify unknown species using a dichotomous key. Development of this tutorial is in progress. The present scope is to include approximately 200 species of the upper Coastal Plain and Western Gulf Region.

The computer presents paired questions (dichotomous key format) with technical terms "hotlinked" to a dictionary. For example, initial questions will be similar to:

Go to Question

Are leaves **opposite**, **simple** and **deciduous** ?
1. Are leaves un**lobed** 2
1. Are leaves **palmately lobed** 44
(Maple graphics)
2. Are leaves **heart-shaped** 67
(Catalpa graphics)

2. Are leaves **ovate, elliptical, lance-shaped**, or **oval** . . . 3

3. **Stipule**s or their scars, present 4
3. **Stipule**s or their scars, lacking 4
etc.

Are leaves **opposite**, **compound** and **deciduous**?

a series of questions here, similar to those above

Are leaves **alternate** , **simple** and **deciduous**?

a series of questions here, similar to those above

By clicking the mouse on bold words (above: opposite, simple, deciduous, ovate, elliptical, stipule, etc.), students read the definition and/or view the graphic image illustrating the technical term. When ready, a click of the mouse returns the student to the original position. Progression through a series of these questions moves the student closer to identifying the unknown species.

Silvics

The purpose of this tutorial is to inform the student of unique ecological, edaphic, hydric, phenological, etc. characteristics fundamental to healthy forests and trees. The computer provides brief essays on each tree species including, but not limited to, a distribution map, site preferences, common associates on these sites, flowering habits, uses, special regeneration characteristics and pest problems. Key words and properties associated with each species will be "hotlinked" to a dictionary. The data base will be the same 120 species as for the previous tutorials above.

Approach and Results

As freshmen, dendrology students are exposed to the information superhighway via the student computer laboratory and the campus network. Students use the computer laboratory for access to the UAM home page (address http://www.uamont.edu) in route to the instructor's home page. Users visited the course outline, course assignments and projects, lecture notes and sample exam questions an average of eight times per day during the fall of 1997. Visitors included members of my classes as well as high school students and teachers in the state and alumni from the region.

An e-mail discussion group was established by developing a distribution list of all students in Dendrology Laboratory I. By using the distribution list, questions and replies are circulated to classmates and the instructor. Some students rarely contributing to class discussions were regular e-mail users. Apparently, some students like to investigate their questions prior to seeking help while others prefer to prepare questions in privacy and at their pace. E-mail provides the flexibility needed for both learning styles and the distribution list helps students learn from each other. Students wishing to not use the distribution list may still use conventional e-mail for assistance. Attendance has not suffered as a result of electronic access to course materials and the instructor.

SUMMARY

PC-based tutorials and a format for electronic discussion groups are presented as part of a package for computer-aided instruction in dendrology for both resident and distant students. The user-friendly tutorials provide easy access to approximately 120 species of native and exotic woody trees, shrubs and vines of the upper Coastal Plain of the Western Gulf Region. The self examination segment of the software allows students to pretest their skill and knowledge in the morphology, identification, and nomenclature of forest species as part of their preparation for actual examinations. The electronic discussion groups helps students learn from other students while catering to diverse learning styles and study schedules. This approach to dendrology is nontraditional and appeals to the high-tech appetites of "Nintendo-Kids" and for the computer challenged students, encourages computer literacy early in their collegiate career. After one semester of use, experience suggests computer-aided instruction in dendrology effectively caters to diverse learning styles and study schedules without reduced participation in traditional classroom experiences.

LITERATURE CITED

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[1] Registered trade mark of Asymetrix Corporation.

FORESTRY CURRICULUM DEVELOPMENT AT CHEMEKETA COMMUNITY COLLEGE: METHODS TO ENSURE STUDENT SUCCESS

Ara K. Andrea[1] and Wynn W. Cudmore[2]

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ABSTRACT: To better prepare technicians for the future workplace, the National Science Foundation created a new program in 1994 that supported attempts to improve technical education across the nation. The Advanced Technological Education (ATE) Program promotes exemplary advanced technological education at the national and regional levels through support of curriculum development and program improvement. One of the ATE "Centers of Excellence," the Northwest Center for Sustainable Resources (NCSR), in Salem, Oregon, addresses improvement in natural resources education. Since its inception in 1995, the center has developed and revised curricula in forestry, fisheries, wildlife, and agriculture programs at five community colleges in Oregon, Washington, and California. The Chemeketa Community College Forest Resources Technology (FRT) program, in Salem, Oregon, under funding provided by the NCSR, is undergoing extensive curriculum updating.

Forestry departments of community colleges are challenged with providing curricula that effectively mirror the skills students need in their potential places of work. This paper describes the efforts of curriculum developers at the Chemeketa Community College FRT Program to assure that a newly developed curriculum is relevant to the demands of employers, provides appropriate general education skills to students and parallels current thinking in natural resource management. Chemeketa's FRT program is in the process of developing course work that reflects qualitative data gathered from current literature, a DACUM task analysis, and interviews conducted with representatives from the public, private, and academic sectors of forestry in the Northwest.

An overview of the data gathered reveals some predominant educational needs of today's two-year forestry students: 1) exposure to a broader base of biological science and sociology courses, 2) more proficiency in written and verbal communication skills, 3) an understanding of what their intended job entails, 4) exposure to newer natural resource technology, such as GIS and GPS tools, 5) proficiency in some basic technical forest measurement skills, 6) aptitude in algebra, trigonometry and statistics, and 7) introduction to specific forestry courses.

GENDER ISSUES IN NATURAL RESOURCES MANAGEMENT: PREPARING FOR DIVERSITY IN THE WORK PLACE*

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ABSTRACT: Women comprise a growing number of undergraduate and graduate students who are pursuing degrees in the natural resource disciplines. Likewise, women represent an ever increasing percentage of natural resource professionals. Gender issues thus become a relevant attribute of training for both women and men so that awareness may lead to improved, stable and productive working environments.

This paper's goal is to assist in increasing understanding of gender issues in natural resource management by discussing a course that addresses gender issues relevant to natural resource disciplines and the professional work environment. Awareness by both women and men of gender issues that affect the working environment may help prepare professionals to enact change in some current behaviors and practices. The goal of this paper is to include both women and men in this awareness building.

This paper gives a brief history of a gender diversity course which has been taught in the College of Natural Resources at Utah State University since 1992. The course has three principal objectives. First, the course seeks to empower students to address gender issues in natural resource management by assisting them to acquire knowledge of sociological issues involved in gender stratifications in society and to help students develop skills for recognizing and assessing gender-specific images, languages and policies. The second objective is to stimulate discussion in the College of Natural Resources about gender roles in the natural resource professions through college-wide presentations or seminars by interested students or faculty. Thirdly, the course seeks to encourage participants to pursue further education on sociological and cultural issues that affect natural resource management.

The course is broadly composed of two sections. First, sociological conceptualizations of gender and feminist theory are discussed in the context of the culture of science with a focus on the natural resources. Using this theoretical and conceptual basis, the second part of the course examines women's roles in the natural resource professions and the challenges they experience in the work place. Special attention is directed to the challenges women experience as scientists and strategies they have developed for successful contributions in their fields. Discussions focus around issues of affirmative action, backlash to equal employment opportunity programs and the role of mentoring for enhancing professional growth. The paper is enhanced by a home page available on the Internet so that the course contents can be applied to in-service training sessions in the natural resource agencies.

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ASSESSING THE WILDLIFE INFORMATION NEEDS OF FORESTRY PROFESSIONALS, POLICY MAKERS, AND NATURAL RESOURCE EDUCATORS

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Public concern over stewardship and conservation of biological diversity have caused a reduction in the timber supply from federal lands in the Pacific Northwest. This reduction in the availability of federal timber has resulted in an intensification of management activities on private forest lands. The reduced timber supply has also increased timber prices to the point that many non-industrial private woodland owners, who previously were not interested in selling timber, have entered the market. This intensification of management activities on private forest lands has resulted in increased concerns for fish and wildlife species, especially those that are threatened, endangered, or sensitive. Reliable and readily accessible information about these species is crucial to the resolution of such concerns.

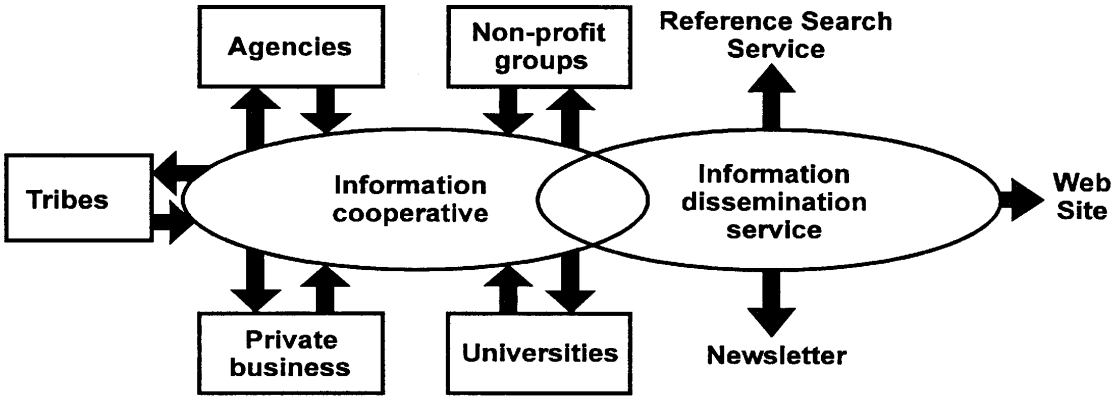
Elevated concerns for fish and wildlife species in forested habitats of the Pacific Northwest have resulted in considerable research and subsequent regulatory activity. However, forest managers, technical staff, policy makers, natural resources educators, and the public often have difficulty accessing information concerning species ecology and habitat requirements, management strategies, socioeconomic impacts, and the implication of policies and regulations. Although information is available from a variety of sources, including journals, research centers, education programs, and experts and specialists, the fragmented nature of these sources restricts accessibility to needed information. Currently, centers and other sources that provide these publics with credible, comprehensive information are often not well known or easily accessible.

In the spring of 1997 the authors conducted a phone survey of 59 natural resources professionals to assess the need for an information center focused on threatened and endangered species in forest managed for timber production. Included in those surveyed were biologists and managers (approximately 50%), elected and non-elected policy makers and administrators (approximately 25%), and education and public information specialists (approximately 25%). The survey addressed three major questions: 1) what are the current information needs of these targeted user groups (and where do they currently seek that information); 2) how successful are they in acquiring the information they need (and what are the major barriers they encounter); and 3) what new information services might they need or want (and what type of information and form should the service take? In the fall of 1997, phone survey respondents were mailed a questionnaire investigating their willingness to pay for three types of services suggested in the phone survey; a web site, a newsletter, and a reference search service.

Results were used to assess the need and lay the groundwork for a new information center on threatened and endangered species in managed forests at Oregon State University. We propose an information center with a two-pronged mission (figure 1): 1) to improve the flow of information on threatened and endangered species between those who generate it and those who use it; and 2) to improve the flow of information on threatened and endangered species among the scientists and organizations who generate new information.

Insufficient coordination between organizations providing information is a primary reason professionals involved with natural resource issues are often unable to find what they need. The proposed cooperative of information generators would facilitate communication and information transfer by: 1) providing a single source where natural resource professionals can be directed to needed information; 2) determining holes in the current knowledge about threatened and endangered species; and 3) reducing unnecessary duplication of research projects and other programs. An effective information cooperative would save

Figure 1. The cooperative would facilitate the transfer and sharing of information between groups. The information dissemination service would centralize multiple-group information and make it available via different formats.



all its participants time and money while facilitating effective management and policy development for threatened and endangered species.

The proposed cooperative would consist of formal relationships between itself and its members. Cooperative members (such as agencies and non-profit groups) would make information available to the cooperative. In return, the cooperative would: 1) help its members and others locate and retrieve information generated by member organizations. Natural resource professionals having difficulties finding needed information could contact the cooperative. The cooperative would actively seek needed documents and sources and assist retrieving the information and passing it along to users; 2) facilitate communication between natural resource professionals from participating groups. The cooperative would help its members seeking information by putting them in contact with experts, specialists, and information managers in other groups who have what they need to know, thereby establishing inter-group networks; and 3) update cooperative members about activities and policy changes of other information generators. This could be done via an internal document, a listserve or newsgroup, and/or a web site.

The proposed information dissemination service should centralize and distribute information about policies and regulations, on-going research and demonstration sites, and species ecology, habitat, and population dynamics from multiple groups. Other types of information pertaining to threatened and endangered species could be included as the center gains momentum. Information should initially be disseminated via a newsletter and a web site. The newsletter should summarize new research and projects and bring to attention new sources of information. The web site would connect users to other credible sources for threatened and endangered species information, including other web sites and sources without internet access. As the service stabilizes, the web site could include an internet version of the newsletter. When the center establishes its clientele, a reference search service could be added.

Many groups already disseminate information. The intent of the proposed information service is not to replace or interfere with existing programs. The intent of the center is to provide one place that helps natural resources professionals find needed information more efficiently by directing them to existing sources, such as the services provided and literature generated by other groups.

UTAH STATE UNIVERSITY'S ACADEMIC PROGRAM IN WILDLIFE DAMAGE MANAGEMENT

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Wildlife damage management is the buffer between wild animals and people. This field attempts to enhance human-wildlife relations by resolving conflicts between humans and wildlife and increasing the positive values of wildlife. In 1990, Utah State University realized that its students' education in this area was lacking and created an academic program in wildlife damage management with the support of the U.S. Department of Agriculture, Animal Plant Health Inspection Service, Wildlife Services. Two years later, USU's program expanded and became the Jack H. Berryman Institute for Wildlife Damage Management which is part of the Department of Fisheries and Wildlife and the College of Natural Resources. The Berryman Institute has education, research, and extension components. The Berryman Institute currently has 17 faculty members, 29 graduate students, and 11 undergraduates. During its last biennial period, Berryman Institute members organized 12 national symposia, presented 99 papers and seminars at scientific meetings, and published 48 papers. Six courses in wildlife damage management were conducted last year: Principles of Wildlife Damage Management, Techniques in Wildlife Damage Management, Urban Wildlife Management, Wildlife Fertility Control, Predator Ecology and Management, and Directed Readings in Wildlife Damage Management.

