Research

Learning in Adaptive Management: Insights from Published Practice

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ABSTRACT. Adaptive management is often advocated as a solution to understanding and managing complexity in social-ecological systems. Given the centrality of learning in adaptive management, it remains unclear how learning in adaptive management is understood to occur, who learns, what they learn about, and how they learn. We conducted a systematic review using the Thomson Reuters Web of Science, and searched specifically for examples of the practical implementation of adaptive management between 2011 and 2013, i.e., excluding articles that suggested frameworks, models, or recommendations for future action. This provided a subset of 22 papers that were analyzed using five elements: the aims of adaptive management as stated in each paper; the reported achievements of adaptive management; what was learned; who learned; and how they learned. Our results indicate that, although most published adaptive management initiatives aimed at improvements in biological conservation or ecosystem management, scholars of adaptive management tend to report on learning more about governance and about learning, than about ecosystems or biological conservation. Whereas almost all the papers (91%) listed improvements in biological conservation and ecosystem management as aims, 59% reported these as achievements. Whereas only 27% listed improved governance as an aim, 73% mentioned this as an achievement. Conservation scientists and academics reporting on adaptive management tend to learn among themselves, and very seldom (18%) with external stakeholders. Adaptive ecosystem management is dominated by direct assessment and single-loop learning aimed at improving existing practices (86%), with about 50% engaged in double-loop learning and a similar number in deutero-learning (learning about learning). Some adaptive managers (36%) combined double-and single-loop learning and the majority of these (6/8) reported on conservation achievements. A possible explanation for these findings is that adaptive management is an evolutionary process and in most instances is still in an early pioneering stage, possibly held back by participants' capacity for learning. The constraint of learning capacity may also explain why so few adaptive management initiatives reported on learning with societal stakeholders.

Key Words: *adaptive management; biological conservation; ecosystem management; governance; social learning*

INTRODUCTION

Adaptive management involves knowledge accumulation through a process aimed at ensuring tight feedbacks between ecosystem change and decision makers (Allen et al. 2011, Westgate et al. 2013) in a structured cycle of conceptualizing, doing, monitoring, reflecting, learning, and adapting. Over time, adaptive management has become a popular response to the challenges of complexity and the demands of a "shifting world" (Hughes et al. 2007:586). Although originally designed to incorporate continuous reflection, adjustment of management actions, and constant experimentation and repetition by managers (Walters and Holling 1990), more recently the approach has been broadened to involve participation by those outside an organization to broaden the knowledge base and reduce conflicts (Stringer et al. 2006, Rist et al. 2013). Adaptive management is widely advocated as a solution to a wide range of issues, including challenges with elusive solutions such as "wicked problems" (Ludwig 2001); complexity and uncertainty in decision making (Holling 1978, Walters 1997); as a remedy for "analysis paralysis" (Snowden and Boone 2007); a solution to communication break-downs within and between agencies (McCook et al. 2010); a learning tool to increase knowledge (Armitage et al. 2008); a method to tap into traditional and indigenous knowledge (Berkes et al. 2000); a way to link monitoring to decision making (McGeoch et al. 2011); and a method to assess costs, benefits, and risks (Gregory et al. 2006). The goals of adaptive management reflect this wide range of uses (Westgate et al. 2013) and may include improved ecosystem management, better governance, public participation, and responsiveness, a universally accepted

goal implicit in the adaptive management concept (Allen et al. 2011, Keith et al. 2011, Roux and Foxcroft 2011, Rist et al. 2013). With such wide-ranging possibilities associated with it, many natural resource management agencies, realizing the intricacies of social-ecological systems management, have embraced adaptive management (Runge 2011, Williams 2011).

