

Summer 2011

# Turning Students into Problem Solvers

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Powell, Larkin A.; Tyre, Andrew J.; Conroy, Michael J.; Peterson, James T.; and Williams, B. Ken, "Turning Students into Problem Solvers" (2011). *Papers in Natural Resources*. 349.

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# Turning Students into Problem Solvers

## INTEGRATING ADAPTIVE MANAGEMENT INTO WILDLIFE CURRICULA

By Larkin A. Powell, Ph.D., Andrew J. Tyre, Ph.D., Michael J. Conroy, Ph.D., James T. Peterson, Ph.D., and B. Ken Williams, Ph.D.



Credit: Brett Hampton/  
University of Nebraska-Lincoln

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In the popular movie *Apollo 13*, based on the actual NASA mission, three astronauts are stranded in space, their craft's electrical system broken, their oxygen quickly running out. To help them fix the problem and return home safely, mission controllers summon a group of engineers, dump a pile of equipment onto a desk—the tools available to the astronauts—and tell them to find a solution, or more specifically, “a way to put a square peg in a round hole. Rapidly.” Eventually, the engineers' plan saves the day, and the astronauts make it home.

State and federal agency biologists generally do not face life-or-death decisions of this magnitude, but many do face day-to-day decisions that share traits with the *Apollo 13* crisis. Biologists and managers have deadlines, uncertainty, and a limited toolset. The critical need, and the missing part of the analogy, is the team of engineers—trained problem solvers who are intimately familiar with the decision environment and the tools available to create a solution.

Structured decision making (SDM) is a formal process that problem solvers can use to document and weigh alternative management scenarios in terms of their respective benefits, costs, and likelihood of success or failure (Clemen 1996). SDM serves as a vital complement to Adaptive Resource Management (ARM), which—through an iterative cycle of planning, doing, monitoring, and evaluating—provides a learning-based framework for making conservation decisions (Knutson *et al.* 2010, Williams *et al.* 2007).

Although natural resource professionals are increasingly relying on SDM and ARM to make decisions about complex management situations, university programs in wildlife management rarely teach undergraduate or graduate students about decision-making strategies (Boyles *et al.* 2008). We believe that university and college faculty must respond to the need for student training in ARM. Here, we describe ways that existing undergraduate and graduate curricula can be modified to produce graduates who are ready to tackle today's complex wildlife management problems.

### An Integrated Approach

In our view, the strategy should not entail simply adding a new ARM course as a degree requirement—such a “one-off” exposure to a difficult idea is insufficient. Pedagogical research suggests that repeated exposure to concepts across an entire curriculum can be more effective. For example, researchers have found that repeated use of geospatial information technology (GIT) from the freshman to senior year not only reinforced the ability to use GIT, but it also reinforced quantitative skills that will be needed in the student's career (Furner and Ramirez 1999). In a parallel fashion, we believe that integrating ARM's components across the wildlife biology curriculum can help students build needed problem-solving and creative-thinking skills. An added benefit of the integrated approach? It can engage faculty in the educational process as a team.

The broad relevancy of ARM means that some university curriculum committees may feel that their program is, by default, training students to use ARM. While that may be true, we encourage these committees to assess their curricula to ensure that ARM learning objectives—such as understanding ecological dynamics, management techniques, study design, data analysis, and effective communication—are achieved. Faculty members should also inform students why ARM is part of their course of study. A General Ecology instructor, for example, should remind students that having a firm understanding of ecological theory is going to be critical to making management decisions in the future.

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Course objectives may need to be updated to refer to decision-making end goals.

## Approaches for Curricula

The two tables in this article present ARM learning objectives that curriculum committees and other faculty members may use to incorporate the principles of SDM and ARM into their wildlife students' programs of study. Depending on whether one is educating undergraduate or graduate students, the approach to including ARM may differ.

**Undergraduate Level:** There is no need to develop additional courses to integrate ARM into the undergraduate curriculum. Instead, redesigning communication courses to address conflict resolution, interpersonal communication, and use of various media may be the best method for introducing ARM, as communication failures among stakeholders and ARM facilitators are cited as a common reason that ARM does not succeed (Williams *et al.* in review). Likewise, assessing ecological data and creating models require applied mathematical and statistical skills, which may not be the focus of traditional courses taught to undergraduates. Thus, an integrated curriculum will require the cooperation of instructors in several subjects outside a natural resources department, including statistics, other mathematics, English, and communications.

**Graduate Level:** Graduate curricula approaches to ARM are very different from undergraduate. First, most MS degrees contain approximately 20 hours of coursework—only five or six courses—and many programs have no required courses. Incorporating ARM training into a program of study will thus fall to the student, advisor, and graduate committee. Second, because most graduate students have not been exposed to ARM as an undergraduate, graduate programs will need to perform “remedial” training during the next decade. This will gradually become unnecessary as undergraduate programs begin to provide introductory ARM training.

