
Understanding Barriers to Implementation of an Adaptive Land Management Program

SUSAN K. JACOBSON,*†† JULIE K. MORRIS,* J. SCOTT SANDERS,† EUGENE N. WILEY,†
MICHAEL BROOKS,† ROBERT E. BENNETTS,‡ H. FRANKLIN PERCIVAL,§
AND SUSAN MARYNOWSKI*

*Department of Wildlife Ecology and Conservation, University of Florida, P.O. Box 110430, Gainesville, FL 32611-0430, U.S.A.

†Florida Fish and Wildlife Conservation Commission, 620 South Meridian Street, Tallahassee, FL 32399-1600, U.S.A.

‡Greater Yellowstone Network, National Park Service, 1648 S. 7th Avenue Bozeman, MT 59717, U.S.A.

§USGS Florida Cooperative Fish and Wildlife Research Unit, University of Florida, P.O. Box 110485, Gainesville, FL 32611-0485, U.S.A.

Abstract: *The Florida Fish and Wildlife Conservation Commission manages over 650,000 ha, including 26 wildlife management and environmental areas. To improve management, they developed an objective-based vegetation management (OBVM) process that focuses on desired conditions of plant communities through an adaptive management framework. Our goals were to understand potential barriers to implementing OBVM and to recommend strategies to overcome barriers. A literature review identified 47 potential barriers in six categories to implementation of adaptive and ecosystem management: logistical, communication, attitudinal, institutional, conceptual, and educational. We explored these barriers through a bureau-wide survey of 90 staff involved in OBVM and personal interviews with area managers, scientists, and administrators. The survey incorporated an organizational culture assessment instrument to gauge how institutional factors might influence OBVM implementation. The survey response rate was 69%. Logistics and communications were the greatest barriers to implementing OBVM. Respondents perceived that the agency had inadequate resources for implementing OBVM and provided inadequate information. About one-third of the respondents believed OBVM would decrease their job flexibility and perceived greater institutional barriers to the approach. The 43% of respondents who believed they would have more responsibility under OBVM also had greater attitudinal barriers. A similar percentage of respondents reported OBVM would not give enough priority to wildlife. Staff believed that current agency culture was hierarchical but preferred a culture that would provide more flexibility for adaptive management and would foster learning from land management activities. In light of the barriers to OBVM, we recommend the following: (1) mitigation of logistical barriers by addressing real and perceived constraints of staff, funds, and other resources in a participatory manner; (2) mitigation of communication barriers through interpersonal and electronic communication channels; (3) development of an OBVM external advisory committee; and (4) adoption of characteristics of an organizational culture that promotes flexibility and learning.*

Keywords: adaptive management, communication, ecosystem management, organizational change, vegetation management, wildlife management

Entendiendo las Barreras para la Implementación de un Programa Adaptativo de Gestión de Tierras

Resumen: *La Comisión de Pesca y Vida Silvestre de Florida gestiona más de 650.000 ha, incluyendo 26 áreas de gestión de vida silvestre y ambiental. Para mejorar la gestión, han desarrollado un proceso de gestión de vegetación basado en objetivos (GVBO) que enfoca condiciones deseadas de las comunidades de plantas mediante un marco de manejo adaptativo. Nuestras metas eran entender las barreras potenciales para la*

††email jacobson@ufl.edu

Paper submitted December 27, 2004; revised manuscript accepted December 13, 2005.

implementación de GVBO y recomendar estrategias para superar esas barreras. Una revisión de literatura identificó 47 barreras potenciales, en seis categorías, para la implementación de manejo adaptativo y de ecosistemas: logística, comunicación, de actitud, institucional, conceptual y educativa. Exploramos esas barreras a través de un muestreo de 90 personas involucradas en GVBO en agencias y entrevistas personales con gestores, científicos y administradores. El muestreo incorporó un instrumento de evaluación de cultura organizacional para medir como pueden influir factores institucionales en la implementación de GVBO. La tasa de respuesta al muestreo fue de 69%. La logística y la comunicación fueron las mayores barreras para la implementación de GVBO. Los encuestados percibieron que la agencia tenía recursos inadecuados para la implementación de GVBO y proporcionaba información inadecuada. Cerca de un tercio de los encuestados creían que GVBO reduciría la flexibilidad de su trabajo y percibían mayores barreras institucionales al método. El 43% de los encuestados que pensaban que tendrían mayor responsabilidad con GVBO también tuvieron mayores barreras de actitud. Un porcentaje similar de encuestados reportó que GVBO no daría suficiente prioridad a la vida silvestre. El personal pensaba que la actual cultura de agencias es jerárquica pero prefería una cultura que proporcionara mayor flexibilidad para el manejo adaptativo y pudiera propiciar el aprendizaje a partir de actividades de gestión de tierras. A la luz de las barreras para GVBO, recomendamos lo siguiente: (1) mitigación de barreras logísticas mediante la atención a restricciones, reales o potenciales, de personal, fondos y otros recursos de manera participativa; (2) mitigación de barreras de comunicación mediante canales de comunicación interpersonales y electrónicos; (3) desarrollo de un comité asesor externo para GVBO; y (4) adopción de características de una cultura organizacional que promueva la flexibilidad y el aprendizaje.

Palabras Clave: cambio organizacional, comunicación, gestión de ecosistemas, gestión de vegetación, gestión de vida silvestre, manejo adaptativo

Introduction

Managing natural resources at a broad scale is a difficult and complex task. Ecosystem management focuses on a variety of issues, including sustaining the system's health, integrity, diversity, and resilience to disturbances. To further complicate matters, land managers are working in a setting where change is continuous and unpredictable (Bosch et al. 2003). As social contexts are incorporated, land managers must operate under even more complex and uncertain conditions. In the management of landscapes, there is a growing interest in adaptive management (AM), first introduced by Holling (1978). Adaptive management is the integration of science, management, and learning within a collaborative framework. It is characterized by socially defined objectives, holistic science, broad spatial and temporal scales, collaborative decision making, and flexible institutions (Cortner et al. 1998).

Adaptive management treats actions and policies as experiments yielding results that contribute to learning (Stankey et al. 2003). Risk and uncertainty are not avoided as in traditional management (Knight & Meffe 1997) but are embraced as an opportunity to build new understanding. Science is used to monitor and analyze systems. Lessons learned are then incorporated into subsequent actions, and the feedback cycle is repeated. Although the concepts behind AM are widely accepted, there are few examples of its successful implementation (Meffe et al. 2002). The actual and perceived barriers to implementing a holistic management practice are little understood.