However, although adaptive management is based on intuitive and practical concepts and should therefore be easy to understand and implement, it has the danger of becoming a catch-all phrase for any type of "trial and error" management (Rist et al. 2013, Westgate et al. 2013). Many scholars (e.g., Walters 1997, Gregory et al. 2006, Stringer et al. 2006, Keith et al. 2011) have critiqued its utility, questioning the over-emphasis on process vs. action and the circularity of learning and reflection. Three issues dominate the numerous critiques of adaptive management: the plurality of interpretation of the concept and its application (Rist et al. 2013); the scarcity of real-life examples (Keith et al. 2011, Rist et al. 2013, Wesgate et al. 2013); and the lack of understanding, clarity, and purpose of the learning component of the process (Allen and Gunderson 2011, Keith et al. 2011).

Given the centrality of learning in adaptive management, it is important to understand how learning is understood to occur. Learning in adaptive management was originally regarded as an iterative process based on the scientific modeling of carefully planned experiments (Walters 1986). It was expected to involve scientists and decision makers setting objectives, planning, taking action, monitoring, and reflecting on outcomes, learning, and taking action again in a cyclical process. Although early work on

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adaptive management focused on individual learning, Lee (1993) expanded this by introducing the idea of organized human endeavor as part of adaptive management. For Lee, social learning involved experimentation, conflict, and social change. This insight transformed the mechanistic understanding of learning over short time scales through experiments to a broader view in which learning and change were expected to occur over many decades within both individuals and organizations. Lee expected social learning to take place among resource managers, policy makers, and scientists, who learned how to cope with uncertainty through an iterative process of experimentation that expanded awareness of ecosystem change across scales, and that created opportunities for social change (Lee 1993).

Given the central, and early, focus on learning in adaptive management it is surprising that this component is often taken for granted and seldom critically analyzed. Although several authors (e.g., Allen et al. 2011, Conroy et al. 2011, McCarthy et al. 2011, Rehme et al. 2011, Scholes and Kruger 2011) have conceptually and theoretically discussed learning in the context of adaptive management, few have analyzed learning in a practical context where adaptive management is being implemented (but see Biggs et al. 2011, Clark and Clarke 2011, Marcot et al. 2012). After three decades of experience with adaptive management, researchers and practitioners are no clearer about who learns during the process, what they learn about, and the processes that support the kind of learning outcomes observed or recorded.

The lack of focus on learning in the adaptive management literature is mirrored by the fact that most papers on the topic focus on frameworks and theories, and not on practice. McFadden et al. (2011) found that only 14% of 96 papers on adaptive management reviewed by them dealt with the practical implementation of adaptive management. Of these, only 5 explicitly focused on learning and reflection. Rist et al. (2013) found that only 8% of the 187 articles (i.e., 15) on adaptive management published in 2009 reported on real-life experience with the approach, whereas Westgate et al. (2013) found that fewer than 5% of the 1336 articles they reviewed for the period 1978-2011 explicitly aimed at enacting adaptive management. All these authors called for further discussion and systematic assessment and drew attention to the confusion in terminology and conceptualization.

We systematically assess practical experiences of enacted adaptive management appearing in the Thomson Reuters Web of Knowledge (http://wokinfo.com/citationconnection/) between January 2011 and 20 August 2013. We ask: what are natural resource managers' aims with adaptive management; who learns during adaptive management; what do people learn; and how do they learn? We attempt to explain the reasons for the observed patterns and recommend future arenas for research.

METHODS
We searched the Thomson Reuters Web of Knowledge literature database for articles published between January 2011 and 20 August 2013 that contained the phrase "adaptive management," and the words "conservation" or "ecosystem" or "ecology" in the title, keywords, or abstract. We deliberately excluded papers with the phrase "adaptive comanagement" in the title because of their explicit emphasis on governance (Olsson et al. 2004, Fabricius et

al. 2007, Plummer 2009), arguing that this would skew the sample. Although every effort was made to be unbiased and as thorough as possible, we do not claim this to be a comprehensive collection of adaptive management papers published over that period. Our search yielded a sample of 379 articles. This sample went through a further round of refinement by selecting only those papers that reported on the practical implementation and enactment of adaptive management. We thus excluded papers that presented only frameworks, protocols, or models or merely made recommendations without reflecting on implementation and learning. This left us with a subset of 22 papers, i.e., 6% of those from the first search. This percentage is in line with the recent experiences of other scholars who found similar percentages of papers referring to the practical implementation of adaptive management (e.g., Rist et al. 2013, Westgate et al. 2013).

