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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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