The Florida Fish and Wildlife Conservation Commission (FWC) is responsible for the management of over 650,000 ha of land, including 26 wildlife management

areas and wildlife environmental areas. Previous management objectives of the FWC have been based on activity prescriptions (e.g., burn intervals or hectares treated) and indirect management products (e.g., wildlife numbers), rather than on measurable plant community conditions. This management approach makes it difficult to assess long-term accomplishments and does not encourage learning from management activities.

The FWC consequently developed a new management approach that establishes objectives based on desired conditions of natural plant communities. This objective-based vegetation management (OBVM) process seeks to quantify the present and future conditions of natural communities in management areas, incorporate a monitoring and analysis program for learning from management actions, and supply FWC with greater accountability and support for management decisions. Similar to other adaptive management approaches, OBVM is a process of implementing management activities in incremental steps and evaluating whether desired outcomes are being achieved at each step. If conditions deviate substantially from predictions, management activities are adjusted to achieve desired outcomes (Moir & Block 2001). Similar to other ecosystem management approaches, OBVM focuses on ecosystem-level goals and a broad geographic and temporal perspective (Groom et al. 2006). The technical plan for OBVM includes baseline mapping, quantifying desired future conditions, applying management treatments, and monitoring and learning from results.

The FWC administrators believed the agency could implement the technical aspects of OBVM but had reservations about how best to introduce the program to field managers. Administrators anticipated a range of

responses from field managers based on past experience with the introduction of new approaches at FWC and other agencies.

A review of the literature on adaptive management and ecosystem management programs revealed six categories of barriers to implementing experimental or holistic land management approaches (Table 1):

- *Logistical barriers* are based on a perceived lack of resources, time, and staff to implement management practices and data collection and a lack of clear timelines, goals, and objectives.
- *Communication barriers* arise from an inability to interact across disciplines, a lack of interaction among stakeholders, and a lack of information flow within the management institution.
- *Attitudinal barriers* form from misperceptions that managers and scientists have of each other and from concerns about adaptive and/or ecosystem management and how it will affect jobs or natural systems.
- *Institutional barriers* stem from an organizational culture and structure that is not suited to AM. Organizational culture includes what is valued, the dominant leadership style, language, and procedures of an organization (Berrio 2003). Characteristics such as collaborative decision making, flexibility, and learning are often needed to support AM (Clark 1996; Cortner et al. 1998).
- *Conceptual barriers* arise from individuals' lack of understanding or experience with the process of holistic land management approaches. Concepts of the utility of a management approach, the appropriateness for a particular management unit, and how well the approach fits with current policies and laws all have an impact on program success.
- *Educational barriers* relate to the level of knowledge that managers, scientists, and other key stakeholders have of adaptive and/or ecosystem management. Managers or scientists may need additional training in new methods of natural resource management.

Our goal was to identify and measure the barriers to implementation of OBVM to develop recommendations for successful adoption in the field. We used the six barrier categories as a basis for exploring specific constraints associated with the introduction of OBVM. Our three hypotheses reflect administrators' concerns related to managers' perceptions toward adaptive approaches to land management: (1) A perceived loss of individual flexibility and control precludes acceptance of OBVM by local area managers. Adherence to an experimental design or a focus on desired future conditions may preclude some of the flexibility managers have experienced previously, such as basing land management practices on personal observation rather than measurement. (2) Increased responsibility or accountability precludes acceptance of OBVM by local area managers. Under the previous regime, man-

agers were responsible for whether or not they had performed a prescribed action. Under OBVM, managers may be responsible not only for whether the action was performed, but also for whether or not the desired outcomes were achieved. (3) The OBVM program is not perceived by local area managers as being relevant to other management goals (e.g., wildlife numbers). Land management for wildlife is based on responses of the species to management actions. Under OBVM, managers will be working toward plant community objectives rather than emphasizing indirect measures such as specific wildlife numbers.

Methods

We used two methods to identify barriers to implementing OBVM: a bureau-wide survey of FWC to measure potential barriers to implementation across the organization, and personal interviews with FWC area managers to provide in-depth data about initial implementation of OBVM.

Bureau-Wide Survey

We conducted a survey of managers and biologists ($n = 90$) in the FWC Bureau of Wildlife Management to measure attitudes, knowledge, and concerns regarding OBVM and to identify actual and perceived barriers to the approach. Surveys were sent by mail in January 2004 to managers and biologists at all the 26 wildlife management and wildlife environmental areas in Florida. Two email reminders, an additional mailed copy of the survey, and a postcard reminder were sent to help ensure a high response rate (Dillman 2000).

The survey included 74 open- and close-ended questions focusing on the six barriers and followed standard design and pretesting techniques (Dillman 2000). In the first part of the survey, respondents answered close-ended questions on a five-point Likert scale, with 1 (strongly disagree) indicating a larger barrier and a 5 (strongly agree) indicating a smaller barrier. Means and standard deviations were calculated for all survey questions. Survey results were analyzed with t tests and F tests to compare group means. We grouped questions to determine barrier scale scores and used principal components analysis to verify groupings of items into barrier scales. A pairwise comparison test was used to determine significant differences among barriers.

To enhance our understanding of institutional barriers, it was necessary to understand the organizational culture of FWC and its suitability to implement an AM approach. Thus, the second part of the survey used an organizational culture assessment instrument (OCAI) developed by Cameron and Quinn (1999). The OCAI asks respondents to rank different organizational values to characterize the cultural profile of an organization as a combination

Table 1. Barriers to adaptive and ecosystem management based on a literature review.