AN EMPIRICAL EXAMPLE OF TRADEOFFS BETWEEN TEACHING AND RESEARCH

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ABSTRACT: Continuing public pressure on major research universities has caused a reevaluation of the balance between teaching and research. The preeminence of research is being questioned, and the focus on teaching and credit hour generation has been stated to be dominant at many institutions. Many states have begun to fund programs based on enrollment or credit hours generated, causing significant changes in the orientation of academic programs at Research I institutions. These changes in funding and philosophy suggest that research productivity may decline, and teaching quantities should increase.

Based on a two-year snapshot of faculty productivity in the NC State Department of Forestry, an empirical estimate of the tradeoffs between teaching and research was made. Teaching and research are considered multiple outputs produced by a single input (faculty). This represents a simple production possibilities curve. The tradeoffs occurring from 1995 to 1996 in faculty outputs were measured using a simple marginal rate of product substitution (MRPS) calculation. Results indicate that the anticipated inverse relationship between teaching and research productivity does hold, and indeed that more teaching greatly decreases research outputs at the current margin.

A few summary statistics from the calendar year 1995 and 1996 accomplishment reports provide revealing snapshots of changes in productivity and focus in our programs, and the tradeoffs involved in some of our strategic directions. The statistics for number of credit hours taught, academic publications, grants received, and speeches by departmental faculty are summa-

rized below. As expected, we have increased our efforts to teach more credit hours, and fortunately, have been moderately successful. This increase, however, has been associated with a proportionately larger decrease in our research productivity. Some of this may be coincidental, but the magnitude suggests that some is related.

Output Indicator	1995	1996	Change	% Change
Teaching Credit Hours	3456	3842	386	11.2
Research Grants (no.)	70	55	- 15	- 21.4
Grants Received (mm $)	5.6	4.5	- 1.1	- 24.4
Refereed Publications	54	35	- 19	- 35.2
Total Publications	117	105	- 12	- 10.3
Professional Speeches	155	141	- 14	- 9.0

Based on the data summarized above, one can calculate the "cross-product elasticities" or marginal rates of product substitution that might approximate the magnitude of the tradeoffs involved in teaching more and researching less. Elasticities are unitless measure that estimate the proportional change in one output versus another. For two outputs (teaching/research) and one input (faculty time), one would expect some negative elasticity measure if the outputs were competitive. The best judge of scientific productivity still probably is research grants awarded and refereed publications—indicators of success in the judgment of scientific peers. Specifically, the relevant teaching/research elasticities (Marginal Rates of Product Substitutions, MRPS) can be calculated as:

Teaching Credit Hours for Total Grant Funding:	MRPS = -2.18
Teaching Credit Hours for Refereed Publications:	MRPS = -3.15
Teaching Credit Hours for Total Professional Publications:	MRPS = -0.92

In brief, this suggests that there is a very high elasticity of product substitution between teaching more credit hours and receiving grant funds or publishing refereed papers, and a almost proportional elasticity of substitution for the overall publication rate. For example, the elasticity of substitution for grants and refereed publications amounted to about 3 times as much, indicating that a 10% increase in credit hour generation "cost" about a 30% decrease in research productivity, at the margin. This would not hold for the entire range of production possibilities, but even at the margin it would suggest that we can drive research into the ground quickly by even a 20% to 30% increase in credit hour generation. Doubling the credit hours generated, without some significant structural change in the way we teach (e.g., eliminating field classes), could well decimate intensive research programs. This would reduce the reputation of leading graduate research programs, prevent us from getting funds to pay graduate student stipends, and not do much for morale either. While some change in NC State's forestry productivity may be coincidental, surely some is due to the focus we are placing on teaching. We reward teachers more, based on priorities perceived from the College and the University. Faculty have tried to teach more on the margin. And furthermore, this focus probably infers or suggests psychologically that research productivity is not that important. Given that it is difficult to write and obtain grant funds or publish refereed journal articles (and be rejected), we do need to be careful about sending messages that research is not important.

The balance among teaching and research activities is crucial for all departments of forestry and natural resources. Teaching appears to have a very high opportunity cost in terms of foregone research. This can reassure teachers who have feel their work is under-appreciated. But it also must worry administrators who want to build academic reputations and strong graduate programs based on external funding. Extension or corroboration of these preliminary findings would of course be desirable. I unfortunately will have to leave that to researchers who have more time because they are not teaching much or administering large programs.

EDUCATIONAL PARTNERSHIPS

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ABSTRACT: A key objective of the professional forestry program in the School of Forestry at Northern Arizona University (NAU) has been to prepare students to become practicing land managers. But in a state where the vast majority of the commercial forestland ownership rests with the federal government or in tribal holdings, providing NAU students with exposure to private forestland management practices is difficult.

To help address this issue, the authors began to develop a partnership with among School of Forestry, VESTRA Resources, Inc., and Louisiana-Pacific Corporation (L-P). This effort was initially supported by a grant obtained from NAU's Office of Instructional Development and by funds provided by the Chair of the School of Forestry. The original intent of the grant proposal was to acquire forest inventory data to use to create a case study in ecosystem management as part of the junior year professional forestry curriculum. Initially, the goal of this case study was to combine two already inter-related components of the forestry curriculum: Stand and forest level management.

This effort has generated benefits for all parties involved. For the NAU forestry program, the strong links with VESTRA Resources have allowed us to further the development and application of forest ecosystem management decision support systems. Relationship with one of their clients, Louisiana-Pacific Corporation, has provided us with an opportunity to acquire "real world" case study materials to use in the curriculum. We have also extended the discussion into other avenues to develop these partnership relationships.

For VESTRA Resources, the partnership provides a unique opportunity for development and validation of new or improved approaches to forest ecosystem management planning and decision support. VESTRA has received valuable feedback on the effectiveness of analysis methodology in their decision support software, and how the software tools and interfaces can be changed to improve their usability. The partnership has also helped to incorporate some of the latest concepts and approaches into the system. The real advantage of the partnership is that it provides a more rapid and complete advancement of the science and technology needed for managing natural resources in the information age.

Louisiana-Pacific seeks to partner with Northern Arizona University around the issue of decision support tools for several reasons. L-P does not have the expertise to internalize the continuing development of such tools to advance the utility of the analytical process. L-P wants and needs to find future resource professionals who have a working knowledge of the processes and tools needed to create sophisticated planning documents. And L-P would very much like to share its experience in developing decision support systems and documents with resource-based university programs to meet its social as well as regulatory obligations. L-P believes that Northern Arizona University has positioned itself to meet the needs of forest resource companies and can provide the theoretical as well as practical skills through its faculty, staff, and students that will help meet the needs of companies seeking to use advanced forest management planning tools.

ON-LINE GIS INSTRUCTION AT THE NORTH CAROLINA STATE UNIVERSITY COLLEGE OF FOREST RESOURCES

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ABSTRACT: The College of Forest Resources GIS Research and Teaching Program at North Carolina State University has developed a student directed learning program for GIS applied to Natural Resource Management. Students in the introductory GIS course independently learn elementary spatial analysis over the computing network and apply these concepts in the professional development courses. The core of this two year GIS curriculum design effort is the campus-wide GIS delivery system. This system is a cooperative effort among the NC State Libraries, the Instructional Technology Office, and the College of Forest Resources. The Libraries house and maintain the spatial data and provide assistance to users, the Informational Technology staff provide the delivery of GIS to over 2000 campus computer seats, and the College delivers the formal instruction program and houses the spatial analysis research effort. The instruction program is centered on student laboratories that are offered on the World Wide Web. Students review the material demonstrated in class and practice application of this material in a "virtual" laboratory environment. Homework submission and return, help sessions, and project presentations are all done electronically. This paper highlights the on-line GIS instruction system, curriculum, laboratory exercises, and student evaluations of this on-going effort.

USE OF COLLABORATIVE TECHNIQUES TO PROMOTE LEARNING IN AN ENVIRONMENTAL PROBLEM SOLVING COURSE

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ABSTRACT: NR 206, Environmental Problem Solving and Impact Assessment, is a senior-level course, the last in a sequence of seven CORE courses required of all students in our School of Natural Resources at The University of Vermont. These students represent seven different majors. Development and presentation of this course, which I began teaching in 1993, has proven to be the greatest teaching challenge I have faced in my 28+ years at the university. Although I have offered the course seven times (it is now offered both semesters), the course is still evolving; one of the major changes is that we now spend much more time in student collaborative (i.e., 'group effort') activities rather than in the typical 'lecture-listen' format. In this abstract, I briefly summarize the course content and some of its current activities.

I. Course content — The course focuses on the following topics: 1) concepts of environmental problem solving; 2) environmental impact assessment; 3) process of environmental problem solving as mandated by the National Environmental Policy Act (NEPA); 4) group dynamics as they pertain to environmental problem solving; 5) decision making (under conditions of certainty and uncertainty or risk); and 6) risk assessment.

II. Collaborative activities and other processes to promote learning in a less stressful environment:

1. Food and drink — The 'lecture' portion of the course meets from 9:30 till 10:45 a.m. on Tuesdays and Thursdays. For many students, this is their first class of the day. Consequently, I provide free coffee, tea or hot chocolate. Students are required to bring in their own non-disposable cups, and they are asked to sign up to bring in 'goodies' twice during the semester. Each class period, about four students bring in 'goodies' (which usually vary from fruit, to donuts, bagels, or homemade muffins). This activity has proven to be very popular; it appears to produce a much more relaxed learning environment.

2. Text — Although many texts are available dealing with individual components of this course, i.e., problem solving, environmental impact assessment, NEPA, group dynamics, etc., no single text covers all topics. Consequently, during our recently completed Christmas break, I compiled all of my lecture notes into a broad compendium and made it available to the students ($10). Students are expected to complete the reading assignment (usually less than 20 pages) before each class period.

3. 'Lecture' format — Rather than providing 75-minute lectures based upon the assigned readings, much of the 'lecture' time is now spent having groups of students respond to questions designed to promote creative and critical thinking. The process for doing this is outlined below. Mini lectures are provided as needed.

4. Student involvement (collaborative activities) — Students are involved in several teams, usually with 4 or 5 students per team:

a) 'Lecture' teams — At the beginning of the semester, students were asked to form a 4- or 5-person team of their choosing, and each team was supplied with a notebook to record responses to questions I pose. Throughout the semester, usually at least once or twice per class period, I will pose some type of question, which requires critical or creative thinking. After the question has been posed, the students meet in their individual group, record their responses and record the names of all group members present. I collect these 'Activity Journals' at the end of each class period, look over the responses, and use them as the basis for comments during the following class. Responses are not 'graded', but I keep a record of who was involved and this comprises 15 % of each student's course grade.

b) Teams to complete an Environmental Impact Assessment — Students are formed into approximately 5-person teams that are as heterogeneous as possible (based upon their college major) and are given information regarding an actual land management project proposed to take place on a nearby national forest. Each team visits the project site and is required to complete an Environmental Impact Assessment for one environmental component (e.g., water quality, aesthetics or wildlife, for example) that might be affected by the proposed project. Each team's activities result in the preparation of a chapter for a document, which, in total, summarizes the expected environmental impacts of the proposed project. In addition to their written document, each team makes an in-class presentation of its findings.

c) Teams to complete an Environmental Assessment — Working in the same teams as those described above and working on the same proposed project, students complete an Environmental Assessment (EA) prepared in compliance with requirements of the National Environmental Policy Act (NEPA). This assignment requires that teams: 1) prepare a 'scoping' letter to identify issues of public concern (students in another of our CORE courses act as the public and respond to this scoping letter); 2) develop viable alternatives that work toward solving the initial problem and address the identified key issues; and 3) assess the expected impacts that each alternative would have on each of the identified key issues (much of this information is derived from techniques described in the previously prepared Environmental Impact Assessment). After finishing their Environmental Assessment, students prepare a Decision Notice and complete the NEPA process in a public meeting during which individual teams present and defend their decisions to the same group of students who responded to the scoping letter.

5. Exams — Students complete two in-class exams, a mid-term and a comprehensive final. Exams are not 'open book', but students may bring in two pages of any 'notes' they'd like. In addition, in order to promote teamwork and to foster learning, students have the option of completing the exams individually or working with one other student of their choosing.

In my presentation, in addition to providing more details on the activities described above, I will:

1) involve the audience in developing group responses to some of the questions I have posed this semester in my problem-solving course;

2) describe some of the student-based, instructor-based, learning environment-based and institution-based challenges facing those who implement collaborative learning activities; and

3) show samples of my course syllabi, draft text, "activity journals", and recently completed student projects (Environmental Impact Assessments, and Environmental Assessments and Decision Notices).

INTERDISCIPLINARY CAPSTONE COURSE: THE MIZZOU EXPERIENCE

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During the winter semester of 1992, in response to a university-wide mandate through its General Education Program for each academic unit to have a capstone experience in their degree programs, the School of Natural Resources initiated an interdisciplinary course that would bring together students from forestry and fisheries and wildlife. After eight years, the capstone course has grown to include students from Parks, Recreation and Tourism as well.

The process of developing the interdisciplinary capstone experience has been driven by our vision to produce a learning experience in which the student can feel comfortable and confident in working as a productive member of an interdisciplinary team on a complex natural resource problem. In this developmental stage both student and instructors have benefitted from the experience. The students have identified the importance of working within interdisciplinary teams to solve natural resource conservation problems and a need to work effectively as a member of a team. At the request of students, a "team building" exercise was added to the class to help the students understand the personality types that might be represented on teams and how to best blend these "types" to help the team function smoothly. Other actions taken to improve the quality of the capstone experience included providing the students with feedback on their plan from a panel of outside reviewers and requiring the students to incorporate the panel's feedback into their final draft.

The ultimate goal of the capstone experience is the achievement of the desired outcomes for the student. Based upon an evaluation of the capstone experience the students realize that cross-disciplinary teamwork is essential to address today's complex natural resource problems. Likewise, they tell us that they feel more comfortable and confident in using the knowledge and skills they have gained in the classroom.

This paper will describe the course, outline our vision, and share in the actions taken in the past and projects designed for the improvement of the course in the future.