Each paper was systematically read and analyzed to extract the following information from it for storage in an annotated database:

- The aims of adaptive management in each case study

- Noted achievements of adaptive management in each case study

- What was learned, including challenges and recommendations

- Who learned during the adaptive management process

- How they learned during the adaptive management process

- Type or category of learning, i.e., single- or double-loop learning, deutero learning, or a combination

The descriptive information was then coded and assigned to subcategories (Table 1) within the six main categories listed above. Most papers were assigned to more than one subcategory within each category.

The main aims of adaptive management
Five subcategories were identified based on existing literature and after assessing the papers: (i) improved biological conservation and ecosystem management outcomes (Walters 1997, Roux and Foxcroft 2011); (ii) improved governance (Clark and Clarke 2011); (iii) improved public participation (Stringer et al. 2006, Allen and Gunderson 2011, Roux and Foxcroft 2011, Kelly et al. 2012). Two additional subcategories: (iv) learning and understanding (Johnson 2011), and (v) adaptation and responsiveness (Pahl-Wostl 2009), although being inherent traits of adaptive management (Holling 1978), were nevertheless included to verify that papers had been correctly selected.

Achievements of adaptive management
Papers were assessed for evidence of positive outcomes in the same subcategories as those listed under "aims of adaptive management." Only explicitly stated outcomes were taken into account.

Table 1. Frequencies of occurrence of various elements of adaptive management appearing in 22 papers published between January 2011 and August 2013. Papers were selected for their focus on the practical implementation of adaptive management, rather than on models and conceptual frameworks.

Category	Subcategories	Percentage	Frequency
Aims of adaptive management	Improved adaptation and responsiveness	100%	22
	Learning and understanding	100%	22
	Improved conservation and ecosystem management	91%	20
	Improved governance	27%	6
	Improved public participation	23%	5
Achievements	Improved adaptation and responsiveness	100%	15
	Improvements in learning and understanding	91%	20
	Improved governance	73%	16
	Improved conservation outcomes	59%	13
	Improved public participation	36%	8
What has been learnt	Governance	86%	19
	Organizational buy-in	64%	14
	Better aligned systems and processes	55%	12
	Common understanding	50%	11
		45%	10
	Improved communication	27%	6
	Conservation and ecosystem management	27%	4
	Constituency building and public participation	20%	3
Who has learnt	Scientists and conservation managers	64%	14
	Scientists and academics only	50%	11
	Scientists, conservation managers, and societal stakeholders	18%	4
How they have learnt	Assessment	64%	14
	Experimentation and reflection	55%	12
	Dialogue and oral transfer	36%	8
Modes of learning	To improve existing practices (single loop)	86%	19
	Reflection and innovation (double loop)	50%	11
	Learning about learning (deutero)	50%	11
	A blend of different types of learning	36%	8

What was learned
This was assessed by analyzing the learnings explicitly mentioned by the authors as well as implicit learnings such as recommendations stemming from implementation experiences, challenges, and obstacles identified in the papers. Subcategories emerging from our assessment of the papers included: conservation and ecosystem management; constituency building and public participation; and organizational governance. After more detailed assessment we found that "governance," a multifaceted term, could be subdivided into five subareas: strengthened capacity; better aligned systems and processes; common stakeholder understanding; organizational buy-in; and improved communication.

Who learned
This aspect included three subcategories: scientists only; scientists and conservation managers; and scientists, conservation managers, and societal stakeholders.

