Adaptive management

What is Adaptive Management?

Adaptive management (AM), also known as adaptive resource management (ARM), is a structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously maximizes one or more resource objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is a tool which should be used not only to change a system, but also to learn about the system (Holling 1978). Because adaptive management is based on a learning process, it improves long-run management outcomes. The challenge in using adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future and achieving the best short-term outcome based on current knowledge (Stankey and Allen 2009).

There are a number of scientific and social processes which are vital components of adaptive management these are:

1. Management is linked to appropriate temporal and spatial scales
2. Management retains a focus on statistical power and controls
3. Use of computer models to build synthesis and an embodied ecological consensus
4. Use of embodied ecological consensus to evaluate strategic alternatives
5. Communication of alternatives to political arena for negotiation of a selection

The achievement of these objectives requires an open management process which seeks to include past, present and future stakeholders. Adaptive management needs to at least maintain political openness, but usually aims to create it. Adaptive management must therefore be a scientific and social process. It must focus on the development of new institutions and institutional strategies in balance with scientific hypothesis and experimental frameworks (resilience.org).

Adaptive management can proceed as either passive adaptive management or active adaptive management, depending on how learning takes place. Passive adaptive management values learning only insofar as it improves decision outcomes (i.e. passively), as measured by the specified utility function. In contrast, active adaptive management explicitly incorporates learning as part of the objective function, and hence, decisions which improve learning are valued over those which do not (Holling 1978; Waters 1986). In both cases, as new knowledge is gained, the models are updated and optimal management strategies are derived accordingly. Thus, while learning occurs in both cases, it is treated differently. Often, deriving actively adaptive policies is technically very difficult, which prevents it being more commonly applied.

Key features of both passive and active adaptive management are:

- Iterative decision-making (evaluating results and adjusting actions on the basis of what has been learned)
- Feedback between monitoring and decisions (learning)
- Explicit characterization of system uncertainty through multi-model inference
- Bayesian inference
- Embracing risk and uncertainty as a way of building understanding

Adaptive management is particularly applicable for systems in which learning via experimentation is impractical. However, any one of five process failures can seriously compromise effective adaptive management decision making (Elzinga et al. 1998; Alana & Michael, 2009):

- The monitoring is never completed.
- The monitoring data are not analyzed and cannot assure its definitely accuracy.
- The analyzed results are not conclusive.
- The analyzed results (Boormann et al. 1999).
Adaptive management

History

The use of adaptive management techniques can be traced back to peoples from ancient civilisations. For example, the Yap people of Micronesia have been using adaptive management techniques to sustain high population densities in the face of resource scarcity for thousands of years (Falanruw 1984). In using these techniques, the Yap people have altered their environment creating, for example, coastal mangrove depressions and seagrass meadows to support fishing and termite resistant wood (Stankey and Shinder 1997).

The origin of the adaptive management concept can be traced back to ideas of scientific management pioneered by Frederick Taylor in the early 1900s (Haber 1964). While the term ‘adaptive management’ evolved in natural resource management workshops through decision makers, managers and scientists focussing on building simulation models to uncover key assumptions and uncertainties (Bormann et al 1999).

Two ecologists at The University of British Columbia, C.S Holling (1978) and CJ Walters (1986) further developed the adaptive management approach as they distinguished between passive and adaptive management practice. Kai Lee, notable Princeton physicist, expanded upon the approach in the late 1970s and early 1980s while pursuing a post-doctorate degree at UC Berkeley. The approach was further developed at the International Institute for Applied Systems Analysis (IIASA) [1] in Vienna, Austria, while C.S. Holling was director of the Institute. In 1992, Hilbourne described three learning models for federal land managers, around which adaptive management approaches could be developed, these are reactive, passive and active.

Adaptive management has probably been most frequently applied in Australia and North America, initially applied in fishery management, but received more broad application in the 1990s and 2000s. One of the most successful applications of adaptive management has been in the area of waterfowl harvest management in North America, most notably for the mallard (Johnson et al., 1993; Nichols et al., 2007).