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FORESTRY EDUCATION AND EMPLOYMENT: VIEWS FROM ALUMNI OF A SOUTHERN FORESTRY SCHOOL

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ABSTRACT: Forestry alumni of the School of Forest Resources at Mississippi State University were surveyed to elicit their views on curriculum improvements and employment success in their fields of study. The Forestry major consists of two options: Forest Management and Wildlife Management. About two thirds (68%) of responding Forest Management alumni worked in private forest industry. Interestingly, more Wildlife Management Option graduates were employed in a forestry-related (50%) enterprise than a wildlife-related enterprise (about 38%). Almost one third (31%) of the forestry jobs held by wildlife graduates were in timber procurement.

Results of the survey suggest the need for curriculum improvements that enhance communications and personnel management skills, agreeing with several critics of both natural resources education and the forestry profession. At the same time, a more practical, field-orientation approach to forestry programs has been suggested, particularly as it pertains to subjects like timber procurement - an area in which many Forest Management and Wildlife Management graduates are employed. In an already often crowded curriculum, the challenge will be to maintain a balance between a broad-based education of citizens who are aware of and appreciate the world around them and a more focused training of foresters who are well grounded in the practices and theories associated with forest science. This has become an increasingly difficult task in many programs in which requirements for accreditation and/or certification encounter university policies to decrease the number of credits required for graduation.

That a significant number of Wildlife Option graduates are employed in forestry-related jobs, many of which are in timber procurement, reinforces the value of forestry training for some undergraduate wildlife students, particularly those not planning to continue their education beyond the baccalaureate level. This notion is reinforced by the objectives of the Wildlife Management Option that are clearly articulated in the Bulletin of the Mississippi State University: (1) "provides education necessary for today's multiple use management of our forest land;" (2) "prepares the student for a number of wildlife management positions and fulfills requirements for certification as a Wildlife Biologist by the Wildlife society," and (3) "most important, it prepares the student for graduate work in the wildlife ecology area. The M.S. degree in wildlife ecology is almost necessary for employment in this field."

That almost 86% of recent Wildlife Option graduates were employed in either forestry or wildlife careers and almost 95% of recent Forest Management Option graduates were employed in their field is encouraging. Statistics like these may be important recruiting tools for this program, and perhaps others like it in the South.

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BENEFITS OF UNDERGRADUATE PARTICIPATION IN FACULTY RESEARCH IN NATURAL RESOURCES

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ABSTRACT: Graduate student assistance with faculty research is common in university natural resource programs. Traditionally, undergraduate students are involved less with research programs of faculty. The Uintah Basin Branch Campus of Utah State University provides a unique setting for developing research projects in natural resources that involve undergraduates. We use a research project on the control of greasewood (Sarcobatus vermiculatus) in the Book Cliffs, Utah to illustrate the benefits and challenges for undergraduate students and faculty of collaboration on research. Students benefit by interacting with faculty outside the classroom; by applying classroom learning to field problems; and by working with natural resource management personnel. Faculty benefit by observing the ability of students to apply classroom learning to field situations; by maintaining a scholarly research program; and by interacting with students outside the classroom.

APPLYING THE MASTERY LEARNING MODEL IN A WILDLAND RECREATION PLANNING AND MANAGEMENT CLASS

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ABSTRACT: Wildland Recreation Planning and Management is a 400 level course taken by Wildland Recreation majors (B.S. in Forestry) in the spring semester of their Junior year prior to their summer internship. Due to the number of field trips taken during the semester, the course is limited to 12 students. Generally 7-9 students are Wildland Recreation majors with the remaining students from Wildlife and Fisheries Science, Ornamental Horticulture and Landscape Design, or Liberal Arts. The course meets once a week from 12:40 to 6:30 pm although the class period varies with the use and length of field trips.

The Mastery Learning approach in this class evolved out of the desire to raise the competency level of students in preparation for their internship experience and their future professional careers. In particular, the need for a mastery approach was based on the demands and expectations placed on the students by their internship experience. In their internships, students address issues and concerns associated with visitor and resource management often in presentations, conversations, and meetings with people from different backgrounds and disciplines. Essentially, the students are communicating with and educating the public and other professionals about concepts related to resource protection and visitor management.

Assuming that competency in answering multiple choice questions or even essay questions does not mean that a student is prepared for the role of a new professional in an internship, what will prepare students to assume this role? In part, the proposed solution is to actively engage students in learning the course material; that is, listening, talking, speaking, and openly discussing and criticizing ideas and concepts in a sometimes competitive, but otherwise friendly and supportive environment. This environment is more characteristic of professional work settings than the traditional classroom. The assumption is that familiarity with this type of experience in the classroom will help prepare students for similar experiences in their internship and the workplace. This type of interaction in the classroom also allows for immediate assessment, feedback, and re-assessment which is the cornerstone of Mastery Learning Theory.

According to McCabe (1997), the Mastery Learning Model is based on four hypotheses proposed by Bloom. They are:

(1) "A normal person can learn anything that teachers teach." (Time is the limiting factor.)
(2) "Individual learning needs vary greatly." (Using a variety of learning techniques will enhance learning for the class as a whole.)
(3) "Under favorable learning conditions, the effects of individual differences approach a vanishing point, while under unfavorable learning conditions, the effects of individual differences is greatly exaggerated." Is lack of student success in the classroom attributable to poor students or the lack of a favorable learning environment?
(4) "Uncorrected learning errors are responsible for most learning difficulties." Evaluation, feedback and re-evaluation is the key to learning and a basic psychological precept in learning theory.

In the mastery approach in wildland recreation planning and management, students are given a syllabus with twelve general questions. The objective for the class is for all students to be able to converse intelligently about the information associated with the answers to the twelve questions by the end of the semester. Throughout the semester, the students are actively engaged in and challenged by the course material -- listening, speaking, criticizing ideas, and having ideas criticized in a supportive environment. Students are randomly called on to answer questions. Exams involve applications of concepts and problem solving exercises in short essay format. Answers are stringently graded, returned and discussed with those providing high quality and innovative answers sharing their knowledge with other students. Future exams are individualized and include questions missed on previous exams. During the last week there is a review of the all course material and students are given oral exams covering all twelve questions, but focusing on areas of weakness. Any remaining weaknesses are further tested in individual final exams. This student oriented approach does not lower standards, but raises performance to a higher level of excellence in a collaborative learning environment.

As a result of the Forestry 423 class, I have greater confidence that my students are more prepared for success in their upcoming internship between the junior and senior year. Prior to using this approach, I had a limited sense of how confident I was in how well students were prepared for their internship. For almost all of the students, I now feel very confident at the end of the semester that students can function well as rising new professionals in their internship. Their self-confidence appears to be stronger as well. Certainly there are many factors other than mastery learning involved, but intern supervisors thus far have expressed considerable satisfaction in the performance of our interns, often inviting them to come back for another summer or offering them jobs. Students return from their internships indicating that they were well prepared and that material they learned was relevant to their positions. Certainly other factors common to most recreation training programs, such as interdisciplinary training in communication, human behavior, and natural resources are important in their success. There is also a self-selection factor in terms of who is more likely to choose the recreation field for a career.

Course evaluations from the first two years are significantly more positive for this course than in previous years and are high relative to the Department and College as a whole. One of the highest scores is "instructor commitment to student learning." Overall, comparative mean scores are higher (4.33) than Departmental (3.98), and College (3.89) mean scores for the two years that the mastery learning technique has been used. Four (4) is a "Very Good" rating and "5" is "Excellent."

In summary, a variety of learning methods are used to satisfy various modes of student learning in recognition that "Individual learning needs vary greatly" (Hypothesis #2). Evaluation, feedback and re-assessment are used to enhance learning (Hypothesis #4) with most students appearing to reach a higher level of excellence (Hypothesis #3). The class size and intensive class time (3-6 hours, one day per week) help overcome time as a limiting factor in teaching and learning (Hypothesis #1). These techniques, combined with student performance, seem to satisfy the basic tenets of Mastery Learning as defined by Bloom (1976). Feedback about the course seems to suggest that this application of the Mastery Learning Model (Bloom, 1976) has considerable potential in an applied professional development curriculum in Wildland Recreation Management.

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PBL -- MAKING NATURAL RESOURCE EDUCATION REALLY REAL

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ABSTRACT: A major concern in education today is making the student learning experience relevant to facilitate workforce readiness. Problem-Based Learning (PBL) is an instructional format which actively engages students in the learning process by requiring them to solve real-life problems (Arambula-Greenfield 1996, Norman and Schmidt 1992). Often times, however, the real-life experiences used are hypothetical and, as a result, simplify the problem to the point that the realness of the problem no longer exists (Nolan and Nolan 1997). Natural resource educators can make PBL activities real by having students work with local park and natural resource agencies to solve natural resource problems. Through a cooperative agreement with Monocacy National Battlefield in Frederick, Maryland, students master general ecology course content by involvement in projects to develop a natural resources inventory and to prepare a deer environmental impact statement for the Battlefield. These activities are similar to the tasks the students will perform when employed as natural resource managers, thus making the student learning experience really real and they foster the learning of fundamental ecological concepts.

Keys to successful PBL implementation include using ill-structured problems and having a well stocked reference library (Arambula-Greenfield 1996). Ill-structured problems differ from traditionally used learning problems in that there is no one correct solution, the students have insufficient prior information to adequately solve the problem and the problem definition often changes as the students gather and interpret information (Barrows 1990). PBL is an effective learning strategy because it activates prior student learning thereby facilitating new knowledge acquisition, fosters knowledge elaboration thus increasing knowledge retrieval and puts learning in a meaningful context to enhance knowledge recall (Norman and Schmidt 1992). Effective PBL better prepares students for workforce entry by improving their problem solving skills, enhancing concept rather than factual content mastery, increasing intrinsic subject/content interest, promoting self-directed, lifelong learning (Norman and Schmidt 1992) and improving causal recognition (Patel et al. 1991). Major drawbacks to implementing PBL are reeducating faculty to become knowledge acquisition facilitators or academic coaches rather than knowledge dispensers (Arambula-Greenfield 1996, Gallagher *et al*. 1992) and student unwillingness to assume responsibility for and control over their own learning. I describe the theoretical basis for PBL, outline problem solving basics, define student and faculty roles, describe the challenges for implementing PBL and present the results of a PBL activity conducted for the Battlefield. This approach to PBL is applicable across all academic disciplines and can be adapted for use in a variety of course settings

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THE DEVELOPMENT AND DELIVERY OF AN INTERNET-BASED WILDERNESS MANAGEMENT COURSE

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During winter quarter of 1996-97, the University of Montana's School of Forestry and Center for Continuing Education; provided an Internet-based wilderness management class to 23 students majoring in Natural Resources Management at the University of Minnesota, Crookston.

The course was designed to feature student's ability to interact among themselves and the instructors. The interaction was facilitated through the use of Network News Groups, chat rooms, e-mail, and live Internet conferencing. Using the Internet as a resource, assignments were designed to help students gain mastery in complimenting textbook information with wilderness information available from government agencies, universities, and non-profit groups and to apply than information toward real world management problems.

The use of this multi-layered educational delivery system allowed the students at a relatively small, remote campus to access training, resources, and expertise available through a nationally recognized center for wilderness management and philosophy. Conversely, this arrangement allowed the wilderness management distance education program the ability to expand it's audience from the traditional field manager to the college environment. The experimental nature of this offering provides an opportunity to assess educational outcomes, institutional cooperation and the emerging role of distance learning in higher education.

Evaluation of the course's success was based on strengths and weaknesses of the course as compared to the traditional classroom interaction. The evaluation included, group interviews and follow-up questionnaires. A majority of the students considered the quality of course content, discussion, interaction with instructors, assignments, presentations and improvements in learning skills to be greater than or equal to the traditional classroom environment. Criticisms of the course centered on technical difficulties and scheduling problems that arose from school closures.

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TEACHING AQUATIC ECOLOGY WITHIN ECOSYSTEM AND MANAGEMENT CONTEXTS: THE LAKE POWELL COOPERATIVE EDUCATION PROGRAM

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ABSTRACT: Resource managers are increasingly asked to work at the ecosystem level of organization and to use team approaches to address management problems. Here we describe a senior/graduate level course that helps students to understand the complexity of an ecosystem, and to begin working with a resource agency. We have collaborated with the Glen Canyon National Recreation Area (National Park Service) to find research problems that will help them manage the Lake Powell ecosystem. The Park Service receives useful research from the program, and they have partially underwritten the considerable cost of teaching the course. Projects undertaken have included studying the significance of the pelagic food web for endangered fishes, and the importance of production processes in the extensive side canyons of the reservoir.

At the beginning of the quarter, individual or pairs of students in the class choose subcomponents of the research question, then develop hypotheses by using the literature. The students, with the assistance of the instructors, write research proposals describing their hypotheses and methods for testing their hypotheses. Also included in the proposal is a section describing the student's role in the overall project. Usually the projects encompass topics ranging from physical limnology to fish ecology. The field work for the research is conducted on a 3-5 day field trip to Lake Powell where we work from a houseboat-laboratory and from axillary boats. For the remainder of the quarter, the students analyze the data as a class so that everyone learns the specific techniques. Students then process their data, integrate it with the data of others in the class, and prepare oral and written reports. The reports are edited, bound, and provided to resource agencies working at Lake Powell. Pedagogical benefits of the program for the students include: (1) students must integrate a project from conception through final report writing; (2) they must collaborate to be successful; and (3) diligence is encourages because the students realize that their work may actually be used by agency personnel and other scientists.

EXPERIENCE AND EXPERIMENTS IN INTEGRATING ECOLOGY AND ENVIRONMENTAL POLICY IN AN UNDERGRADUATE CURRICULUM

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ABSTRACT: In 1986 the School of Natural Resources (SNR) embarked on a project to define and implement an undergraduate core curriculum that integrates natural and social science in the context of natural resource education. Currently this curriculum includes seven courses (21 credits) taken over five semesters beginning in the student's first semester and ending in their last year. At the outset, the students take two separate introductory courses, one introducing them to concepts in natural science and the other introducing them to natural resources from a social and cultural perspective. This paper describes the next phase of their curricular experience, a set of three courses taken concurrently. The overall goals of the courses are to introduce and integrate theories and approaches to analysis in ecology and social science as applied to environmental issues. This paper describes our use of the concept of integration in the context of natural resource education and three models for incorporating it into this portion of the SNR Core Curriculum. Our working definition of integration involves three levels: (1) process-logistics integration, (2) content integration, and (3) framework integration. The first is related to the process of establishing and delivering the courses including management of instructor, student, and teaching assistant roles across the disciplines. The second is related to bringing together ecological and social science knowledge to provide different views of a single natural resource case or issue. The third is related to recognizing and using conceptual frameworks shared across ecological and social science.