Barrier	Citation*
Logistical	
lack of clear timelines, goals, and objectives	6, 9, 17, 25, 26, 29, 42
political boundaries do not fit with ecosystem boundaries; transboundary issues	6, 8, 11, 28, 33, 43
lack of money/resources/staff	1, 30, 39, 44
monitoring plans insufficient	41, 42, 43
conflicts of resources/priorities across management units	13, 37
lack of money for doing research experiments	38, 41
lack of time/resources for planning, implementing, monitoring	6, 30
regular meetings lacking	32, 40
substantial, multilevel data requirements	26, 31, 42
lack of forum for public support/involvement	8, 26
Communication	
Lack of a belief in teamwork	3, 9, 10, 12, 13, 15, 20, 31, 34, 37, 38, 44
Lack of interaction/negotiation among scientists/managers/decision makers/stakeholders	6, 11, 13, 20, 26, 28, 42
Need for external collaborative partnerships; peer review	11, 17, 25, 27, 29, 31
Need for public/stakeholder support	8, 11, 17, 34, 44
Stakeholders need to feel safe questioning ideas	10, 12, 29, 44
Interdisciplinary communication problems of jargon, paradigms	9, 14, 35, 37
Need for scientists to communicate results effectively	6, 14
Past unsuccessful experiences working with others	19, 35
Need for interaction in the field	9
Attitudinal	
Data collection and monitoring is not valued	1, 9, 10, 12, 40, 41
Stakeholders do not believe their input affects outcome	9, 10, 12, 20, 29, 40
Objectives do not reflect stakeholders' values	20, 21, 33, 39
Managers used to risk-averse policies	9, 28, 39
Fear of admitting uncertainty/distrust of the process	27, 31, 41
Risk to sensitive species/Ecological Society of America	19, 37, 39
Scientists and managers do not value each other's needs	9, 39
Belief workload/accountability will be increased	19
Belief flexibility will be decreased	19
Institutional	
Culture of agency impedes success	2, 4, 15, 16, 20, 21, 31, 41, 42, 43
Need for adaptive learning environment	7, 10, 16, 17, 26, 31, 41, 42, 43
Need for flexible framework	20, 31, 39, 41, 43
Lack of framework for decision making; top-down approach	13, 28, 31
De-emphasis on individual thinking	7, 31, 39
Training needs to be team based	22, 27
Unsuccessful experience with past management mandates	19
Lack of long-term time frame	19
Conceptual	
Need for systems view of process	1, 3, 5, 10, 15, 23, 24, 27, 33, 37, 44
Lack of awareness about different mental models	15, 23, 27, 31
Inconsistent definitions of AM	19, 33, 37, 41
Current theories emphasize individual	8, 37
Inadequate ecological information	6, 44
Ideas and methodologies complex	42
Educational	
Lack of knowledge of AM	1, 41
Managers lack training in plant ecology	19
Managers lack training in scientific method	19
Scientists lack training in management	19

*Citation code: 1, Bellamy & Johnson 2000; 2, Berrio 2003; 3, Bosch et al. 2003; 4, Cameron & Quinn 1999; 5, Checkland 1981; 6, Christensen 1996; 7, Clark 1996; 8, Cortner et al. 1998; 9, Cote et al. 2001; 10, Daniels & Walker 2001; 11, Dombek 1996; 12, Franz 2003; 13, Geisler & Bedford 1996; 14, Ghazoul & McAllister 2003; 15, Grabam & Kruger 2002; 16, Gunderson 1999; 17, Haney & Power 1996; 18, Heissenbuttel 1996; 19, Jacobson et al. 2003; 20, Johnson 1999; 21, Johnson & Williams 1999; 22, Kasl et al. 1997; 23, Kraiger & Wenzel 1997; 24, Lee 1993; 25, Lee 1999; 26, Meffe et al. 2002; 27, McKee et al. 2000; 28, McLain & Lee 1996; 29, Mills & Clark 2001; 30, Moir & Block 2001; 31, Pinkerton 1999; 32, Ringold et al. 1996; 33, Roe 1996; 34, Seely et al. 2003; 35, Sbeiffer 1996; 36, Shindler & Creek 1999; 37, Stankey et al. 2003; 38, Szaro et al. 1998; 39, Walters 1997; 40, Webler et al. 1995; 41, Wilbere 2002; 42, Williams 2003; 43, Yaffee 1996; 44, Yaffee et al. 1996.

of factors on a multidimensional graph of four culture types: (1) hierarchical (value efficiency and organization; formal rules and policies hold the organization together; stability, security, predictability, and cost-effective operations are major concerns); (2) market (value competitive actions and achievement of measurable outcomes are exemplified by stability, production, and "winning"); (3) clan (value collaborative work environment, human resources, cohesion, morale; leaders act as mentors; teamwork, participation, flexibility, and consensus are emphasized); (4) adhocracy (value experimentation and innovation; growth, creativity, freedom, individual initiative, and development of new services are emphasized) (Cameron & Quinn 1999). Although each culture type has inherent strengths and weaknesses, clan and adhocracy cultures value collaboration and learning inherent to the adaptive approach of OBVM.

In the OCAI, respondents rated current and preferred future (5-year) organizational characteristics. Each of the two sections consisted of six organizational characteristics, each containing four alternatives among which the respondents were asked to divide 100 points based on their experience at FWC. We plotted mean scores to determine the predominant culture at FWC and the discrepancy between current and preferred culture types relative to characteristics important for AM. Differences in scores over 10 points were viewed as significant discrepancies (Cameron & Quinn 1999).

Personal Interviews

We conducted telephone interviews with all 13 area managers and biologists and 6 FWC monitoring staff and administrators who attended four site-specific workshops that introduced OBVM to field staff. Interviews lasted from 40 to 110 minutes and followed a discussion guide with 57 open-ended questions based on the potential barriers identified through the literature review. Additionally, we interviewed 11 external scientists from the Florida Division of Forestry, Tall Timbers Research Station, U.S. Department of Agriculture Forest Service, Joseph W. Jones Ecological Research Center, and The Nature Conservancy, whom FWC administrators asked to provide peer review of OBVM plans. In five open-ended questions, we asked about their role in peer review and requested suggestions for increasing input from external scientists.

Results

The survey response rate was 69%. Scales were calculated for each category of barrier (Table 2). Interviews were conducted after the workshops with all 13 participating local-area managers and biologists. Participants at the four workshops perceived similar key barriers to those reported in the survey.

Survey respondents perceived logistical barriers as significantly greater than other barriers ($p < 0.01$ in all pairwise comparisons, overall mean score of 2.6). Interviewed area managers mentioned logistical barriers most often. Logistical concerns included a fear of increased workload and lack of staff, money, and other resources. Managers were concerned about getting their work done in a timely fashion, if required to wait for sampling and data analyses before implementing their management practices. Communication was perceived as the second greatest barrier and scored significantly more than remaining barriers ($p < 0.01$ in all pairwise comparisons, mean score 3.01). Twenty-seven percent of FWC staff in the Bureau of Wildlife Management did not know about OBVM. About 35% had no opinion about OBVM, and only 13% agreed they had received adequate information on OBVM (55% disagreed that they had received adequate information on OBVM). The majority of respondents preferred to receive and share management information via group meetings and email.

Interview results also indicated that a lack of communication between the administration and the field staff was a barrier to understanding the roles of OBVM research, management, and monitoring. Barriers such as the lack of communication about the OBVM implementation timeline and a perception that managers' opinions might not make a difference were often raised. Most respondents said they could express their opinion freely if they had an objection, question, or suggestion but were not sure of the impact they would have. Area managers reported that the easiest ways to share information among FWC staff were email, telephone, and meetings. Managers felt there was a need for more meetings, especially small meetings, to encourage group discussion. Interviewees also believed it was essential to share the results of OBVM planning and implementation with scientists outside FWC. They did not believe communication about OBVM was necessary with members of the general public who provide comment on general management plans every 5 years.