Graduate curricula may benefit from an introductory course in SDM. Such a course could include general principles of management and decision making, science and logic, and learning by doing—in other words, ARM in practice. We encourage faculty to consider how colleagues in related fields might contribute to such a course, and we emphasize that ARM should be a critical component, but not the focus, of the course.

## Adaptive Resource Management Learning Objectives for Undergraduates

### Stakeholder interactions

- Learn to constructively engage hypothetical stakeholders through student role-playing.
- Study at least one potential stakeholder's mission statement through internship-type activities.
- Constructively engage stakeholders through limited interaction with small groups of real stakeholders.

### Goal-setting

- Set objectives for management that can be evaluated with monitoring data.
- Identify means and fundamental management objectives.
- Recognize and structure the relationships among management objectives.

### Monitoring/study design

- Learn basic tools for wildlife survey design and implementation.
- Develop monitoring schemes which are designed to feed data toward decision-making processes.
- Develop small-scale research study designs.

### Written communication

- Summarize in writing the key parts of a natural resource problem.
- Summarize and properly cite previous research or ARM exercises that provide insight into current problems.
- Write a formal habitat or wildlife management plan.
- Report the results of a quantitative analysis in terms that can be understood by stakeholders.

### Law and policy

- Demonstrate knowledge of the derivations of public policy, as well as of the agencies and personnel responsible for public policy.
- Investigate legal issues pertinent to natural resource problems.

### Model-based system predictions

- Use simple models to make predictions under contrasting scenarios.
- Evaluate the use of complex models to make predictions.

### Data analysis

- Use basic statistical tools to evaluate research data.
- Evaluate trend-type data to detect changes over time in monitoring data.
- Interpret the results of statistical analysis in terms of management and biological significance.

### Adaptive resource management

- Learn the basics of the ARM framework.
- Use the ARM process on an applied problem.

### Formal decision making

- Apply the concept of uncertainty as management options are developed.
- Develop basic concepts of a decision-making process by solving simple problems with low levels of uncertainty.
- Develop skills needed to solve moderately complex problems with moderate levels of uncertainty.
- Apply decision-making skills to complex problems with multiple types of uncertainty.



## Ready to Face a Complex Future

The University of Nebraska-Lincoln (UNL) has developed MS and Ph.D. specializations in Adaptive Resource Management; the graduate-level learning objectives listed in the table at right arose from that process. The University of Georgia has also incorporated ARM into select graduate courses. We've seen signs that including ARM material in our courses is working: After taking UNL professor Larkin Powell's spring 2010 course on wildlife ecology and management, students were asked to name one thing they learned of critical importance to wildlife management. The most frequently named lesson? Structured decision making. "I think that the topic is very important—if not indispensable—to today's wildlife managers and biologists, who must take on complex and multifaceted problems with diverse interests at stake," says UNL fisheries and wildlife major Ian Hoppe.

Though wildlife faculty can lead the way in introducing ARM to their students, they will require administrative support to be successful in implementing the new objectives. In addition, The Wildlife Society may be able to encourage incorporation of ARM principles into uni-

versity learning by requiring such coursework in their wildlife biologist certification process.

Now, more than ever, we need wildlife biologists who have an integrated, interdisciplinary background in decision-making skills. Exposing students repeatedly to ARM at the undergraduate and graduate levels will prepare students for challenges they will face in their careers. ■

## ARM Learning Objectives for Graduate Students

### Quantitative methods

- Learn advanced methods in study design and hypothesis generation.
- Study advanced methods to evaluate trend-type data to detect changes over time in monitoring data.
- Do parameter estimation.
- Interpret the results of statistical analysis in terms of management and biological significance.
- Practice advanced modeling techniques for wildlife populations and natural systems.
- Use complex models to make predictions under contrasting scenarios.

### Stakeholder interaction

- Interact and cooperate with scientists, agency personnel, and other stakeholders in real-world situations.
- Facilitate a discussion among stakeholders in a real-world situation.

### Communication and human dimensions

- Develop skills to work with groups in conflict situations.
- Gain leadership skills as a facilitator of a group discussion.

### Law and policy

- Demonstrate knowledge of the derivations of public policy, as well as knowledge of the agencies and personnel responsible for public policy.
- Investigate legal issues pertinent to natural resource problems.

### Interdisciplinary activities

- Summarize a natural resource problem that includes human dimension, ecological, economic, and legal issues.
- Demonstrate their use of the ARM decision-making process to make a simple decision.
- Apply the ARM process to a moderately complex problem with moderate uncertainty.
- Adapt ARM principles to complex problems with high levels of uncertainty.

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