Adaptive management in a conservation project and program context can trace its roots back to at least the early 1990s, with the establishment of the Biodiversity Support Program [2] (BSP) in 1989. BSP was a USAID [3] funded consortium of WWF [4], The Nature Conservancy [5] (TNC), and World Resources Institute [6] (WRI). Its Analysis and Adaptive Management Program sought to understand the conditions under which certain conservation strategies were most effective and to identify lessons learned across conservation projects. When BSP ended in 2001, TNC and Foundations of Success [7] (FOS, a non-profit which grew out of BSP) continued to actively work in promoting adaptive management for conservation projects and programs. The approaches used included Conservation by Design [8] (TNC) and Measures of Success [9] (FOS).

In 2004, the Conservation Measures Partnership [10] (CMP) – which includes several former BSP members – developed a common set of standards and guidelines for applying adaptive management to conservation projects and programs. These [http://conservationmeasures.org/CMP/Site_Docs/CMP_Open_Standards_Version_2.0.pdf

Adaptive Management in Environmental Practices

Applying adaptive management in a conservation project or program involves the integration of project/program design, management, and monitoring to systematically test assumptions in order to adapt and learn. The three components of adaptive management in environmental practice are:

- **Testing Assumptions** is about systematically trying different actions to achieve a desired outcome. It is not, however, a random trial-and-error process. Rather, it involves using knowledge about the specific site to pick the best known strategy, laying out the assumptions behind how that strategy will work, and then collecting monitoring data to determine if the assumptions hold true.

- **Adaptation** involves changing assumptions and interventions to respond to new or different information obtained through monitoring and project experience.

- **Learning** is about explicitly documenting a team’s planning and implementation processes and its successes and failures for internal learning as well as learning across the conservation community. This learning enables...
conservation practitioners to design and manage projects better and avoid some of the perils others have encountered (Stankey et al. 2005). Learning about a managed system is only useful in cases where management decisions are repeated (Rout et al. 2009).

**Application of Adaptive Management to Environmental Projects and Programs**

*Open Standards for the Practice of Conservation* lay out 5 main steps to an adaptive management project cycle (see Figure 1). The *Open Standards* represent a compilation and adaptation of best practices and guidelines across several fields and across several organizations within the conservation community. Since the release of the initial *Open Standards* (updated in 2007), thousands of project teams from conservation organizations (e.g., TNC, Rare, and WWF), local conservation groups, and donors alike have begun applying these *Open Standards* to their work. In addition, several CMP members have developed training materials and courses to help apply the Standards. Recent years, Adaptive management primary application in environmental subjects can classify as wildlife protection (SWAP, 2008), forests ecosystem protection (CMER, 2010), coastal protection and restoration (LACPR, 2009), natural resource management (water, land and soil), species conservation especially, fish conservation from overfishing (FOS, 2007) and climate change (DFG, 2010).

- In 2006-2007, FOS worked with The National Fish and Wildlife Foundation (NFWF) to develop an evaluation system help NFWF gauge impact across the various coral reef habitat and species conservation projects;
- In 2007, FOS worked with the Ocean Conservancy (OC) to evaluate the effectiveness of this Scorecard in helping to end overfishing in domestic fisheries.
- Between 1999-2004, FOS worked for WWF’s Asian Rhino and Elephant Action Strategy (AREAS) Program to ensure that Asian elephants and rhinos thrive in secure habitats within their historical range and in harmony with people.
- The Department of Fish and Game (DFG) is developing and implementing adaptation strategies to help protect, restore and manage fish and wildlife, with the understanding that some level of climate change will occur and that it will have profound effects on Massachusetts habitats.
- The Adaptive Management program was created by CMR to provide science-based recommendations and technical information to assist the Forest Practices Board. In April 2010, the Forest Practices Adaptive Management Annual Science Conference was held in Washington.
- In 2009, The Louisiana Coastal Protection and Restoration (LACPR) Technical Report has been developed by the United States Army Corps of Engineers (USACE) according to adaptive management process.
Tools and Guidance for Conservation Practitioners
The following resources offer guidance on designing and planning conservation projects (Steps 1 and 2 of the *Open Standards*), as well as more general guidance on the adaptive management process.