We used three different models to incorporate these levels of integration into the set of three courses. On one end of the spectrum, three instructors taught three distinct courses. One addressed ecology, a second one addressed social science, and a third linked the other two through the use of natural resource case studies. At the other end of the spectrum, two instructors (one ecology specialist, one public policy specialist) co-taught the courses. In this model, the classes were combined into a 7-credit block, and we taught in a collaborative learning and teaching environment using case studies and student-directed projects. The third model is intermediate. It included two primary instructors and a secondary instructor. The two primary instructors each taught a distinct course (one in ecology, the other in social science) while working together with the secondary instructor to create the third component. This third component provided a complementary set of case studies, exercises, and papers which supported student learning in the ecology and social science courses while requiring students to bring together material from both.

This paper discusses the three models and compares them based on the three levels of integration. The paper also assesses the implications of the course models relative to instructor and student effort and success in achieving content and framework integration. We conclude that no single approach is necessarily best, but rather, the three taken together represent a set of tradeoffs and different opportunities for instructor and student learning and effort. Development of this component of the SNR Core Curriculum continues to evolve. An important part of this evolution is a search for a working definition of integration appropriate to undergraduate natural resource education. In our view, it is important that this search continue to include interaction and debate among members of the entire SNR faculty.

ELECTRONIC INFORMATION IN NATURAL RESOURCE EDUCATION: INTEGRATING LIBRARY INFORMATION INTO THE CURRICULUM

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ABSTRACT: Library literacy is a changing concept with the increasing use of the world wide web, electronic databases, fulltext reference sources, electronic journals, digital maps, and other electronically-available datasets.To fully prepare the natural resource student for the world that awaits her outside the walls of the academic institution, she must be literate in many areas, including the new and evolving library literacy. The future natural resource professional needs to know how to find relevant information, how to evaluate the information found, and how to assimilate and synthesize the information into his own work, and how to present his work in electronic format as well as print. Libraries now provide services that will enhance the instructors teaching capabilities as well as the students learning opportunities. The need to integrate electronic information resources into the curriculum provides active learning situations for the students. Include a librarian in your course development. This professional can help you maximize the learning possibilities for your students.

USING ONE-MINUTE TELEVISION SPOTS TO EDUCATE THE PUBLIC ABOUT FORESTRY

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ABSTRACT: In the Pacific Northwest, as in much of the United States, conflicting views among environmentalists, forest industries, government agencies, and policy makers have left the public with a confused picture of forestry issues and practices. So, it should come as no surprise when citizens base their opinions of natural resource issues on incomplete or inaccurate information.

To help combat this problem, the College of Forestry at Oregon State University and the Oregon Forest Resources Institute (OFRI) recently combined forces to create and broadcast seven one-minute television spots based on the latest scientific information about managing Oregon's forests. These spots were educational in nature, not promotional. They were designed to meet the public's desire for science-based information about how their forests are managed. It was hoped that seeing these messages would help viewers make better decisions about their use of natural resources, become more informed and effective participants in policy decisions regarding forests and forest products, and better understand how forests and forestry affect their lives. Their purpose was not to convince viewers that forest practices of the past (or present) are inherently good or bad. Unlike public service announcements, these spots were broadcast frequently and at prime time to reach the target audiences most effectively.

A cooperative team approach was adopted to design and produce the series of TV spots. Each team included media specialists and forest scientists from the College of Forestry, public opinion researchers, mass media experts, and OFRI personnel. Ideas leading to the content of the television spots came primarily from information collected from public opinion polls and focus groups. The design team used this information to identify areas of forest management of greatest concern to the public, and to generate key messages. Scientists whose research was germane to these key messages were identified and invited to help get the word out to the public. A flexible "give and take" between the media specialists and scientists led to the creation of a visual story and "television friendly" script.

It was decided early on that the look and feel of the TV spots should be one of real scientists in the field telling their stories in simple but information-rich presentations. The decision to use non-professional talent was a conscious one; what these scientists lacked in sophisticated on-camera delivery, they made up for in credibility with the viewers.

Both formative and summative reviews were an integral part of the production process. Draft videos were reviewed by panels of content specialists, other media producers, OFRI staff and board members, mass media specialists, and select members of the target audience. In addition, an electronic Perception Analyzer¬ session was used to glean information about moment-to-moment audience reactions to the first three television spots. Use of such group response measuring systems are common in marketing research.

From 1994 to 1997, seven television spots were produced and broadcast during prime time. Air-time was purchased separately for each spot, usually in two-week increments, with approximately six months between each spot. Each program was broadcast repeatedly and on multiple channels throughout the state during its "life." As a result, each spot had the potential to be viewed tens of millions of times, a term referred to in the broadcast industry as "gross impressions". In 1996 alone, gross impressions for two of the forestry spots totaled over 19 million.

While we know the tremendous potential of these educational messages, assessing their actual impact is much more difficult. It is very different from evaluating classroom instruction. For example, we could not pre- and post-test the viewing public to see what they knew about forestry issues before and after viewing the TV spots. Nor could we contact specific viewers to see what they thought about specific messages. However, a compelling amount of anecdotal and some quantitative evidence arose indicating that these spots had captured the attention of the public, the industry, and the forestry community. This evidence included comments collected from focus groups, interviews with stakeholders, letters from the public, and even monetary gifts to the College in support of further TV spot development. Perhaps the highest form of flattery was (and continues to be) the use of our "scientist in the forest" approach by numerous television spots produced by the forest industry.

Although our primary motive was educational, there is also evidence that the TV spots left the public with a more positive perception of forestry. After broadcast of the first three television spots, phone survey data from 650 randomly selected Oregonians revealed an increase of 15 % (±4%) in the approval rating for forest management activities in Oregon and a 7% (±4%) increase in those who believed that forest industry was doing "an excellent or above-average job learning from science to manage forests better." While we cannot presume that the TV spots were solely responsible for positively "moving the needle" on public opinion, the proximity of the ad campaign to this data suggest that the spots played a significant part.

We've learned a number of valuable lessons from this television-based education campaign:

It IS possible to deliver important educational messages in 60 seconds, but it takes a great deal of thought and effort.

It IS possible to capture the attention of television viewers with short natural resource-related messages, but it must be done during prime time-and that's expensive. The cost of broadcasting the messages will far exceed the cost of producing them.

Television viewers WILL respond positively to information-rich, science-based television spots. They want to know facts about resource issues, and they look to the scientific community for unbiased information.

University faculty are well positioned to provide natural resource information to television viewers, and they may well be the most effective spokespersons for their positions-but they need assistance in identifying key messages, in crafting concise "TV-friendly" statements, and in illustrating their points effectively.

Formative evaluation (continual review from the widest possible variety of sources) is key to producing effective messages.

Efforts to educate and influence public opinion on natural resource issues will benefit from teamwork among public agencies, university communication specialists, public opinion specialists, scientists, and mass media experts.

INTEGRATING THE UWSP NATURAL RESOURCES CURRICULUM

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ABSTRACT: Following an intensive five-year program of curriculum review and strategic planning, the College of Natural Resources (CNR) at the University of Wisconsin - Stevens Point (UWSP) has initiated a planned six-year revision of its undergraduate curricula in natural resource management. It is our belief that such revision is necessary for our graduates to have the attributes and capabilities necessary to meet the future challenges of long-term, landscape scale, ecosystem management planning. To meet these challenges, significant change is needed in the pedagogical and technological infrastructure of undergraduate natural resource education. The goal of this revision is to develop programs that will prepare young professionals to comprehend and apply sound interdisciplinary approaches to solving resource management problems, now and in the future, while at the same time providing the technical competencies required by the vast array of employers of our graduates.

The first phase of the six-year revision (years one to three) will focus on the development and implementation of a revised interdisciplinary introductory core curriculum. This curriculum will focus on 1) the need for an ecological basis as a unifying framework, 2) the need for more integration of the various resource management disciplines,
3) the need for a better understanding of human dimensions in resource management, and 4) the need for improved communications skills for resource management professionals. The objectives of this phase are 1) to collaborate with educational experts to define a long-term strategy for undergraduate education; 2) to provide faculty training and develop the technological and pedagogical infrastructure to support these programs; 3) to implement and evaluate the interdisciplinary core curriculum and new instructional approaches, including applications of educational technologies; and 4) to develop a plan for the second phase of the revision project (years four to six).

The second phase of this project will focus on the revision of the CNR's required field studies program and the expansion of the integration of the CNR's upper division curricula in Forestry, Resource Management, Soils, Water, and Wildlife. The goals of this effort are the same as phase one, with specific objectives to be defined by the phase one process.

EDUCATING THE EDUCATORS: GRADUATE STUDENT INVOLVEMENT IN TEACHING NATURAL RESOURCES

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ABSTRACT: Awareness of the need to prepare future faculty for the teaching challenges they will face is growing rapidly. In one response, North Carolina State University established the "Preparing the Professoriate" program in 1994. Doctoral students work with a faculty mentor over the course of 1-2 years, depending on the frequency with which the course is taught, with the students moving from the role of observer to that of instructor. In addition to working closely with a member of the faculty in designing and delivering an undergraduate course, graduate students in the program attend monthly meetings at which they hear presentations and share experiences, and they complete a teaching portfolio. Entry into the program is competitive, as only ten student/mentor teams are selected each year. Selected students receive a $2,000 stipend.

This paper/presentation reflects on the experiences of a graduate student and the faculty mentor in teaching an introductory natural resources course. As the graduate student, Jacobson describes his motivation for seeking to participate in the program, his experiences as observer, his efforts to redesign the course, and his assessment of the experience from the perspective of a first-year tenure-track faculty member. As the faculty mentor, Wellman offers his thoughts on the benefits of the program and steps that might be taken to improve it.

TREE OF THE MONTH: A MENTORED, WEB-BASED LEARNING EXPERIENCE

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ABSTRACT: In Fall 1996 the College of Forestry at Oregon State University conducted a student-led retreat to discuss the need for mentoring in the university environment. It was attended by undergraduate and graduate students, by faculty and staff, and by a few members of the local professional community. We discussed what mentoring is (different things to different people), who needs it (we all do, but in differing amounts), who can provide it (we all can, but in different situations), and what college administrators can do to foster it (fund it!). The key idea that I took away from the retreat is that what mentoring needs most to succeed is personal commitment. Commitment on the part of those who want to be mentored and commitment on the part of those willing to serve as mentors. The rest is details.

Soon after returning to my office, I decided to merge my desire to mentor undergraduate students with my desire to produce teaching materials about trees. I contacted a few students who I thought might be interested in a mentoring relationship, shared a few thoughts about what I had to offer and what I'd like to receive in return, and waited to see what would happen. Since the project I had in mind was dendrologically-based, I contacted students who had already proven themselves in my dendrology class.

The concept was to produce a Web site focused on trees that would be attractive to the widest possible array of audiences—young and old, at home and in classrooms, professional and lay audiences. It was to be image rich, evoke emotion as well as understanding, and be changeable rather than static. I wanted people to be able to visit the site time and again, without having to develop the entire project "up-front." I wanted the project to allow the student protÄgÄ to flex their creativity as well as their knowledge.

I'm not a Web expert—in fact, I hardly use it myself. So the student I chose needed to have Web skills, or be able to develop them on their own. They needed to be knowledgeable about trees and able to find information that they did not know. Accuracy and attention to detail was key, because the site created would be a reflection on me, as well as on them. They needed to be able to write clearly, concisely, and effectively, in an interpretive vein. Essentially, I gave them access to my slide files and my time, and then stood back, intervening as little as possible but as often as needed. The result is the "Tree of the Month" project that I'd like to share with you today.

Several lessons were learned from the production of this Web site:

*Bright students have an amazing affinity to produce Web sites, even if their knowledge in the beginning is limited.
*Good Web sites take a lot of time and effort to produce.
*Mentored projects can play an important role in extending knowledge from one group to another.
*Mentored projects can have professional benefits to the mentor, as well as to the protege.
*Mentoring is good for the soul.

A NEW MASTER OF NATURAL RESOURCES PROFESSIONAL DEGREE PROGRAM AT UTAH STATE UNIVERSITY

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ABSTRACT: The Utah State University College of Natural Resources has recently instituted an inter-departmental, non-thesis Master of Natural Resources degree to meet the needs of students and practicing professionals with a career orientation in natural resource management as opposed to research.

The degree program consists of 30 semester credits in three categories: (1) courses in specified topical areas that make up a minimum of 18 semester credits, (2) 9 semester credits of course work based on an individual student's career goals; and (3) a capstone problem-solving exercise that includes writing a substantial report. To fulfill the first category, students are required to take a new course in Ecosystem Management that emphasizes the integration of bio-physical, socio-economic, and human values in natural resource management; and one course each in five topical areas among nine options that include: policy and administration, economics, human dimensions, business, ecology, quantitative methods, physical environment, information management, and communications. Students with an undergraduate degree in a major other than one of the traditional natural

resources majors (e.g., fisheries and wildlife, rangeland resources, forest resources) will be required to make up deficiencies in undergraduate preparation prior to beginning MNR degree course work.

Oversight for the MNR degree is provided by an associate or assistant dean who chairs an MNR Advisory Committee consisting of representatives from each of the four departments in the college. This committee provides guidance on policy and curricula. Guidelines for application to and matriculation in the MNR degree program are the same as for other graduate degree programs in the college, starting with the Graduate School and moving to individual departments where students reside along with their major professor. As with other degree programs, students have an advisory committee chaired by their major professor.

Our analysis indicates that a shifting of natural resource management away from the traditional commodity orientation toward a broader concept that incorporates the principles of ecosystem management, positions the MNR degree to better meet the needs of natural resource managers than the traditional (mostly research-oriented) MS degrees in natural resources, especially in light of the recent shift in professional training from the undergraduate to the graduate level. Monitoring of enrollments and placement of graduates over the ensuing years will provide a test of this argument.