For survey respondents attitudinal and institutional barriers were of moderate concern (mean score 3.3 each). Among attitude barriers, respondents were most concerned that OBVM would increase workloads and responsibilities and would be difficult to implement. With regard to the institutional measures, respondents were most concerned that FWC would be inflexible and discourage a participatory process.

Attitudinal barriers identified by area managers during interviews included the perceived difficulty of implementing OBVM within FWC, perceptions of increased responsibility and decreased flexibility, and a perceived lack of commitment to OBVM by FWC. In general, managers believed OBVM, if successful, could have the potential to benefit plant communities and wildlife species,

Table 2. Response scores of barriers to objective-based vegetation management reported in the bureau-wide survey.

Barrier ^a	SD	n	Mean ^b
Logistical	0.19	52	2.63
The amount of monitoring required by OBVM is unrealistic given FWC resources. ^c		50	2.58
OBVM program requires more money than current FWC management plans. ^c		50	2.54
The OBVM program requires more time than current FWC management plans. ^c		50	2.4
The OBVM program requires more staff than current FWC management plans. ^c		51	2.47
I am concerned that OBVM will not work on WMAs that I am familiar with due to a lack of money. ^c		51	2.92
I am concerned that OBVM will not work on WMAs that I am familiar with due to a lack of staff. ^c		50	2.72
Communication	0.44	62	3.01
If I express an objection/suggestion regarding the improvement of OBVM, it will have an impact on decisions.		52	2.88
I received adequate information about OBVM.		55	2.25
FWC collaborates adequately with other agencies when working on land management projects.		60	2.90
It is easy to communicate with FWC staff in other positions and divisions.		59	3.13
Research scientists and land managers work well together in the field.		59	3.13
I feel confident that I can share my opinions freely with other FWC employees.		62	3.61
Attitudinal	0.65	61	3.33
Approach will be difficult for FWC to implement. ^c		54	2.85
The OBVM program will benefit wildlife species.		54	3.64
The OBVM program will benefit endangered species.		52	3.67
In general, land management that is based on plant communities will protect wildlife populations.		59	3.98
The OBVM approach will increase my workload. ^c		52	2.42
The OBVM approach will increase my level of responsibility. ^c		51	2.60
Institutional	0.37	62	3.34
When working on projects, I gain new knowledge and skills that I am able to use on future projects.		62	4.16
When there is a new project, FWC administrators, scientists, and managers often work together.		60	3.16
FWC allows managers flexibility in making management decisions.		62	3.37
The FWC administration is flexible and open to change.		61	2.98
Within FWC, mistakes are used as opportunities for learning.		60	3.20
FWC accepts that errors and uncertainty are a part of management.		61	3.21
The planning process within FWC encourages participation.		60	3.36
The decision-making process within FWC encourages participation.		61	3.01
Conceptual	0.24	59	3.63
The OBVM monitoring strategy will change over time as we learn more.		51	3.92
Land management decisions should be made in spite of uncertainty.		58	3.51
OBVM will be most effective if all FWC participants work together to plan/implement/monitor/make decisions.		52	3.94
Monitoring of OBVM will be most effective if done over a period of many years.		52	4.00
Revising a management plan based on the results of monitoring is an important part of OBVM.		48	3.72
Scientific research is important for managing lands.		59	4.13
Scientific research should involve many interactive components and relationships.		58	4.00
Ecosystems are best studied by looking at each part separately rather than the whole system together. ^c		58	3.56
It is necessary to make mistakes in order to learn how to better manage WMAs.		58	3.51
Educational	0.29	62	3.69
I have a good background in wildlife management.		62	4.11
I have a good background in plant ecology.		62	3.58
I have a good background in using the scientific method.		62	3.91
I have a good background in conducting experimental designs in the field.		61	3.68
I have a good background in a management approach called "Adaptive Management."		56	3.28
I have a good background in a management approach called "Ecosystem Management."		58	3.56

^aAbbreviations: OBVM, objective-based vegetation management; FWC, Florida Fish and Wildlife Conservation Commission; WMAs, wildlife management areas.

^bLikert scale: 1, strongly disagree; 2, disagree; 3, neither agree nor disagree; 4, agree; 5, strongly agree.

^cWording of items reversed for analysis of barrier scales.

including endangered and game animals. They did not believe OBVM would have negative impacts on wildlife.

Managers believed the decision-making process was the main institutional barrier. There were some concerns that decision-making control would be taken away from field staff and that more staff should have input to the

preliminary development of OBVM. Managers believed that the main disincentives to implementing OBVM would be a loss of flexibility and freedom in decision making. One manager expressed this opinion, saying, "The dependence on data analysis rather than personal experience may not always be a good thing." The majority

of managers reported that OBVM leadership should provide stronger coordination and a clearer specification of roles and responsibilities. Although managers did not foresee any personal rewards or incentives for implementing OBVM, they believed it would allow them to do their jobs better and would result in better management. Most respondents had worked with their colleagues on management issues in the past and believed they had a history of success with them.

Our three research hypotheses related specifically to attitudinal, institutional, and conceptual barriers. Hypothesis 1 related to perceptions of a loss of flexibility and control. About 38% of respondents thought OBVM would decrease their job flexibility, and this response was related to perceptions of significantly greater institutional barriers ($F = 3.44$, $df = 2$, $p = 0.04$).

Hypothesis 2 related to concerns that increased responsibility or accountability would diminish acceptance of OBVM. Forty-three percent of respondents thought they would have greater responsibility under OBVM. Those who agreed that OBVM would increase their responsibility perceived significantly greater attitudinal barriers than others ($F = 15.8$, $df = 2$, $p = 0.00$). Respondents who agreed that OBVM would increase their workload also held significantly greater attitudinal barriers than others ($F = 10.1$, $df = 2$, $p = 0.00$).

Hypothesis 3 related to perceptions that OBVM would be irrelevant to indirect management objectives. Fifty percent of respondents agreed OBVM gave wildlife populations the appropriate priority. Respondents who thought OBVM would not give appropriate priority to wildlife perceived significantly greater attitudinal ($F = 3.71$, $df = 2$, $p = 0.03$) and conceptual ($F = 5.92$, $df = 2$, $p = 0.01$) barriers.

The second part of the survey, the OCAI, related to institutional barriers as measured by respondents' perceptions of FWC organizational culture. Ratings of current versus preferred cultures differed (Fig. 1). In ratings of the current situation, the 34.7 mean rating for the hierarchy culture was the highest, followed by the market culture (22.3), the clan culture (18.7), and the adhocracy culture (13.5). In ratings of the preferred future (5-year) scenario, managers and biologists rated the clan culture highest (33.9), followed by the adhocracy culture (22.0), the hierarchy culture (20.3), and the market culture (17.0).

