

**American Water Resources Association**  
**2009 SUMMER SPECIALTY CONFERENCE**  
***Adaptive Management of Water Resources II***  
**June 29 – July 1, 2009**  
**Snowbird, UT**

**Monday, June 29**

**3:30 PM – 5:00 PM**

**Session 9: Panel – Applying Adaptive Management: Models, Monitoring, and Uncertainty**

**Panelist Participants:**

**Moderator – Byron K. Williams**

U.S. Geological Survey, Reston, VA

James D. Nichols, U.S. Geological Survey, Laurel, MD

Scott Boomer, U.S. Fish & Wildlife Service, Laurel, MD

Bernard Bormann, USDA Forest Service, Corvallis, OR

Session 9 is the third in a track of four sessions (Sessions 1, 5, 9 and 13) addressing adaptive management and its use, applications, and the institutional framework. These sessions will provide a practical framework and approach to learning-based management of natural resources, whereby learning occurs through the process of management itself and management strategy is adjusted through time based on what is learned. Sessions 1, 5, 9 and 13 described below include panel discussions, technical presentations, and place-based examples of the adaptive management of aquatic resources.

Among other key elements, adaptive management involves the use of models to project the consequences of potential management actions, the use of monitoring to track their outcomes and inform future decision making, and the treatment of uncertainties in understanding and predicting resource behaviors through time. In fact, these attributes of AM are intimately linked, in that each defines and contributes to the influence of the others.

Modeling will be characterized in this session in terms of resources that change through time in response to variable environments and management actions. The temporal nature of renewable resources allows for learning through time and promotes management adaptations based on what is learned. Models play important roles in representing resource changes and the influence of management on resource status and trends. They also can play key roles in characterizing and incorporating uncertainties, as well as the facilitation of learning through comparisons of predicted outcomes against actual resource conditions. These and other modeling functions will be discussed in the context of adaptive decision making with aquatic resources.

Monitoring will be framed in terms of the multiple roles it plays in AM. In particular, monitoring will be described in terms of its use in (1) evaluating progress in achieving management goals; (2) determining resource status, so as to inform management actions; (3) improving understanding via the comparison of predictions against survey data; and (4) enhancing and developing resource models as needed and appropriate. The linkages between monitoring, modeling, and assessment of uncertainty will be emphasized. In particular, the importance of framing and designing monitoring programs in the context of a larger management effort involving AM will be highlighted.

Finally, the session will include a presentation about sources of uncertainty in AM, and the challenges uncertainty presents to effective and efficient management. Of particular concern in AM is the uncertainty (or lack of agreement) about the nature of processes that determine resource dynamics. These uncertainties can be expressed with hypothesized relationships among process elements and included in different resource models. In this way uncertainties can be characterized in terms of model dynamics, and measured via the comparison of actual vs. predicted outcomes. An approach to the updating of model uncertainties will be presented in terms of model projections and monitoring data. In addition, issues concerning the scope of inference and pace of improvements in understanding will be addressed.

The session will consist of three presentations dealing with modeling, monitoring, and uncertainty. The presenters will discuss each of these issues in terms of its linkages with the others, and in the broader context of AM as described in the preceding sessions. The issues involved in modeling, monitoring, and assessing uncertainty will be highlighted in terms of aquatic systems.