SPATIAL INFORMATION TECHNOLOGIES IN GEOGRAPHIC EDUCATION

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ABSTRACT: This paper describes a project focusing on the need to enhance communication and understanding between higher education and the K-12 system through the use of spatial information technologies, specifically geographic information systems (GIS), global positioning systems (GPS), remotely sensed data (RS) and the Internet. The project has developed materials and identified data through an interactive exchange between Colorado State University graduate students studying information technology for resource management and K-12 teachers. The outcome of the project is twofold: 1) to help K-12 students meet content standards of geography: "how to use maps and other geographic representations, tools and technology to acquire, process and report information from a spatial perspective" (National Geography Standard, 1994, p. 106); and 2) to bridge the gap between higher education and K-12 by providing CSU graduate students with an opportunity to apply spatial information technology skills. Content of exercises developed by CSU graduate students focuses on specific natural resource management issues.

INTEGRATION OF ETHICS INTO A FORESTRY CURRICULUM

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ABSTRACT: Following a comprehensive review of their forestry curriculum in 1995, the Oklahoma State University Forestry Faculty elected to modify the way professional ethics are formally addressed. The modifications involve three courses. An introduction of ethics and their role in natural resource management is presented to freshman in an introductory course. This provides a framework for learning and applying the science and practices of the Forestry Profession in the context of an ethical philosophy. Students address ethics a second time between their sophomore and junior years. This happens during the initial summer camp course where students are exposed to philosophical and policy differences between natural resource management agencies. Ethics are formally reintroduced in two senior courses that are usually taken concurrently. One of these courses is a capstone experience where students address real natural resource management problems. The second is a course in forest administration and natural resource policy. In these two courses the instructors cooperate to require the students to consider professional ethics in a philosophical framework for decision making as well as an applied standard for real decisions in the execution of professional work. This is accomplished through discussions of the Ethical Canons of the Society of American Foresters in the forest administration and policy course. These discussions are followed by group presentations to the class of ethical considerations associated with projects from the student's capstone experience.

RESEARCH AND TRAINING OPPORTUNITIES AT MAKERERE UNIVERSITY BIOLOGICAL FIELD STATION LOCATED IN UGANDA'S KIBALE NATIONAL

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ABSTRACT: Makerere University's Biological Field Station (MUBFS), located in western Uganda's Kibale National Park, offers excellent research and training opportunities in the physical, biological, and social sciences. This region of East Africa has exceptional natural and cultural resources, and is home to seven national parks and numerous protected areas. The Station can accommodate researchers and trainees year-round, and offers a wide range of facilities and services, including lodging, meals, laundry, phone, fax, e-mail, a library, and limited transportation and computer access. MUBFS is easily accessible, has a strong 25-year research record, and an extensive forest trail system. Uganda's stable democratic system, English language, and favorable climate make the Station an ideal site for research and training. For more information contact the MUBFS Homepage on the World Wide Web at http://www.usu.edu/~mubfs/index.html.

TREES OF THE PACIFIC NORTHWEST: A WEB-BASED APPROACH TO FORESTRY EDUCATION

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ABSTRACT: Tree identification is a powerful vehicle for introducing people of varying ages and backgrounds to natural resources. For some it's a rewarding and delightful end in itself; for others it provides an important first step into the issues and practices of natural resource management. For most, it's an empowering skill they can share with others. For many, it's a black-box process, filled with obscure terms, uncertain choices, and hidden characteristics.

Traditionally, books and individual experts have been the primary sources of information on tree identification, and they have filled that niche well. But for the next generation of learners, that niche will be shared with CD-ROMS and World Wide Web (WWW or Web) sites. With that in mind, and on the heels of an immensely popular revision of a regional text called Trees To Know in Oregon, we embarked on an effort to extend the process of tree identification to the Web- oriented people of Oregon, and beyond.

Since conifers often present the most difficult identification challenge in the Pacific Northwest, we decided to start there—by making a web-based version of the conifer key in Trees To Know in Oregon. Our basic idea was to combine the visual imagery and interactivity made possible by the Web with the tried-and-true structure of the book.

Our first step was to develop goals and identify audiences for our site. Audiences include college and university students (at Oregon State and elsewhere), elementary and secondary educators and students, natural resource professionals who need a quick reference, and anyone else interested in tree identification—in short, almost everyone. As a result, we needed a design that was technically accurate, yet easy to use; one that would provide details for sophisticated users, but be simple enough for novices; one that relied more heavily on photographs and drawings than on vocabulary and jargon.

Our goals were to provide:

*Descriptions and photographs of common conifers found in the Pacific Northwest. We emphasized native species, but included a few common ornamentals, too. This feature permits users who know what information they want to access it directly.

*An interactive decision-making key that would permit users to identify specimens with which they were unfamiliar. This allows users to sit at their computer, branch sample in hand, and figure out what they're looking at.

*A "quiz" that would permit users without actual specimens to test their knowledge of Northwest conifers.

*A link to additional information on tree identification. Our primary link is to Trees To Know in Oregon, the book that gave rise to the Web site. Ordering information is included in the site.

Next, we built a hierarchy of pages for 3 major sections, corresponding to our first 3 goals. This structure allows users with different needs to approach the site in different ways and find the information they desire. The site was designed to have discrete, but linked, categories that allow users to access information in a variety of ways. The site takes advantage of the asynchronous nature of the Web, yet provides a clear and understandable framework within which to navigate.

One important feature of the site, and central to its interactivity, is a pictorial dichotomous key . This key, identical to the one in Trees to Know in Oregon, takes on a life of its own on the Web. The user is able to click on a series of choices, and find the genus,

and eventually the species, of their specimen. No technical terms to struggle with, and no pages to flip through; within minutes they have arrived at colored photographs with detailed characteristics and descriptions.

The ability to access detailed, color photographs is also key to the site's success, and utilizes one of the Web's greatest strengths. Photographs that would be too costly to include in a printed document are abundant in the Web site. The photographs show detailed characteristics important to tree identification (e.g. bracts on cones), which would be difficult to explain in words, and difficult to decipher in black-and-white.

A Mystery Tree section comprises a third key feature of the site. Essentially, it is a quiz that provides users with an unnamed picture of a tree, directs the user to the pictorial key, and provides an answer when finished.

Paramount to the success of the site was the collaborative nature of the development team. In addition to the Web designer and the content specialist, a technical specialist and graphic artist provided essential support. The content specialist provided the information on the trees as well as input on instructional design strategies; the graphic artist created graphics that supported the goals of the Web site and generated a user-friendly environment; the technical specialist provided a reality check about what was technically feasible, and helped figure out ways of achieving various desired effects; and the Web designer served as a bridge among all, and created the site.

Lessons learned from this project include:

*Web sites have the potential to be powerful educational tools. But to reach this potential, designers must understand and take advantage of the opportunities inherent in the medium.

*Innovative and effective Web sites are most likely to result from teamwork: content experts, instructional designers, computer specialists, Web designers, and graphic artists working together toward a common goal.

*Nothing about Web site construction is easy or inexpensive. As in everything, quality demands effort and resources.

*With good design, a single site can serve multiple audiences and purposes.

*Interesting Web sites will attract attention far beyond what you anticipate—and may require additional attention in return. The first day our site was posted, we received e-mail from across the United States asking when we planned to produce sites for their parts of the country. We receive on a weekly basis requests from young people around the world asking for additional information about trees and forests of the Pacific Northwest, or from their countries. We receive numerous requests to link with other sites, and from others who would like to help us expand our site by including species of importance to them. And we receive far too many requests from home gardeners who want us to identify a particular specimen! Responding to these requests is time-consuming, but they are difficult to ignore.

Trees of the Pacific Northwest may be accessed at (http://www.orst.edu/instruct/for241).

EXPERIENTIAL EDUCATION FOR ENVIRONMENTAL EDUCATORS

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ABSTRACT: In a collaborative arrangement between Utah State University (USU) Department of Forest Resources and Canyonlands Field Institute (CFI), a program has been developed in which qualified students have an opportunity to combine graduate level course work in natural resources with experience teaching these subjects to a wide range of age groups, in a field setting. CFI is a 501 (c) 3 non-profit educational organization located in Moab, UT, a small community served by a local USU extension office. The Institute maintains an office, classroom facilities, and housing for graduate students in Moab, as well as a field campus (Professor Valley Field Camp) on leased BLM land, 20 miles from Moab. The field campus is equipped with kitchen and teaching yurts, camping facilities, and a photo-voltaic generator that allows audiovisual equipment to be used in teaching. Much of the teaching is done on adjacent BLM land, in Arches National Park and on the Colorado River. CFI also has commercial river permits to operate on the Green, Colorado, Dolores, and San Juan Rivers. Programs conducted on the river are typically multiple-day trips incorporating the river corridor as the main focus for teaching. The location of CFI in south-eastern Utah provides access to an ideal outdoor classroom for studying and teaching geology, ecology, recreation and tourism, and land-management issues, particularly on the Colorado Plateau with the high desert, riparian and mountain ecosystems and vast acreage of public lands. The location of the USU extension office in Moab also allows for other university resources for the program, including library and computer facilities and other distance learning courses.

The Graduate Residency in Environmental Education is an 11-month program, that accommodates up to six graduate students. The bulk of the course work is conducted in the first six months, with the students teaching a large part of CFI's programs in the following spring and summer months as part of a teaching practicum. Courses are taught with a strong emphasis on field studies, and with a philosophy of experiential education as a means for effective learning.
The courses taught in the Residency program include an introduction to the cultural and natural history of the Colorado Plateau, desert ecology, geology, elements of environmental education, leadership and conflict resolution, river ecology and management, wilderness first aid and river skills, non-profit organizations and their role in resource protection, cultural history, adventure business and tourism, and public lands management. In the teaching practicum, students teach environmental topics to local elementary school children on nearby public land, conduct CFI's Outdoor Science School residential programs at Professor Valley Field Camp to middle school and high school students, develop curriculum and lead field studies in youth day programs, and teach and guide Elderhostel Intergenerational programs on the San Juan River. Largely as a result of the continuing conflict among various users of the natural resources, particularly in southern Utah, the major focus of the programs conducted at CFI has become a blend of natural sciences and social studies. Graduate students conduct independent service projects and are encouraged to become involved in public meetings, debates, and partnerships relating to public land management as a part of their program.

The Graduate Residency program therefore allows students the opportunity to explore teaching as a profession, to determine the age group with which they may be most interested in pursuing a teaching career, and to enhance their teaching skills in the outdoors, skills that may also be transferred to a classroom setting. They gain the medical and guiding skills required to lead groups into the backcountry and on river trips. The program also exposes the students to a variety of public land management agencies and non-profit organizations operating in the area, and provides them with the scientific bases for resource management decision-making. Students complete graduate-level course work in natural resources that may be transferable towards a graduate degree at USU or other accredited university.

The graduate level courses in geology and ecology offered through CFI and USU are also open to members of the community in Moab, providing the opportunity for graduate students to interact with others, particularly those from the resource management agencies, desiring further education in these subjects. The availability of these courses also provides an alternative to traditional distance learning programs for others in the community working on graduate degrees. This collaboration between CFI and USU therefore is an innovative approach that furthers the educational mission of both institutions.

THE UPLAND FORESTRY FIELD COURSE, SCOTLAND

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The University of Edinburgh School of Forestry has offered field courses during every academic year for over 100 years, and these courses have been regarded as an integral part of forestry education. The program, providing practical forestry experience to students of forestry, ecology, agriculture and wildlife, has been widely held to be a crucial part of their education. Nevertheless, these courses have come under increasing pressure as a result of increased didactic teaching requirements, rising costs and decreasing funding.

This presentation will detail the Upland Forestry Field Course which concentrates on all aspects of forestry under Scottish conditions. One 10 day long field course is offered to third year forestry students as a course requirement, and as an option to other students within the Institute of Ecology and Resource Management. The course has proven extremely popular with students, and student numbers have ranged from 10 to 35 on each course. The course is staffed by between 2 and 4 faculty and 2 graduate student demonstrators.

The course aims: a) to examine the relationships between tree species in upland forests in Scotland and their environment and b) to consider the integration of ecological and economic factors in forest management. By the end of the course the students are able to: i) identify a range of commonly used coniferous and broad-leaved species; ii) understand the selection of tree species in relation to soil and climate conditions; iii) appreciate the silvicultural techniques adopted by managers to attain the objectives of management; iv) be aware of the harvesting methods adopted in upland forests; v) be aware of the interaction of wildlife management, conservation, recreation and amenity with timber production; and vi) appreciate the range of skills required by the forest manager.

A variety of sites are visited each day covering the range of ownership and land uses including Forestry Commission forests (government), private estates, sawmills, nurseries, non-governmental organisations (e.g. RSPB, WWF) and private forestry operations. Exercises are performed at many sites to encourage accurate observation and measurement. Students are required to submit a report on one of a series of topics including silviculture, production forestry, natural regeneration, landscape design and conservation. This field course also has been adapted for post graduate education to demonstrate British forestry to overseas forestry professionals from a number of countries.

After over a century of continuous adaptation, development and improvement the forestry field courses of the University of Edinburgh are a unique and invaluable resource for students in Ecological Sciences. The benefits of such courses to students, future forestry teachers, and to forestry and ecology as a whole, far outweigh their minimal financial costs.

UNIVERSITY-BASED COURSES IN HUMAN DIMENSIONS OF FISH & WILDLIFE MANAGEMENT IN THE UNITED STATES OF AMERICA: A PRELIMINARY INVENTORY AND INVESTIGATION

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Human dimensions is one of the newest areas of emphasis in the evolving field of wildlife management (Manfredo, Vaske and Sikorowski, 1996). Human dimensions is a general term used to describe the application of the social sciences to natural resource-related problems and issues. Manfredo and others (1995) describe the human dimensions approach as consisting of two components. The first emphasizes acquisition of sound information that explains human thought and action regarding wildlife using the concepts and methods of social science. The second component involves determining how to use that information in wildlife decision making. Over the past five years, wildlife managers, policy makers and planners have been applying the human dimensions approach to management of wildlife resources. Likewise, many institutions of higher education have responded to the need for a human dimensions approach by offering courses that focus on this important topic. Unfortunately, no data are available on the number and/or focus of programs of curricula that offer course work in human dimensions of wildlife.