Other categories of barriers were of less concern (conceptual barriers mean = 3.6 and educational barriers mean = 3.7). A higher score for conceptual barriers indicated a more holistic or "systems" understanding of land management. A higher score for educational barriers indicated respondents' belief that they have adequate training and experience. Education was not perceived as a barrier to implementing OBVM. The number of years working for FWC or the number of years in the profession did not make a significant difference in any of the barrier scores.

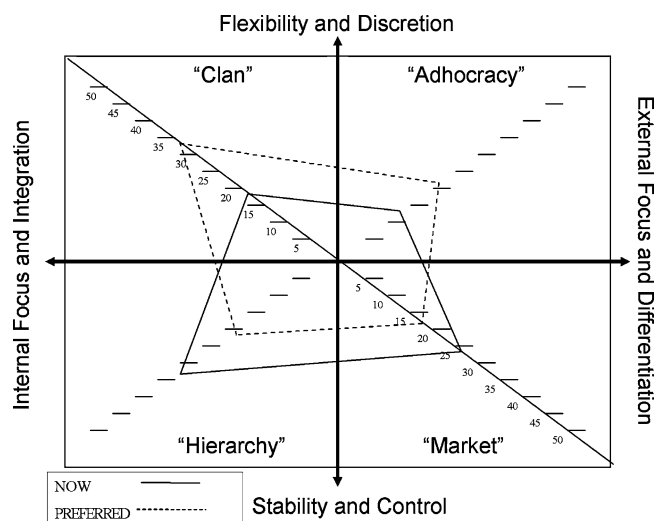


Figure 1. Current and preferred organizational culture types at the Florida Fish and Wildlife Conservation Commission, based on survey responses to the organizational culture assessment index (Cameron & Quinn 1999). Hierarchical and market cultures, the dominant current cultures at FWC, emphasize stability and control; clan and adhocracy cultures, the respondents' preferred culture types, emphasize flexibility and discretion.

In personal interviews, area managers did not mention education or training barriers. Appropriate knowledge of plant ecology and land management approaches was not considered a barrier by managers. Generally, managers stated that outside contractors should have the expertise needed to monitor the attributes of the plant communities of interest.

The main conceptual barrier among area managers was a concern that using OBVM as a management tool would result in experimental research interests superseding managers' immediate needs. "It is important that land managers' needs come first," said one manager. Respondents agreed that it was important for data collection to be based on good science. Everyone noted the benefits of scientific research (e.g., in selecting plant community attributes based on available literature), but managers differed in how researchers should be involved and whether monitoring plans would delay treatments. Many managers believed that external scientists should be included in setting plant community attributes and providing peer review of OBVM. Yet several managers voiced concerns such as, "Outside scientists might use the data to prove we have mismanaged something."

In telephone interviews with 11 of 13 scientists who had been asked to provide external review by FWC, only 2 had been able to provide timely review of an OBVM plan when requested. Despite their minimal response, all of the scientists interviewed indicated they were willing to

lend their expertise to the program. The scientists offered a number of suggestions for improving the peer-review process. These included providing personal conferences or more formal group planning meetings, giving more advance notice that input would be requested, making involvement more active by allowing scientists to undertake field visits and experiments, and providing reviewers with program updates on a regular basis.

Discussion

The quantitative results from the bureau-wide survey were consistent with the results from interviews with managers: logistical barriers were perceived to be the strongest, followed by communication barriers, attitudinal and institutional barriers, and conceptual and educational barriers. Results of hypotheses and investigation of each barrier in depth provided information to FWC about constraints to implementing OBVM. Awareness of the breadth and strength of various barriers should be of use to other institutions implementing adaptive land management approaches.

Logistical Barriers

Logistical barriers arise when there is a perceived or actual lack of resources (Bellamy & Johnson 2000). Managers thought logistical concerns were the largest barriers to implementing OBVM. In the bureau-wide survey, all the questions in the logistical category were considered to be greater than average barriers (e.g., mean scores below the neutral 3.0). The greatest concerns in this category were time, staffing, and money required to implement OBVM.

In any AM effort, time is needed to design implementation plans, to perform actions, and monitor and readjust the plan (Moir & Block 2001). For managers accustomed to short-term projects, monitoring in AM may be perceived as expensive and obstructive. Problems with monitoring and feedback systems have been viewed as AM's weakest link (Moir & Block 2001). The FWC managers expressed concerns that they would have to wait for sampling and analyses to be done before they could implement management actions. Unclear communication about managers' roles and timelines led most managers to report that they were unsure when sampling would be conducted, when data would be collected, how data would be analyzed and results made available. Although they see OBVM as a useful tool, managers expressed concern about accomplishing management tasks on a timely basis. Some commonly cited logistical barriers to adaptive ecosystem management were not of immediate concern to FWC managers (e.g., conflicts involving management across land boundaries; Cortner et al. 1998).

Communication Barriers

Communication barriers are of special concern in AM because of the collaborative nature of the approach. The willingness to be a team player and to communicate openly with scientists, managers, and other stakeholders is a recurring theme in AM literature (e.g., Cameron & Quinn 1999; Seely et al. 2003; Stankey et al. 2003). Among FWC managers interviewed, communication barriers were perceived as large. Survey respondents reported that the greatest communication barrier was inadequate information about OBVM. Most FWC managers and biologists agreed that increased communication between administration and field staff was necessary to successfully implement OBVM.

An open flow of communication is integral to AM—participants must feel comfortable making suggestions and questioning opinions of others (Daniels & Walker 2001; Mills & Clark 2001). The belief that an individual can have an impact is essential to the success of a team-based approach (Webler et al. 1995; Franz 2003). The majority of managers interviewed felt comfortable voicing opinions. Although similar to survey respondents, many were unsure whether their opinions would have an impact. This reflects an institutional barrier and a communication problem.

Regular meetings and an accessible forum for involvement are necessary to maintain the long-term monitoring and reassessment of an AM program (Cortner et al. 1998; Webler et al. 1995). Many FWC respondents expressed the need for more meetings through which they could interact and share information. Survey and interview respondents preferred to receive and share management information via meetings and email. Several respondents suggested an OBVM Web site on which managers could access documents, data, and other information. This strategy has been useful in other AM programs (Szaro et al. 1998).

Although most agency communication may be internally focused, it is also important to cultivate external support for AM programs (Yaffee 1996; McKee et al. 2000; Mills & Clark 2001). There is a need for scientists to adequately communicate AM scientific information to partners, stakeholders, and the public (Sheiffer 1996; Ghazoul & McAllister 2003). The importance of public support for ecosystem management is well documented (Yaffee et al. 1996). Although FWC managers and biologists recognized the value of managers, scientists, and administrators working together, most did not believe other stakeholders—such as public user groups or neighboring landowners—would have an active role in OBVM. Most respondents viewed OBVM as an internal management and monitoring program and saw little need to incorporate other stakeholders.