**Step 1 Conceptualize (Describing the Project’s Context)**
- IUCN-CMP Unified Classifications of Direct Threats and Conservation Actions: A standardized taxonomy of direct threats to biodiversity and conservation actions that helps conservation teams speak a common language across projects to facilitate learning.
- Using Conceptual Models to Document a Situation Analysis: A guide that explains how to build a conceptual model to clearly portray what drives threats to biodiversity within a project site.
- Instruction Manual for completing Step 1 of the WWF Standards – Define: An online course manual to walk users through the conceptualization phase of the adaptive management project cycle.

**Step 2 Plan Actions and Monitoring**
- Using Results Chains to Improve Strategy Effectiveness: A guide that explains how to build results chains – a tool for clarifying a project team's assumptions about how their actions will contribute to reducing threats and conserving biodiversity.
- Instruction Manual for completing Step 2 of the WWF Standards – Design: An online course manual used by WWF’s Online Campus to walk users through the actions and monitoring plan phase of the adaptive management project cycle.

Adaptive Management in other Practices as a Tool for Sustainability
Adaptive management as a systematic process for improving environmental management policies and practices is the traditional application however, the adaptive management framework can also be applied to other sectors seeking sustainability solutions such as business and community development. Adaptive management as a strategy emphasizes the need to change with the environment and to learn from doing. Adaptive management applied to ecosystems makes overt sense when considering ever changing environmental conditions. The flexibility and constant learning of an adaptive management approach is also a logical application for organizations seeking sustainability methodologies. Businesses pursuing sustainability strategies would employ an adaptive management framework to ensure that the organization is prepared for the unexpected and geared for change. By applying an adaptive management approach the business begins to function as an integrated system adjusting and learning from a multi-faceted network of influences not just environmental but also, economic and social (Dunphy, Griffths, & Benn, 2007). The goal of any sustainable organization guided by adaptive management principals must be to engage in active learning to direct change towards sustainability (Verine, 2008). This “learning to manage by managing to learn” (Bormann BT, 1993) will be at the core of a sustainable business strategy.

Sustainable community development requires recognition of the relationship between environment, economics and social instruments within the community. An adaptive management approach to creating sustainable community policy and practice also emphasizes the connection and confluence of those elements. Looking into the cultural mechanisms which contribute to a community value system often highlights the parallel to adaptive management practices, “with [an] emphasis on feedback learning, and its treatment of uncertainty and unpredictability” (Berkes, Colding, & Folke, 2000). Often this is the result of indigenous knowledge and historical decisions of societies deeply rooted in ecological practices. (Berkes, Colding, & Folke, 2000). By applying an adaptive management approach to community development the resulting systems can develop built in sustainable practice as explained by the Environmental Advisory Council (2002), “active adaptive management views policy as a set of experiments designed to reveal processes that build or sustain resilience. It requires, and facilitates, a social context with flexible and open institutions and multi-level governance systems that allow for learning and increase adaptive capacity without foreclosing future development options” (p. 1121).
In an ever changing world, adaptive management appeals to many practices seeking sustainable solutions by offering a framework for decision making that proposes to support a sustainable future which, “conserves and nurtures the diversity — of species, of human opportunity, of learning institutions and of economic options”(The Environmental Advisory Council, 2002, p. 1121).

**General Resources**

Information and guidance on the entire adaptive management process is available from CMP members’ websites and other online sources:

- Miradi Adaptive Management Software for Conservation Projects [17] is user friendly software developed through a joint venture between CMP and Benetech [18]. The software walks conservation teams through each step of the Open Standards.
- Foundations of Success (FOS) Resources [19] and Training [20] web pages list reference materials on adaptive management and monitoring and evaluation, as well as information about online or in-person courses in adaptive management.
- WWF’s web page on the *WWF Standards of Conservation Project and Programme Management* [24] contains detailed guidance, resources, and tools for the steps in WWF's adaptive management process.
- Measures of Success: Designing, Managing, and Monitoring Conservation and Development Projects [25], written in 1998 by Richard Margoluis and Nick Salafsky, was one of the first detailed manuals about applying adaptive management to conservation projects. Also available in Spanish [26].
- Foundations of Success (FOS) [29] web pages list Ocean Conservancy’s Overfishing Scorecard in 2007.
- The Department of Fish and Game (DFG) [30] web pages list Adapting to Climate Change programme.

**References**

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