This paper prepared for presentation at the Second Biennial Conference in University Education in Natural Resources provides a summary of a study completed during the spring and summer of 1997 intended to address these information needs. The purpose of this research was to complete a preliminary inventory of Human Dimensions of Wildlife courses offered in the USA, to collect descriptive information on the institutions and faculty offering these courses, and compile information on the course (e.g., enrollment patterns, course requirements, course title, etc.), and develop a preliminary profile of the objectives and content of the courses identified.

A one-page mail questionnaire was distributed to 110 Universities in the United States. The Wildlife Society provided a list of 80 universities that offer undergraduate degrees in wildlife or fisheries, the Wildlife Society Membership Directory (members affiliated with a university or college who identified "human dimensions" as an interest area (20), the advisory board and associate editors of the Human Dimensions of Wildlife Journal who listed a university affiliation (10), and a general solicitation was provided over the human dimensions of wildlife list server. The letter that accompanied the survey stressed the importance of an accurate inventory of human dimensions courses and offered incentives for participating in the study (i.e., a copy of the study results, a compendium of syllabi, and the publication of a listing of universities offering human dimensions courses).

The survey resulted in the identification of twenty-six colleges or universities that offer a Human Dimensions of Wildlife course. A vast majority of the human dimensions course identified were offered in Colleges or Schools of Natural Resources. A majority of the courses were offered for the first time in the past five years and most are taught by persons with traditional degrees in Wildlife Biology, Natural Resources, or Zoology. Enrollment appears to be fairly stable and averages about 20-30 students. Most of the courses are offered at the junior or senior level. The objectives of the courses varied considerably but typically included exposing students in the natural sciences to the human context of wildlife management decisions. A majority of the courses covered topics related to the identification of key stakeholder groups, the policy making process and an overview of a public involvement techniques. Course topics typically did not include an overview of social science research methods or techniques for integrating the biological and social sciences.

ENHANCING SUCCESS AND PROFESSIONAL DEVELOPMENT OF STUDENTS IN NATURAL RESOURCES

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Graduates from natural resource education programs move into a rapidly changing professional field. Whereas previous emphasis was on specialized technical skills, today's graduates are entering a field that emphasizes a broadly constructed, holistic ecosystem approach. While employers still look for graduates with extensive technical backgrounds, today they also stress the need for graduates with excellent written and oral communications skills, strong critical thinking skills, and teamworking and leadership skills.

Traditional approaches to natural resources education, as in most fields, primarily stressed acquisition of technical knowledge. To produce graduates able to compete in the complex ecological/social/political/economic web of today's natural resource fields, educators need to adopt educational techniques that sharpen critical professional skills in conjunction with technical competence. Universities must move from providing instruction to producing learning, whereby students are encouraged to become active partners in their learning rather than passive receivers of knowledge. Active learning in their college years stimulates students to become effective life-long learners, which will be critical for their professional survival in our rapidly changing fields.

We designed a program to alter the way that faculty teach and students learn in our undergraduate natural resources curricula. Specifically, our objectives were; 1) to create an interdisciplinary educational environment in the College of Forestry and Wildlife Resources (CFWR) at Virginia Tech that fosters higher levels of cognitive development in students, 2) to provide CFWR first-year undergraduate students with the skills needed for success in both their academic and professional careers, and 3) to provide current and future faculty with the support needed to develop and enact alternative teaching techniques that stimulate active learning.

Our objectives were accomplished by drastically altering our approach to the introductory undergraduate natural resources course in CFWR. The new approach incorporated a broad array of teaching techniques to stimulate active learning and critical skills development among the students. The traditional lecture approach was replaced by inquiry-based modules centered on extensive reading, group discussions, formal and informal writing exercises, field exercises, and collaborative research projects. A select interdisciplinary team of faculty, graduate students, and outstanding undergraduate students worked together to create this active learning environment, aided by University teaching and writing specialists. Instructors met regularly for workshops on alternative teaching techniques and for collaborative study group discussions.

The freshmen students in this project reported an increased sense of integration into the College and their chosen field, and a better understanding of what skills they will need to be successful natural resource professionals. Writing and speaking skills dramatically improved, and students reported that these improvements helped them in other courses in the curricula. Students developed problem-solving and teamworking skills that allowed them to tackle broad-scale interdisciplinary questions. Overall student performance in this experimental course was significantly better than under other teaching approaches, despite an increase in the quantity and quality of work demanded of the students.

Contact: murphybr@vt.edu; phone 540/231-5573; Oral presentation; 2x2 slide projector needed

OUTCOMES FOR THE EDUCATION OF PROFESSIONAL REFLECTIVE PRACTITIONERS

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Using the following educational model as a basis for design, a MF program that substantially differs from traditional ones is being developed at the University of New Brunswick.

Student ⟶ *Education Program* ⟶ *Outcomes*

The model states that outcomes are the result of the educational program imposed upon and in interaction with the student. In education design, the model is purposely used to devise an appropriate education program given a description of the student (the system "input") and a set of desired outcomes (the system "output"). This presentation describes the desired set of 'outcomes' which can be used to develop a masters of forestry program.

Outcomes refer to the things students need to know and be able to do. How outcomes are described influences the nature of both the learning program which students will follow, and the assessment approach used to evaluate their ability to achieve the outcomes. In terms of professional practice, explicitly defined outcomes ensure education is relevant because they describe what practitioners need to be able to do. In traditional systems, outcomes are usually loosely defined, focussing either on technical issues students need to know about, or general characteristics under which they need to work. Consequently, student performance is assessed in comparison to peers rather than against absolute standards.

In the program being developed at UNB, outcomes are explicitly described and form the basis for learning and evaluation. A hierarchical framework is used to ensure relevance and track continuity between levels within the hierarchy. The highest level or goal of the program is reflective professional forestry practice. Professional practitioners exhibit a set of qualities and abilities which comprise the second level. Qualities describe attitudes and general qualities including 'adaptability and versatility, reflection, thoughtfulness, excellence etc.' These are indirectly incorporated in the program through the choice of problems, learning structures, and through direct and indirect interaction with students. Abilities describe the specific skill and knowledge areas required for effective professional practice. There are both technical (e.g., silviculture design) and generic professional abilities such as structured problem solving, analysing valuing and decision making, social interaction, formal communication, teaching learning and leading, and effective citizenship. At the next hierarchical step, a set of performance indicators is described which guides student learning is directed and evaluation.

Within forestry, explicit description of desired outcomes is in its early stages. The set presented in this paper will hopefully stimulate discussion and enhance development of professional education systems.

INTEGRATED EDUCATION IN NATURAL RESOURCE MANAGEMENT: CONNECTING THE UNIVERSITY TO NEEDS AROUND IT THROUGH PARTNERSHIP

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ABSTRACT: Education has long been faced with the notion that what they do bears no relation to the world outside academe. The public and private sector have often confronted the new graduate who needs to get a footing in the "real world" and learn how to apply what he has studied. The best solution for higher education is to produce students who both know their subject matter and can apply it while a student.

As demands on the environment and all types of resources increase, universities need to keep pace with the knowledge, and the problem-solving and technical skills that will be needed in the future. Educational partnership can provide dynamic applied learning environments and a more vigorous curriculum which breed innovation and challenge students to find solutions while they study. Application then becomes part of study. Unlike short-term collaborative efforts in education which address a single issue, or isolated philanthropy, the well-designed partnership establishes a long-term relationship among organizations which can assimilate new technology and knowledge, tackle new issues and adapt to changing priorities.

In partnership, the university shares its technical expertise, topical knowledge, and human resources with other organizations to help identify, understand, and derive solutions to natural resource management issues. Partners could initiate and undertake projects outside the realm of their day-to-day tasks. They could also gain visibility and recognition for their support of projects designed to enhance education and the management of natural resources.

MEASURING STUDENT SUCCESS IN NATURAL RESOURCES MANAGEMENT

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Students enrolled as Natural Resources Management (NRM) majors at the University of Alaska Fairbanks (UAF) enter their college careers with various levels of preparation and experience. Many NRM majors at UAF are transfer students from 2 or 4 year institutions. With traditional first time freshmen and transfer students coming to UAF seeking preparation in the management of natural resources, our program has sought to enhance the success of all students. Moving beyond administrative mandates to assess student outcomes, our program has enhanced existing procedures to connect with students at various stages of program completion. Our program continues to build on our campus reputation of providing outstanding advising and guidance to create a "home" for our majors. Some students have excellent study skills and motivation to succeed, regardless of academic ability. However many new students, freshman or transfers, have unique circumstances requiring advising beyond academic suggestions. A new course titled "Orientation to Natural Resources Management" was developed to attract and assist students uncertain about careers in resource management. Student progress is documented throughout the program by course embedded assessment of the selected required courses. Assessment instruments track progress in attaining knowledge, synthesis and evaluation of information, and oral and written communication. A senior thesis presentation, exit interview with the Dean, and a comprehensive exam are other integral components in our plan to review and enhance student success.

BEYOND THE TRADITIONAL CLASSROOM IN NATURAL RESOURCES MANAGEMENT

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Since 1991, the School of Agriculture and Land Resources Management has offered a 10-day field trip to Natural Resources Management majors at the University of Alaska Fairbanks. This trip is currently a 2-credit requirement for NRM majors. The course is titled Resource Management Issues at High Latitudes, with scheduled visits to federal, state and local resource management agencies, as well as private forest product, and agricultural enterprises. The course has enroll successfully and attracts non-majors as well.

"Resource Management Planning", an undergraduate course and "Resource Planning: Principles and Practices", a graduate course, involve community interaction with current issues and projects. Students develop team reports and make presentations to community representatives.

Other NRM courses have implemented distance delivery technology as optional and required components of semester-long courses. Course evaluations and formal senior exit interviews indicate off-campus experiences are positive and integral in completing formal college curricula. Faculty and staff support for off-campus experiences is a key element in providing a successful course to students. Dependable logistic support is necessary for scheduling, transportation, board and room, and unpredictable circumstances. Academic rigor must be maintained in out of classroom situations, with course requirements outlined prior to trip departure.

INCORPORATING SUSTAINABLE FORESTRY INTO STANDARDS FOR PROFESSIONAL FORESTRY EDUCATION

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ABSTRACT: In 1991, the National Association of Professional Forestry Schools and Colleges (NAPFSC) and the Society of American Foresters (SAF) co-hosted a three-day Forest Resources Education Symposium, entitled "Forest Resources Management in the 21st Century: Will Forestry Education Meet the Challenge?" The objectives of the national symposium were to present major forces shaping the country's management of forest resources, and then to discuss the adequacy of educational criteria in preparing tomorrow's resource managers to excel under an expanding array of consumer and employer demands. As an outcome, the discussants developed a summary of specific challenges and solutions within five issue areas: The Future of Forestry, Future Educational Needs, Defining Appropriate Curricula, Student Characteristics, and Faculty Characteristics. Many existing problems were identified as a result of that process, as well as potentially useful strategies for corrective action.

The purpose of this project is to assess any changes in curriculum content or educational strategies (at both the undergraduate and graduate levels) that have resulted from the 1991 symposium, or in relation to subsequent new issues that have emerged within the forestry profession. Many of these new issues have been identified through processes such as the Pinchot Institute's 1996 assessment, entitled *Evolving Toward Sustainable Forestry: Assessing Change in U.S. Forestry Organizations*. This assessment provided an overview of current efforts in each of the major sectors of the profession — forestry education, research, policy, and management — that reflect recent broad-based efforts to articulate public expectations for forests and forestry in the United States. Participants in the 1996 assessment focused not only on the near-term need to change the way some forests are being managed, but the longer-term need to provide the foresters of the future with the skills and expertise to practice sustainable forestry. Among the topics discussed were the changing demand for foresters in the marketplace, the need to incorporate sustainable forestry into curricula at more U.S. forestry schools, the need for continuing education to keep practicing foresters current with the science and techniques of sustainable forestry, and the need for incorporating these considerations in state licensing standards for professional foresters.

This project will consist of two major components:

(1) establishing what a comprehensive curriculum in sustainable forestry might contain, based upon the changing needs of forestry employers who are broadening their approaches to forest resource management, becoming more responsive to environmental concerns in order to "maintain their social license to practice forestry;" and

(2) ascertaining the extent to which professional forestry education programs at universities in the U.S. are providing this comprehensive approach through:

- (a) a review of current course curricula with school administrators and faculty
- (b) a survey of recent graduates, aimed at determining the extent to which they feel their institution has prepared them to practice forestry as it is expected of them today
- (c) a survey of major employers of recent graduates, aimed at determining the extent to which they feel the institutions from which they have recruited or hired foresters have prepared graduates for practicing the kind of forestry that is expected of them.

The results of the study will provide valuable information to a number of different entities concerned with forestry education--forestry school faculty, prospective students, and prospective forestry employers, of course, but also the SAF in its function as the accrediting organization for forestry schools in the U.S., NAPFSC in its function as a forum for forestry school deans to address issues affecting professional forestry education across their respective institutions, and the Seventh American Forest

Congress Education Committee (a follow-up working group charged with reviewing forestry education in light of the "vision and principles" statements that emerged from the 1996 Forest Congress). These and other organizations will be involved in the conduct of this project, and in the dissemination of the results.

The responses are expected to appear first as extension courses or continuing adult education programs targeted to practicing professionals. Through the process of feedback and refinement, forestry educators themselves will get a better understanding of the specific knowledge needed and how it can best be taught. This is expected to facilitate the process by which new knowledge and approaches are incorporated into existing graduate and undergraduate courses, perhaps precipitating the creation of entirely new courses in forestry school curricula and the addition of new faculty with different areas of expertise than have traditionally been found on forestry school faculties.

To help with achieving the goals of this project, the Pinchot Institute for Conservation, in cooperation with the Sustainable Forestry Partnership at Oregon State University and Pennsylvania State University, will be hosting a 90-minute panel at the 2nd Biennial Conference on University Education in Natural Resources. The objectives of this panel will be: 1) to present and discuss the findings of the Pinchot Institute's educational assessment to date; 2) to provide examples of individual university efforts to incorporate new knowledge and approaches into their programs as a way of addressing regional needs and issues; and 3) to engage the audience in a facilitated discussion of the issues surrounding the development of sustainable forestry education programs. The results of this discussion will be incorporated into the Pinchot Institute's final project document, which will be released in late-1998.