The exception to this view was that many respondents thought that partner land management agencies should

be included in the process, especially neighboring agencies. Sharing information with partners—such as Florida's water management districts, The Nature Conservancy, and the Florida Division of Forestry—was identified as a priority. It is likely that as OBVM is implemented an increased need to collaborate with other stakeholders will emerge.

Collaborative partnerships outside of the agency, specifically peer review, are extremely important in the scientific process and can affect the ultimate success of an AM project (McKee et al. 2000; Mills & Clark 2001). Almost all FWC respondents thought it essential to have external peer review of OBVM by non-FWC scientists. However, a communication barrier still could exist because only 15% of the external scientists responded when they were asked by FWC administration to review the results of the first OBVM workshop. Our interviews with 11 of the scientists suggested that establishing an active OBVM advisory committee of outside scientists would help ensure greater involvement through attendance at meetings and review of documents. The scientists also reported that they would be more likely to participate if their input would be incorporated into policy or future management activities.

Attitudinal Barriers

For AM projects to be successful, both scientists and managers must recognize each other as essential and valuable to the program (Cote et al. 2001). None of the survey respondents anticipated a problem working with other scientists and managers. Only 20% of respondents disagreed that "researchers and managers worked well together in the field."

Almost all managers interviewed believed OBVM would be an improvement over the current management approach and believed the monitoring data would help them to better manage the land. However, managers reported a number of attitudinal barriers in the interviews and surveys. Respondents believed that OBVM would result in a loss of flexibility and require increased accountability and responsibility. Many were uncertain as to how they would be accountable for the data provided to them. The perception of increased accountability was related to diminished acceptance of the program by local managers.

Interviewees also expressed the opinion that implementing new management approaches within FWC would be a difficult process. Many were adopting a wait-and-see attitude and were unsure as to the degree of commitment FWC administration had to OBVM. Several managers commented on the need for FWC administration to communicate more with the field staff to get them to embrace the program. Managers felt that some field staff would not want to change their working methods unless they were informed more specifically about why OBVM was being implemented and what would be expected of

them. Area managers did not believe OBVM would be successful without the support of the field staff. For this to occur, data collection and monitoring has to be valued (Bellamy & Johnson 2000; Daniels & Walker 2001).

Institutional Barriers

For successful AM implementation, institutional structures should be flexible and horizontal, rather than rigid and hierarchical (Clark 1996; Cortner et al. 1998). Agencies must be flexible enough to share information and adapt new management strategies, and there must be continuous review of the operation and the organization. Organizations with set structures and routines tend to downplay individual responsibility, which, in turn, discourages creative and independent thinking (Clark 1996).

The greatest institutional barriers recorded by the surveys were the FWC administration's lack of flexibility and lack of a participatory decision-making framework. A large institutional barrier for managers interviewed was that OBVM decisions were being made by FWC administrators and were not necessarily incorporating field staff expertise. Many managers believed FWC administration should include area biologists and managers when making OBVM program decisions, particularly to provide a solid foundation in daily management activities. Greater decision-making responsibilities also should be accompanied by equivalent rewards. For example, successful implementation of components of OBVM needs to be tied to job performance or other measures of individual success. An increased participatory focus at OBVM meetings may also decrease the staff's sense of institutional barriers to participation.

Our results supported our hypothesis that a perceived lack of flexibility and control is related to diminished acceptance of OBVM by local managers. A concern about loss of flexibility due to OBVM reported by about one-third of the respondents was significantly related to a perception of greater institutional barriers. Respondents who did not think of FWC as flexible, open to change, or participatory also believed OBVM would result in a lack of flexibility in their jobs. If the FWC organization can become more flexible and participatory through the OBVM process, this would reduce the associated perceived barrier.

Survey respondents believed that a formal and structured "hierarchical" culture dominated FWC. This is a common culture type of government agencies (Cameron & Quinn 1999). The market culture was perceived as the second-most dominant culture. Both of these contrast with the preferred future scenario in which most survey respondents wanted FWC to reflect the values of a clan culture; an adhocracy was the second-most desired culture.

Lack of a flexible framework and adaptive learning environment can be barriers to AM programs (Yaffee 1996; Walters 1997; Wilhere 2002). Individual thinking and use

of innovation and creativity, as in an adhocracy, is important for learning and growth. Organizations with rigid rules and policies can discourage individuals from independent thinking (Clark 1996).

Land managers and biologists perceive the current FWC hierarchy culture as discouraging or inhibiting the implementation of OBVM. For FWC to more easily implement OBVM, an increase in values associated with clan and adhocracy cultures would be helpful, as would a decrease in the values of the hierarchical and market cultures. An increase in clan characteristics would mean more employee empowerment, participation, and involvement. An increase in teamwork and an open flow of communication among field personnel and between field personnel and the administration are also needed. An increase in adhocracy would promote risk taking, acceptance of mistakes, and listening to and using employee suggestions.

A decrease in hierarchy characteristics would mean less micromanagement, fewer roadblocks to trying new ideas and techniques, and less centralized decision making. A decrease in market characteristics would mean less focus on results and more focus on learning as management activities progress. These changes would satisfy the future organizational preferences of biologists and managers and exemplify organizational characteristics that facilitate AM as reflected in the experiences recorded in the literature review.

Conceptual Barriers

An important aspect of AM is the concept of a holistic or "systems" approach to science and the world in general (Lee 1993). Individuals who embrace a more holistic approach are more likely to understand complex systems and predict the consequences of management actions (Kraiger & Wenzel 1997; Bellamy & Johnson 2000; McKee et al. 2000; Bosch et al. 2003). Furthermore, a holistic view of the world enables more successful collaborative learning (Daniels & Walker 2001), which is an important component of AM. Although FWC survey respondents reported a holistic view of the world, they did not necessarily believe this perspective was needed for OBVM, which presents a conceptual barrier to program implementation.

Approaches such as OBVM may be perceived by managers as a drastic departure from traditional management practices (Meffe et al. 2002). Despite the emphasis of AM on feedback and adaptive learning, most managers interviewed believed OBVM actually offered a more rigid approach to land management than their traditional approach. Almost all participants reported that the biggest difference between OBVM and traditional approaches was the greater reliance on science and data by the former. Some individuals said that the program "was taking the art out of management" and taking away the freedom

of the managers to prescribe treatments they deem most appropriate. This perceived loss of flexibility at the individual level may be balanced by an increase in flexibility at the institutional level across different management areas, bringing the "art" and opinions of managers back into the equation at the planning and policy level.