How learning took place
This included three preselected subcategories: assessment, i.e., immediate evaluation of performance (Biggs et al. 2011, Williams 2011); dialogue and oral transfer (Berkes et al. 2000, Leys and

Vanclay 2011); and experimentation and reflection (Walters 1986, Lee 1993, Biggs et al. 2011, Moore et al. 2011).

Type or category of learning
This aspect included four subcategories aimed at capturing broader learning processes: learning that leads to improvements in existing practices, i.e., "single-loop learning" (Tosey et al. 2012); learning that leads to reflection, that challenges the status quo, and that explores innovative approaches, also called "double-loop learning" (Tosey et al. 2012); learning about learning or "deutero-learning" (Argyris and Schön 1996, Clark and Clarke 2011, Tosey et al. 2012); and a blend of different learning processes.

RESULTS

Aims of adaptive management
As can be expected all 22 papers cited adaptation and responsiveness, the central tenet of adaptive management, as an aim. In addition, the vast majority of papers (20) mentioned improved biological conservation and ecosystem management as an aim. Six papers mentioned improved governance as an aim and five aimed for improved participation.

Achievements of adaptive management
Twenty of the papers mentioned learning and improved understanding as achievements. After learning, the greatest achievement of adaptive management was reported as improvements in governance, reported in 16 of the papers, compared with only 6 that mentioned it as an aim. Thirteen of the papers listed improved biological conservation outcomes as an achievement, compared with 20 that mentioned it as an aim. The observed and expected frequencies differed significantly (P < 0.01, Chi-square test).

Learning outcomes
Adaptive managers tend to learn about governance, rather than biological conservation. Nineteen of the 22 papers reported that they learned about governance, compared with eight that reported learning about biological conservation and ecosystem management. Specific governance challenges included a low capacity to implement adaptive management (14); weak organizational understanding of adaptive management (11); lack of buy-in within the organization (10); and poor communication (6). Seven of the papers reported learning about stakeholder participation.

Who learned
Adaptive ecosystem managers tend to learn among themselves and seldom with external stakeholders. The majority of papers (14) documented learning between professional scientists and managers inside the organization. Eight papers documented learning by conservation scientists and academics without management participation. Only four of the papers provided evidence of learning among professionals and societal stakeholders.

How they learned
Adaptive ecosystem managers learn mostly through direct assessment and experimentation, but dialogue also plays a role. Fourteen of the papers mentioned learning methods indicative of direct assessment, 12 reported on experimentation, including modeling, and reflection, and 8 mentioned that learning took place through dialogue and oral transfer followed by reflection.

Type or category of learning
Nineteen of the papers reported learning about improving existing practices, i.e., single-loop learning, while 11 provided evidence of reflective learning that challenged the status quo and explored innovative alternatives, i.e., double-loop learning, and 8 provided evidence of using a blend of both. Eleven of the papers described a process based on learning about learning, i.e., deutero-learning.

DISCUSSION

Learning to improve current practices, learning to challenge the status quo and innovate, or just learning to learn?
Natural resource management professionals involved in adaptive management learned mostly through assessment, i.e., direct evaluation (e.g., Biggs et al. 2011, Kingsford et al. 2011, Martin and Pope 2011, Bonanno 2013, Giebels et al. 2013), as well as through experimentation and reflection (e.g., Briceño-Linares et al. 2011, Bunnefeld et al. 2011, Johnson 2011, Smith 2011, Van Wilgen et al. 2011, Marcot et al. 2012), and to a lesser extent through dialogue (e.g., Foxcroft and McGeoch 2011, Moore et al. 2011, Pollard et al. 2011, Kelly et al. 2012, Varady et al. 2013).