USE OF THE DYADIC ALTERNATIVE TO MAKE LEARNING MORE ACTIVE, COLLABORATIVE, AND FUN

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ABSTRACT: I use the Dyadic Alternative in two sophomore-level courses that I teach at the Ranger School: "Forest Mensuration and Statistics" and "Tree Structure and Growth." The Dyadic Alternative is an innovative teaching/learning method that involves students working together in cooperative pairs. It was suggested by Licht (1993) and is based on the idea that "two heads are better than one." In essence, the Dyadic Alternative is a non-traditional, "upside-down", teaching/learning model, since formative quizzes on a chapter or unit *precede* the lecture and/or discussion of that unit. Moreover, students have the opportunity to collaborate on quizzes when using this method. The Dyadic Alternative forces students to take more responsibility for their own learning and encourages cooperation and active learning.

The Dyadic Alternative, as used by this author, consists of five steps. In step 1, students form groups of two by selecting partners. Resulting pairs, or "dyads", agree to remain as a unit for a specified period of time, possibly for the entire semester. For step 2, all students read the assigned chapter or unit in the course textbook for homework. When class meets again, students are quizzed individually on the assigned chapter. After turning in their first quiz, students immediately take the quiz again, but this time with their dyad partner. The higher of the two grades is recorded, completing step 3. In step 4, the instructor discusses the quiz and/or other material that may still be confusing, and/or reinforces key ideas, concepts, and methods. Finally, in step 5, the instructor arranges for summative testing of *individuals*.

The Dyadic Alternative is non-traditional in two important ways. First, students are tested on assigned subject matter *before* it is presented and/or discussed in class. This motivates students to complete homework assignments, and it forces them to

take more responsibility for their own learning. This increased motivation and responsibility usually leads to students being more alert, attentive, and inquisitive (i.e., prepared) in class. In short, it forces students to become more active learners.

The second unusual element of the Dyadic Alternative is the group testing component. After individually taking a quiz on an assigned chapter, students immediately re-take the same quiz with their dyad partner. Not only does this promote active learning, but the latter process also encourages cooperative learning, decreases test anxiety, and fosters a more enjoyable teaching/learning environment. In addition to these benefits, Sharik and Strong (1996) suggest that group testing actually increases learning. Unlike Sharik and Strong (1996), I did not utilize a formal, statistical approach to evaluate the merits of group testing; however, my qualitative observations are consistent with theirs. For example, I have observed that dyad partners develop a special bond, tutoring each other on course material both in and out of class. Also, the best students, even though their grades may not improve noticeably, derive personal satisfaction from helping others. Still another shared observation is that students come to class more prepared in order to contribute "their fair share" and/or so as not to appear ignorant or lazy in their partner's eyes.

Student feedback concerning the Dyadic Alternative has been very positive since I began using the method three years ago. The Dyadic Alternative helps create a more social, less competitive atmosphere that the students value and enjoy. Moreover, it exposes students to a more realistic teaching/learning model, one where collaboration is necessary and important. The Dyadic Alternative is just that, an alternative. What it offers to students, at the very least, is a change of pace…an appreciated break from the traditional lecture method of teaching/learning.

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DEVELOPMENT AND TESTING OF INNOVATIVE LEARNING TECHNIQUES IN WOODY PLANT IDENTIFICATION AND TREE BIOLOGY

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Computer-enhanced delivery of instructional materials is finding increased use in the classroom. This is even true for instruction which has traditionally been taught in an outdoor laboratory setting. A good example of this is woddy plant identification, which typically involves a series of outdoor laboratories supplemented in part by herbarium specimens and photographic material. For the past several years we have been developing and testing computer- and world wide web (WEB)-based classroom material for enhancing instruction of woody plant identification and forest biology. Our goals were to (1) provide unlimited self-paced learning that emphasizes the use of high-quality photographic images and student interaction; (2) provide students with an opportunity for self-evaluation and immediate feedback; and (3) increase the availability of teaching aids and frequently asked questions through the use of WEB-based material.

In the area of woody plant identification we have developed a multimedia computer tutorial that supplements our traditional outdoor instruction. The program is being distributed commercially by Kendall-Hunt Publishing. The software provides over 2,000 high-quality color images of twigs, leaves, bark, fruit, flowers, and form for species common throughout the eastern United States. A morphology section familiarizes students with terms used in plant identification. Multiple images of critical plant parts are available so students can develop a feel for normal field variation. Immediate side-by-side comparisons of similar-looking species is possible for all plant parts. Full text descriptions, range maps, critical distinguishing features, and interesting tidbits are provided for each species. Perhaps most useful is a quiz section, which allows students to evaluate themselves.

The success of this software was determined by a perception survey administered to students. Results of the survey indicated that the software was well liked by the students (Table 1) (Seiler et al. 1997).

Table 1. Average response to student perception study. Twenty and fifty-five students responded to the survey in 1995 and 1996, respectively.

	Average Response*	
Question	**1995**	**1996**
Tree ID was easy to use	1.22	1.35
The overall program was useful	1.56	1.48
Tree ID should be used as a supplementary aid in Dendrology Lab	1.56	1.53
Tree ID could be used to replace some outdoor instruction	3.11	3.14
The self-paced quizzing module assisted me with later tree identification in the field	—**	1.99
The pictures and graphics were of high quality	1.67	1.87
The tutorial text and tree descriptions were useful	1.67	1.79

*1 = strongly agree; 2 = agree; 3 = disagree; 4 = strongly disagree.
** Question was not asked in 1995 survey.

Controlled testing of the software in 1995 indicated that after two weeks of use it helped to improve actual field identification (Figure 1). Further evaluation in 1996 found that the final course grade was 5 percent higher (p=0.07) in users compared to non-users of the program. Among users, neither total use time, average time per visit, nor number of visits was correlated with grade received in the class. However, this does not suggest that computer use did not help students. Potentially, a student who might have received a D in the course received a D+, or a student who might have received a B received a B+ by using the software.

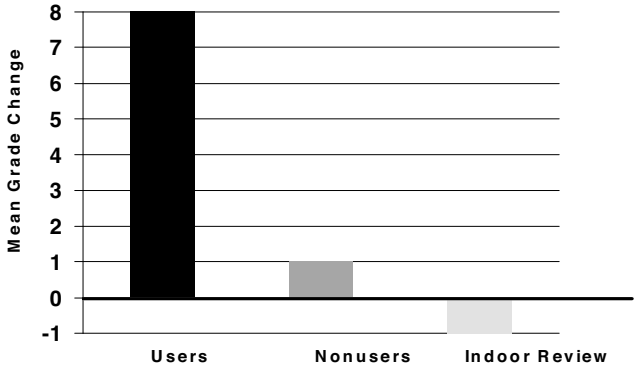

Figure 1. Percent change in quiz grades for the two weeks prior to computer tutorial use compared to the two weeks following use (students are routinely quizzed every week). Users had access to the program for a two-week period. Indoor review students received a "conventional" session with an instructor.

We have also developed a Dendrology class home page (http://www.fw.vt.edu/dendro/dendrology/dendro.htm) where students can view their grades, check the weather, and link to other interesting sites. One of the most useful features of our homepage are tree fact sheets. These fact sheets contain a text description of the tree and color pictures of key plant parts. They are arranged by lab as well as alphabetically. Students are encouraged to print these sheets out ahead of time so that in the field they can look at key plant features instead of taking notes. Maps to off-campus labs are also avaliable so students can preview new species and potential quizzes for that day in the field.

At Virginia Tech we teach a two-semester-hour course in Forest Biology. The class covers basic structure, development,

and physiology of woody plants, as well as forest biomes. Historically, it has been difficult to find a textbook suitable for this class given the wide range of material presented and the short contact time (2 credits). Through grants fromVirginia Tech's Center for Excellence in Undergraduate Teaching and Center for Innovation in Learning, we have developed an on-line interactive textbook which students access through a class homepage http://www.fw.vt.edu/dendro/forestbiology/forbio.htm). On-line help via e-mail links is available to assist students with gaining access to the textbook.

The textbook is arranged by topic area (e.g., carbon uptake). Each topic area begins with a set of major learning objectives and the text closely follows lecture material. High-quality visuals and interactive activities are placed throughout. Hypertext words are linked directly to a glossary. A bank of test questions is being developed that will generate on-line practice tests for students. We are in the process of evaluating the electronic textbook. The results of a student perception survey will be presented as well as insights gained from interacting with students. Use of the textbook is not mandatory.

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THE HUCKLEBERRY STORY: BUILDING A BRIDGE BETWEEN CULTURE AND SCIENCE

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"Wi'wnu"—big huckleberry—plays a prominent role in the lives of Pacific Northwest Indians. As a food and as a symbol, it is deeply rooted in their culture and their heritage. For many, it is a link to their past; for others it is a bridge to their future.

Despite their obvious importance, huckleberries—and the culture that surrounds them—are facing difficult times on many tribal lands. Young people growing up today are not as familiar with huckleberry traditions as their elders would like, and the huckleberry resource itself is dwindling, as long-productive fields are being invaded by trees and plants are losing vigor.

This 20-minute, award winning educational video addresses both challenges. The first half of the video features interviews with tribal elders from the Confederated Tribes of the Warm Springs in central Oregon. In moving passages the elders describe the importance of huckleberries to the lives of Northwest Indians, both for sustenance and for ritual. The second half of the video features a prominent US Forest Service researcher who explains how to rejuvenate historically important huckleberry fields and how to maintain their productivity over time. This educational approach, combining heritage and science, will provide a culturally important resource for years to come.

Produced in partial fulfillment of the requirements for a Master's degree in Natural Resource Education and Extension, this project also provides an intriguing model that other graduate students might like to emulate.

THE PROFESSIONAL RESIDENCY IN NATURAL RESOURCES AND ENVIRONMENTAL EDUCATION

Using Non-Traditional Methods to Complement Effective Natural Resource Education

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ABSTRACT: Since 1967, Teton Science School (TSS) has been an important resource in educating, training, and inspiring students of all ages. The school enjoys a reputation as the premier natural science education center in the northern Rocky Mountain region.

Founded by Ted and Joan Major, the school is situated within the Greater Yellowstone Ecosystem on the eastern edge of Grand Teton National Park. The school's location, surrounded by the aspen and conifer forests of the Gros Ventre Mountain foothills, is ideal for natural science studies.

Originally a guest ranch, the school's log buildings include over twenty cabins and a main lodge. The school has grown to include two dormitories, a log dining lodge, a graduate student commons, a natural history museum, and a field sciences laboratory. The school is equipped with many computers as well as fax, modem, and Internet connections.

The school's field studies curriculum has always been comprehensive and progressive. Responding to the growing needs of the education community for a higher standard in natural science instruction, the school has recently pioneered the development of a unique academic residency for college graduates interested in careers in the development, teaching, or management of private and public natural resource and environmental education programs.

The TSS Professional Residency for Natural Science and Environmental Education (PREE) is a one-year experiential academic program for college graduates. The goal of the Residency is to offer students comprehensive, high quality training, using a unique combination of academic work and extensive hands-on, teaching opportunities.

PREE offers post-baccalaureate students extensive training in field-based, natural science education as part of graduate studies at participating universities. The Professional Residency began as a unique partnership with Utah State University, Department of Forest Resources. Students that are accepted into both the Teton Science School Professional Residency and Utah State University, spend one year at TSS completing a very concentrated practicum in natural resource and environmental education that includes extensive teacher training as well as academic support work taught by USU adjunct faculty at TSS. These students then finish their graduate education under the tutelage of USU faculty at the university.

While the program's course work offers an opportunity to examine environmental education issues in an academic context, direct teaching opportunities provide students with invaluable hands-on experience. Students play a significant daily role in planning, organizing and teaching the many elementary and secondary students who attend TSS annually. To balance course work and fieldwork, students are provided with one-on-one guidance with a TSS faculty member.

Other colleges and universities are now active participants in the PREE program. In order to complete their graduate degree in natural resource management or environmental education, graduates of the PREE program enter programs at associated universities either prior to or at the completion of the PREE program: Utah State University, Prescott College, Colorado State University, University of Montana or University of Wyoming.

The important elements of the Professional Residency model that are embedded in the educational philosophy of Teton Science School are useful themes for natural resource professionals. This approach to graduate education offers essential skills and knowledge that match closely the skills and knowledge base that resource professionals find to be essential in the world of public participation and natural resource conflict. Some examples:

*Graduate residents develop extensive natural history knowledge and critical naturalist skills. The graduate students that come to TSS arrive with exceptional undergraduate backgrounds in the sciences, yet they have very little practical, field experience and direct knowledge of nature. At TSS, their theoretical knowledge is grounded in real world experience in nature which promotes their effectiveness as communicators and teachers. The curriculum of the PREE program has as a fundamental focus the notion that the essential character of any kind of environmental or natural resource education is helping students find a "sense of place" in their natural and human community.

*Graduate residents learn natural resource conflict management skills, including effective communication, negotiation and mediation. Often graduate students that spend a year at Teton Science School arrive with academic training in resource and environmental policy and management, but have had little real life experience working with and through conflict. Their communication skills are primitive and their understanding of the nature of conflict is underdeveloped. We help to improve these skills by exposing them to regional conflict and asking them to teach these skills to visiting students. In addition, each student participates in three intensive seminars in which they explore their personal and professional communication skills, their ability to work through conflict and their awareness of the essential elements of a professional life.

*Graduate residents use long-term, TSS field research projects as educational opportunities with students that visit TSS. Although many graduate students come with some research experience, the opportunity to teach the research process to students as well as to help them collect and analyze data, deepens their appreciation for and understanding of the nature of science. They become communicators of good science and effective management rather than merely technicians.

Offering direct exposure to these sorts of skills and experiences is difficult in more traditional university settings. The Professional Residency, because of its experiential and real-world setting, presents an interesting and effective complement to more typical natural resource education.