Most respondents agreed that OBVM is relevant to indirect management objectives, such as wildlife species (hypothesis 3). Yet the 29% of respondents who believed wildlife would be overlooked by OBVM had significantly worse attitudinal- and conceptual-barrier scores. Because the core goal of wildlife management areas is wildlife management, it is understandable that managers who believe OBVM will ignore wildlife present attitudinal and conceptual barriers to implementation of the program. If these managers become convinced that OBVM gives appropriate consideration to wildlife, perceptions of barriers should decline.

Programs such as OBVM also may be constrained by laws and theories that guide resource management (Cortner et al. 1998). For example, AM programs may conflict with legislation, such as the U.S. Endangered Species Act (Stankey et al. 2003). If a guarantee of no adverse effect is needed, then implementing an AM experiment in the presence of endangered species may be difficult. Most managers believed OBVM would benefit endangered species.

Respondents had different opinions about the appropriate role of scientific research in the OBVM program. Many believed that OBVM should include more scientific research, whereas others believed this was unnecessary. Most respondents agreed that external scientists should participate in the review and implementation of OBVM. For example, some managers interviewed felt uncomfortable setting attributes for plant communities; they believed that the input of external scientists should be used in establishing objectives.

Interaction with external scientists would help decrease conceptual barriers concerning the technical implementation of OBVM and would provide a broader range of perspectives for accomplishing better monitoring and management. Managers' concerns about outside criticism could be assuaged through a more formal partnership with an established group of external advisors that could develop into a collaborative relationship over time.

Educational Barriers

Adaptive management is a relatively new methodology in natural resource management, so managers may need to be informed about it (Bellamy & Johnson 2000). Some of the problems associated with AM in habitat conservation plans are attributed to lack of knowledge about the AM approach (Wilhere 2002). The knowledge a person has upon entering a team-centered AM project will affect

his/her ability to participate in creating a plan and thus will affect the overall success of the program.

Because OBVM focuses particularly on plant communities, we were concerned that wildlife managers would perceive a lack of training; however, relevant education was not reported as a barrier to implementing OBVM. All participants had some training in plant ecology, land management, and scientific research. Because much of the data for OBVM would be collected by outside contractors, respondents were unconcerned about their own limited knowledge. The number of years working for FWC or the number of years in the profession did not reflect a significant difference in any of the barrier scores, so neither formal education nor experience was considered a major barrier to OBVM.

Conclusions

Our results suggest several strategies to overcome barriers to implementing OBVM. Logistical barriers should be mitigated by distinguishing between and addressing real and perceived constraints of time, staffing, funds, and other resources in a participatory manner. Many perceived barriers could be ameliorated by a transparent planning process actively involving managers in the field. Communication barriers should be mitigated by developing and enhancing interpersonal and electronic communications. Local and regional gatherings would bring staff together to exchange ideas. Face-to-face meetings create a learning and support network. Regional meetings allow learning from each other's successes and mistakes and result in suggestions for program improvement and an understanding of the application of OBVM at a larger scale. Ongoing communications should include the development of an interactive internal Web site to share information and to allow posting of questions and suggestions on implementation of various components of OBVM.

Development of an external advisory committee would provide a formal mechanism for obtaining feedback and participation by outside scientists. It would help ensure that timely input can be obtained. External scientists also could be involved in group planning meetings, field visits and experiments, and review of program results. Interaction on a regular basis would facilitate the flow of information and a long-term, trusting relationship.

Adoption of characteristics of an organizational culture that promotes flexibility and learning would help mitigate institutional barriers. Although hierarchical cultures are typical for many government agencies, decentralizing decision-making responsibilities would promote more participatory problem solving in the field to address perceived barriers to implementing OBVM.

A key understanding from this study is that a perceived loss of local management flexibility may be mitigated

by an increase in organizational flexibility in the establishment of an adaptive OBVM approach. This flexibility needs to be communicated to field staff. In addition, a more participatory culture is necessary for the full emergence of a program that includes continuous feedback and learning. These changes would reflect the future organizational preferences of biologists and managers and exemplify the organizational characteristics that facilitate adaptive-management programs. As adaptive approaches become more popular in the management of natural resources, it is important to understand and break down the many barriers to the adoption of these new programs.

Acknowledgments

We thank T. O'Meara, K. Williges, and S. Spencer of FWC for their collaboration. We are very grateful for the time and valuable insights of the FWC staff who participated in our study, especially the managers at Triple N Ranch, Guana River, Lake Wales, and Apalachicola WMAs/WEAs. We thank J. Archer, D. Brown, I. Guillermetty, L. Hawkins, L. Marks, D. Palacios, and J. Hardesty for their assistance. This project was partially funded by the U.S. Geological Survey State Partnership Program and the Florida Fish and Wildlife Conservation Commission. This is a Florida Agricultural Experiment Station publication.

Literature Cited

- Bellamy, J. A., and A. K. L. Johnson. 2000. Integrated resource management: moving from rhetoric to practice in Australian agriculture. *Environmental Management* 25:265–280.
- Berrio, A. A. 2003. An organizational culture assessment using the competing values framework: a profile of Ohio State University extension. *Journal of Extension* 41: <http://www.joe.org/joe/2003april/a3.shtml> (accessed July 2003).
- Bosch, O. J. H., A. H. Ross, and R. J. S. Beeton. 2003. Integrating science and management through collaborative learning and better information management. *Systems Research and Behavioral Science* 20:107–118.
- Cameron, K. S., and R. E. Quinn. 1999. *Diagnosing and changing organizational culture*. Addison-Wesley, Reading, Massachusetts.
- Checkland, P. 1981. *Systems thinking, systems practice*. J. Wiley and Sons, New York.
- Christensen, N., et al. 1996. The report of the Ecological Society of America Committee on the scientific basis for ecosystem management. *Ecological Applications* 6:665–691.
- Clark, T. W. 1996. Learning as a strategy for improving endangered species conservation. *Endangered Species Update* 13:5, 6, 22–24.
- Cortner, H. J., M. G. Wallace, S. Burke, and M. A. Moote. 1998. Institutions matter: the need to address the institutional challenges of ecosystem management. *Landscape and Urban Planning* 40:159–166.
- Cote, M., D. Kneeshaw, L. Bouthillier, and C. Messier. 2001. Increasing partnerships between scientists and forest managers: lessons from an ongoing interdisciplinary project in Quebec. *The Forestry Chronicle* 77:85–89.
- Daniels, S. E., and G. B. Walker. 2001. *Working through environmental conflict: the collaborative learning approach*. Paeger, Westport, Connecticut.