NATURAL RESOURCE DATA ANALYSIS: FINDING COMFORT WITH COMPUTERS

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ABSTRACT: For the past six years Michigan State University Department of Forestry has offered a course, "Natural Resource Data Analysis," that has evolved as computer technology and the skills that students bring to the class have changed. In addition to the mastery of basic computer skills, there are three principle objectives in the course: identifying a natural resource problem and obtaining relevant data; conducting an objective, quantitative analysis of the data; and presenting the analysis in a way that is clear to a non-technical audience. The course consists of a combined lecture/lab where fundamental concepts oral and written communication, quantitative analysis, and spatial analysis/cartography are introduced and a hands-on lab where students practice specific computer and analytic skills. The ultimate course objective is the presentation of an analysis of a natural resource problem via World Wide Web pages, a written report and an oral, computer-assisted presentation.

When the course was first offered in 1993, the primary course objective was to increase student proficiency in the use of computer applications and to help them become more comfortable with computers. Few students at that time came to the course with a high level of computer competence and confidence. Today's students are more likely to have gained some

computer experience before enrolling in this course, so we have now refocused to concentrate more on analysis and communication objectives.

The course has always involved teaching the core software tools that are essential in almost every professional setting: word processing, spreadsheet and presentation applications. Early on, instruction in the design and use of relational databases was included; this module has since been replaced with an introduction to GIS and geospatial analysis (which includes some elements of data management). Despite a changing mix of software, the course has always had an emphasis on integrating the applications for seamless communication through reports, spreadsheet generated graphics and slide show presentations.

The data gathering stage of the course has changed dramatically since 1993 when instructors supplied students with research oriented data sets (e.g., plot data from a regeneration study or timber price time series, fire history databases). In part due to enthusiastic student response to the GIS module, spatial information now plays a more prominent role in the course. Students are now provided with core sets of Michigan county-level geographic, demographic, socio-economic, and resource-based data. They can then supplement this core with data appropriate to the natural resource term paper topic of their choice. We expect to realize significant advantages such as improved consistency in student projects as a result of building common data sets which can also be used for weekly homework exercises.

Requiring students to search for some of the data they will analyze acquaints them with the variety of data resources now available including library reference materials, CD ROM data bases, and an increasingly rich stockpile of on-line data sources. One challenge is to teach students to think critically about the data that they find and to evaluate its suitability for the analyses they wish to conduct considering such issues as resolution/scale, lineage, accuracy, objectivity, and currency. A few years ago it was a challenge to make students aware of the World Wide Web as a resource; today the challenge is to make them understand that it is not the only resource.

The data analysis objectives for the course have been refined and are now articulated as a set of analytic tools such as descriptive statistics, trend line analysis, histograms, thematic mapping, and spatial query with which students should be proficient by the end of the course. These tools are demonstrated by the instructors and practiced by students using in-class and homework exercises. Students are expected to appropriately use a certain number of these techniques in the course of the analysis they conduct for their term projects.

All class components are integrated in the term project (which builds gradually over the semester in a series of incremental blocks). As students gather project data and develop a project prospectus, they are expected to design and publish a web site that describes the goals of their analysis and documents the sources of the data they will use. By the end of the course, students are expected to be capable of creating appropriate, clear graphics, generating focused text slides, and presenting a lucid oral report with a question and answer session. Students must also write reports that integrate tabular and graphic presentation of analysis results with documentation of analytic methods. Examples of recent student projects include: Great Lakes Water Quality, Urban Sprawl and Land Use Change in Michigan, Fire Effects in Northern Michigan Forests and Michigan Super Fund Sites.

Other uses of technology during the course include a web-based discussion page on which students are encouraged to post questions that come up between class sessions; other students and/or course instructors (who regularly monitor the site) can respond with suggestions or clarifying questions. Groups are paired so that they can offer feedback to another group on their web page information based on certain criteria (e.g., Is it clear? Are the data sources reliable?). Homework grades are regularly posted on-line allowing students to track their progress. Another innovation has been the addition of on-line quizzes available only during lab sessions. The results are automatically emailed to the teaching assistant and serve to reinforce key points as well as tracking attendance.

As the importance of computer and analytic skills has been more widely recognized, this course has been added as a requirement for both Forestry majors and as an option for Resource Development and Fisheries and Wildlife majors. The emphasis of this course has been to train students to take advantage of computer technology to make them more marketable and effective natural resource professionals. One benefit of the course is that it allows instructors of upper division courses to teach at a higher level since basic computer competency can be assumed. Comments from previous students suggest that they have been able to apply these skills both in their later education and on the job.

THE ROLE OF GRADUATE STUDENTS IN UNIVERSITY EDUCATION IN NATURAL RESOURCES: A VIEW FROM WITHIN

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ABSTRACT: Concern has recently arisen on the changing role graduate students play in natural resources education at the university level. For example, there is the perception that an M.S. degree is little more than a preliminary step towards a Ph.D., rather than having its own quantifiable merits. Questions have also been raised about the degree of professionalism exhibited by graduate students, the expectations faculty have of students and the expectations students have of faculty.

We hope to address concerns we as doctoral students in the Department of Forest Resources at Utah State University have regarding our academic and professional environment. With this as a context for discussion, we plan to evaluate possible changes to be made to the educational surroundings to create an environment more conducive to academic and intellectual intercourse between graduate students, faculty and other professionals. The graduate students of today are the faculty and resource/policy managers of tomorrow, so their academic success and satisfaction is essential to the success of future generations.

A re-evaluation of the roles graduate students play within educational constructs may be in order. We feel that graduate students should be more involved in the decisions affecting their education, the personal and professional development of undergraduate students and other graduate students and demonstrate greater interest in treating graduate work more professionally. In addition, we believe faculty should show more leadership in developing a dynamic and challenging graduate curriculum, should facilitate greater contacts with other students across disciplines and provide an environment conducive to the professional development of graduate students.

Encouraging and sustaining social and academic interactions is the responsibility of all members of the department. Without such interactions a fundamental aspect of graduate education and personal development is sorely lacking. This deficiency could have cascading detrimental effects, including less effective natural resource and policy decisions, communication failures and misunderstandings and, potentially, a disintegration of our academic system. We hope the themes arising from our presentation will be further developed at a later round-table discussion in this conference.

TEACHING NATURAL RESOURCES POLICY THROUGH CASE STUDIES, AUTHENTIC ASSESSMENT AND THE INTERNET

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ABSTRACT: The teaching of natural resources and environmental policy does not lend itself well to the traditional methods of teaching found in the field of natural resources. Instead, a teaching triangle composed of methods from the social sciences and the application of technology allow for a more complete and thorough understanding of the subject by the student. Use of case studies forms the basis of this teaching method, removing the abstractness of the subject and showing the actual field application of what is taught. Authentic assessment or reliable evaluation methods expand the students thinking on the subject while giving the instructor a solid indicator of student learning. Finally, the Internet and the use of a listserve provide for information access and instructor-student interaction not possible before.

INTRODUCTION

People are drawn to the natural resources professions because they believe it is here that they can spend time in the great outdoors, helping preserve nature's beauty while making a livable wage. Yet, ask anyone who has been in the profession for more then five years what they spend most of their time doing. They are Likely to answer that they spend the built of their time dealing with government policy and regulation. Some have even gone so far as to saSI they should have completed degrees in political science, public administration, policy or government instead of a natural resources field. The challenge then becomes how do we educate tomorrow's natural resource manager, someone who Likely wants nothing to do with government regulation and policy, about these same subjects, subjects critical to their professional growth. The answer is through the use of a teaching triangle composed of case studies, non-traditional teaching methods and modern technol~gy as a complimentary resource.

USE OF CASE STUDIES

The use of case studies is a key component in teaching policy to future natural resource professionals, something that is broadly used in the social sciences. Usually, natural resources students do not have the general political science, public administration, government and policy background that is needed to work with environmental and natural resources policy in the theoretical sense, nor is the theoretical application of that knowledge of much use. What is of use is an explanation of the basics of these fields; then specifics, on how these can be practically applied. The use of case studies allows the students to see how the concepts of policy and public administration are components of natural resources policy and why it is important for them to have a basic understanding of these fields. It also allows for a higher level of interaction between the student and the instructor; not so much lecturing, teaching and grading, but leading, mentoring, constructive criticism and evaluation.

RELIABLE EVALUATION OF STUDENT LEARNING

The second key to this triangle is the use of what would be considered nontraditional teaching methods in the field of natural resources. With few exceptions, the field of natural resources is, by its very nature, a predominately quantitative type field. Natural resources policy is one of those exceptions. Quantitative fields are generally thought to be best taught by using lecture and labs, then testing for understanding and memorization of the concepts and facts presented. Policy, being a qualitative field, does not adhere to this method. It is possible to test a basic understanding of the concepts presented, becomes much more difficult to check and see if the student understands how these concepts interact and if they can express this relationship. So instead of

traditional tests, other methods should be used such as papers, group projects and journals to assess how well the students are understanding the material and bringing it together. Though this might require more time and effort on the part of the instructor, it is worth it in that it allows for a better understanding of the material by the student.

USE OF THE INTERNET

The third leg of this triangle is the use of additional resources outside the classroom as an additional teaching opportunity. In the past, the sources for information and teaching outside of the policy classroom generally has been confined to books and articles. There are other opportunities such as field trips and internships, but those are extremely limited. Technology, specifically the Internet, and the Fncreased level of computer sophistication among students has provided for a new and exciting way to reach students outside of the classroom. By the very nature of the subject, there isn't enough time in one semester to truly give the student all of the information they need through the traditional lecture and resources such as books and articles. This gap can be filled by the Internet by creating a web page as a third resource for the student. The web page can serve as a class reference with information on it such as the class syllabus, the instructors office hours and alternative ways to reach the instructor such as via email. It can also serve as a source for handouts and outlines, allowing the student to choose whether or not to use this information. Lastly, it can serve as a link to other information that the student can explore if they choose to, such as links to other web sites Like the EPA, NOAA, USFS, NPS, Congress, the President and others. The amount of information that is available via the Internet can never be brought completely to the classroom, but by using a web page, we can show the students the way for them to explore outside the classroom.

CONCLUSION

The use of this triangle as a basis for teaching policy in the natural resources field provides the instructor with opportunities that conventional teaching methods in the field can not. Since policy is not a traditional field within natural resources, it requires that methods from its parental fields be used in its teaching.

TEACHING FOREST STAND DYNAMICS OR WHAT HAPPENS WHEN YOU THIN YOUR MARIGOLD PLANTATION

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ABSTRACT: Teaching forestry students about forest stand dynamics can be an abstract activity. Very quickly concepts are reduced to mathematical formulae, graphs and diagrams, all with relatively complicated explanations. Alternatively, computer simulation and individual tree models can be used to demonstrate important concepts such as the '3/2 Power law' of self thinning. Students can also be taken to visit plantations to talk about practical issues of density management and perhaps produce a thinning prescription. However, no single teaching strategy enables students to have 'hands on' practice at manipulating a real plant population while being able to wait and see the results of their work.

Density-mortality relationships were largely developed from research on agricultural crops, where growth and development proceeds at a quicker pace than in forestry. In theory, the application of different spacings and/or thinning regimes should follow similar density-mortality relationships regardless if the crops is pine or wheat. In this paper we outline an exercise that has been used successfully at the School of Forestry, University of Edinburgh and the Faculty of Forestry, University of Toronto to demonstrate principles of stand dynamics with the aid of young plants of marigold (Tagetes patula L.).

Seed is sown in seed trays in plots of 6 x 15 rows at 2.5 cm spacing. After a month of growth, when the leaves of plants are just beginning to overlap, the trays are brought into the class and a range of treatments is applied. These include a control (no thin), thinning from above, thinning from below, removal of one row in three, and removal of 2 rows in 6. Density in all cases is reduced by one third, but the pattern of removal means that different dynamic processes should ensue. The plants are left to grow for another month, after which the plots are harvested and plants are individually oven dried and weighed. Students are then encouraged to plot graphs of plant-size distributions and mortality and write a report explaining the differences between the various treatments. Ambitious students may want to pursue more complicated statistical analyses.

In addition to providing an opportunity to observe dynamic processes in detail, this exercise also introduces students to the concepts of experimental design, replication and statistical analysis. By incorporating discussion and presentation of the results the exercise can serve as a focus for several academic and practical learning objectives. From a teaching perspective it is a very effective and efficient tool. As a student-centred activity, each participant makes an important contribution to the success of the whole exercise, and gains experience of density-dependent mortality and stand dynamic processes in action.

THE PROBLEM-BASED LEARNING MODULE: COMPUTER-AIDED PROFESSIONAL EDUCATION IN FORESTRY

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A fundamental element of professional practice is the application of knowledge and skills to solve problems. Traditionally, foundation knowledge is taught independently of problem-solving (PS) skill development and the individual knowledge components are taught independently of each other. As a result, students are often unable to integrate knowledge across disciplines or to use foundation knowledge to solve new and complex problems. Professional problems are a powerful tool to help motivate and integrate learning. Problems create "teachable moments" where students recognize learning needs. Since students progress through problems differently, providing instruction at a time optimal for each individual student is a logistical challenge in large classes and distance education with limited library resources and access to instructors.

As with all skills, PS development requires practice and feedback. A large number of problems must be attempted and the student's PS process examined, criticized and iteratively improved. Trying to infer the PS process from problem solutions is inefficient and ineffective. Instructors therefore usually also ask questions and observe students actually solving problems to identify roadblocks in the PS process or basic knowledge deficiencies. This approach is impractical with large groups and in distance education formats due to limited student contact with instructors.

Since this typifies our situation, we developed a software tool to help cope with the challenges it presents. We therefore identified a need for a software tool to: present a realistic professional problem; provide easy access to problem-related information and help in context and "just in time"; track and score student PS performance. This paper presents software to address these needs. It presents a problem in a natural form and a list of questions the student can ask to solve the problem. It contains both relevant and irrelevant questions, to avoid providing solution cues. The student moves through the problem naturally, asking questions and receiving answers. When help is needed in understanding the answers given or questions to be posed, the student accesses on-line technical help modules. A student's "pathway" through the problem is tracked, recording the questions asked and their order, help files accessed and notes made when students are prompted to describe their reasons for asking a given question or taking an action (e.g., ordering a forest inventory for a woodlot). The pathway can then be scored according to various criteria such as time to complete the solution, cost of information used, quality of answer and environmental risk and compared to experts' pathways. This software also has potential to be used for assessments of potential employees and continuing education needs.

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