- Dillman, D. A. 2000. Mail and internet surveys: the tailored design method. John Wiley & Sons, New York.
- Dombeck, M. 1996. Thinking like a mountain: BLM's approach to ecosystem management. *Ecological Applications* 6:699-702.
- Franz, N. K. 2003. Transformative learning in extension staff partnerships: facilitating personal, joint, and organizational change. *Journal of Extension* 41: <http://www.joe.org/joe/2003april/a3.shtml> (accessed July 2003).
- Geisler, C. C., and B. L. Bedford. 1996. Who owns the ecosystem? LTC paper 17. Land Tenure Center, University of Wisconsin, Madison.
- Ghazoul, J., and M. McAllister. 2003. Communicating complexity and uncertainty in decision making contexts: Bayesian approaches to forest research. *International Forestry Review* 5:9-19.
- Graham, A. C., and L. E. Kruger. 2002. Research in adaptive management working relations and the research process. Research paper 538. U.S. Department of Agriculture Forest Service, Pacific Northwest Research Station, Portland, Oregon.
- Groom, M. J., G. K. Meffe, and C. R. Carroll. 2006. Principles of conservation biology, 3rd edition. Sinauer Associates, Sunderland, Massachusetts.
- Gunderson, L. 1999. Resilience, flexibility and adaptive management—antidotes for spurious certitude? *Conservation Ecology* 3: <http://www.consecol.org/vol3/iss1/art7> (accessed July 2003).
- Haney, A., and R. L. Power. 1996. Adaptive management for sound ecosystem management. *Environmental Management* 20:879-886.
- Holling, C. S. 1978. Adaptive environmental assessment and management. John Wiley, London.
- Heissenbuttel, A. E. 1996. Ecosystem management-principals for practical application. *Ecological Applications* 6:730-732.
- Jacobson, S. K., J. Archer, and J. Morris. 2003. Identifying barriers to an adaptive management program in Florida: planning workshop questionnaire results of FWC and external scientists. Report. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.
- Johnson, B. L. 1999. Introduction to the special feature: adaptive management—scientifically sound, socially challenged? *Conservation Ecology* 3: <http://www.consecol.org/vol3/iss1/art10> (accessed July 2003).
- Johnson, E., and K. Williams. 1999. Protocol and practice in the adaptive management of waterfowl harvests. *Conservation Ecology* 3: <http://www.consecol.org/vol3/iss1/art8> (accessed July 2003).
- Kasl, E., V. J. Marsick, and K. Dechant. 1997. Teams as learners. *Journal of Applied Behavioral Science* 33:227-246.
- Knight, R. L., and G. K. Meffe. 1997. Ecosystem management: agency liberation from command and control. *Wildlife Society Bulletin* 25:676-678.
- Kraiger, K., and L. H. Wenzel. 1997. Conceptual development and empirical evaluation of measures of shared mental models as indicators of team effectiveness. Pages 63-84 in M. T. Brannick, E. Salas, and C. Prince, editors. Team performance assessment and measurement: theory, methods, and application. Lawrence Erlbaum Associates, London.
- Lee, K. N. 1993. Compass and gyroscope: integrating science and politics for the environment. Island Press, Washington, D.C.
- Lee, K. N. 1999. Appraising adaptive management. *Conservation Ecology* 3: <http://www.consecol.org/vol3/iss2/art3> (accessed July 2003).
- McLain, R. J., and R. G. Lee. 1996. Adaptive management: promises and pitfalls. *Environmental Management* 20:437-448.
- McKee, N., E. Manoncourt, Y. Chin, and R. Carnegie. 2000. Involving people, evolving behaviour. United Nations Children's Fund, New York.
- Meffe, G. K., L. A. Nielsen, R. L. Knight, and D. A. Schenborn. 2002. Ecosystem management: adaptive community-based conservation. Island Press, Washington, D.C.
- Mills, T. J., and R. N. Clark. 2001. Roles of research scientists in natural resource decision-making. *Forest Ecology and Management* 153:189-198.
- Moir, W. H., and W. M. Block. 2001. Adaptive management on public lands in the United States: commitment or rhetoric? *Environmental Management* 28:141-148.
- Pinkerton, E. 1999. Factors in overcoming barriers to implementing co-management in British Columbia salmon fisheries. *Conservation Ecology* 3: <http://www.consecol.org/vol3/iss2/art2> (accessed July 2003).
- Ringold, P. L., J. Alegria, R. L. Czapslewski, B. S. Mulder, T. Tolle, and K. Burnett. 1996. Adaptive monitoring design for ecosystem management. *Ecological Applications* 6:745-747.
- Roe, E. 1996. Why ecosystem management can't work without social science: an example from the California Northern Spotted Owl controversy. *Environmental Management* 20:667-674.
- Seely, M. K., J. Zeidler, J. R. Henschel, and P. Barnard. 2003. Creative problem solving in support of biodiversity conservation. *Journal of Arid Environments* 54:155-164.
- Sheifer, S. C. 1996. Integrating the human dimension in ecoregion/ecosystem studies—a view from the ecosystem management national assessments effort. *Bulletin of the Ecological Society of America* 77:177-180.
- Shindler, B., and Cheek, K. A. 1999. Integrating citizens in adaptive management: a propositional analysis. *Conservation Ecology* 3: <http://www.consecol.org/vol3/iss1/art9> (accessed July 2003).
- Stankey, G. H., B. T. Bormann, C. Ryan, B. Shindler, V. Sturtevant, R. N. Clark, and C. Philpot. 2003. Adaptive management and the Northwest Forest Plan—rhetoric and reality. *Journal of Forestry* 101:40-46.
- Szaro, R. C., J. Berc, S. Cameron, S. Cordle, M. Crosby, L. Martin, D. Norton, R. O'Malley, and G. Ruark. 1998. The ecosystem approach: science and information management issues, gaps and needs. *Land-use and Urban Planning* 40:89-101.
- Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology* 2: <http://www.consecol.org/vol1/iss2/art1> (accessed July 2003).
- Webler, T., H. Kastenholz, and D. Renn. 1995. Public participation in impact assessment: a social learning perspective. *Environmental Impact Assessment Review* 15:443-463.
- Wilhere, G. F. 2002. Adaptive management in habitat conservation plans. *Conservation Biology* 16:20-29.
- Williams, B. K. 2003. Policy, research and adaptive management in avian conservation. *The Auk* 120:212-217.
- Yaffee, S. L. 1996. Ecosystem management in practice: the importance of human institutions. *Ecological Applications* 6:72.
- Yaffee, S. L., A. F. Phillips, I. C. Frenzt, P. W. Hardy, S. M. Maleki, and B. E. Thorpe. 1996. Ecosystem management in the United States: an assessment of current experience. Island Press, Washington, D.C.