In the papers we analyzed, the emphasis on assessment is paralleled by the dominance of single-loop learning (e.g., Briceño-Linares et al. 2011, Grant et al. 2011, Holness and Biggs 2011, Kingsford et al. 2011, Martin and Pope 2011, Bonanno 2013), with only a small number of papers (e.g., Biggs 2011, Pollard et al. 2011, Varady et al. 2013) exclusively adopting double-loop learning. However, a significant number of papers showed evidence of the parallel and blended use of single- and double-loop learning (e.g., Bunnefeld et al. 2011, Johnson 2011, McLoughlin et al. 2011, Moore et al. 2011, Rumpff et al. 2011, Scheepers et al. 2011, Smith 2011, Marcot et al. 2012) by implementing and modifying field experiments or developing, testing, and refining models, consistent with the approach advocated by Walters (1986) and Holling (1978). Ideally, adaptive managers should do both, realizing that a singular focus on double-loop learning will not get the job done and could result in endless cycles of reflection without implementation as suggested by Allen and Gunderson (2011). In ecosystem management single-loop learning is essential to make progress with natural resource management in practice (all 13 papers that provided evidence of conservation achievements also provided evidence of single-loop learning), whereas double-loop learning is essential for innovation and critical appraisal. In fact, in situations in which institutional culture does not permit error, and therefore adaptive management, double-loop learning may be necessary to allow for single-loop learning and the practical adjustment of decision making. However, the challenge in moving beyond "learning for the sake of learning" in adaptive management is to find the appropriate blend or balance between single-loop learning with a focus on doing, and double-loop learning with a focus on reflection and changing practices.

Scholars of organizational learning (Argyris and Schön 1996, Clark and Clarke 2011, Tosey et al. 2012) distinguish between single-loop learning, i.e., learning to improve existing practices, and double-loop learning, i.e., learning that challenges existing practices and explores alternatives. Some organizational theorists have portrayed double-loop learning as more progressive than single-loop learning and have even proposed a third, more advanced type of learning called triple-loop learning (e.g., Flood and Romm 1996, Pahl-Wostl 2009, McCarthy et al. 2011). Contemporary authors such as Tosey et al. (2012), however, believe that double-loop learning is not necessarily more advanced than single-loop learning, and that the two types are complementary rather than one being more advanced than the other. They question the validity of triple-loop learning as a separate category. For that reason triple-loop learning was not included as a category because of its ambiguous definition and challenges to its validity as a stand-alone learning process.

Learning about ecosystems, or about governance and learning?
Our data highlight an incongruence between the aims of adaptive management, the achievements reported, and the learning outcomes. Most natural resource management professionals aimed for improved biological conservation and ecosystem management and only a minority explicitly aimed for improved governance. However, a large majority of the achievements centered on learning, understanding, and governance with a smaller than expected proportion focusing on biological conservation. Likewise, the vast majority of learning was about governance-related issues such as better aligned systems and processes, organizational capacity and buy-in, with only a small

proportion learning about biological conservation. On the whole, most adaptive natural resource managers are learning about learning and governance, not biological conservation. This is also reflected in the substantial proportion of papers that provided evidence of learning about learning, also referred to as deutero-learning, which Tosey et al. (2011:301) views as "reflexivity about processes of learning," i.e., learning how to develop the capacity that improves performance, and learning how to reflect, question, and interrogate norms and values.

Participatory or exclusive learning?
Given the importance assigned to social change (Lee 1993) and thus more recently participation in adaptive management (Stringer et al. 2006, Allen and Gunderson 2011, Roux and Foxcroft 2011) the low frequency of stakeholder participation reflected in the aims, learning outcomes, and to a lesser extent achievements is remarkable. It seems that, consistent with early conceptualizations of who learns during adaptive management (Walters 1986), most of the learning is occurring between natural resource scientists and managers, with only four of the papers mentioning public participation in learning. It thus appears that despite recent theoretical emphasis on participation in adaptive management, in practice natural resource managers and scientists prefer to learn among themselves. The opposite is probably the case in adaptive comanagement, which we excluded from our analysis, and where the emphasis is placed on participation and governance (Armitage et al. 2008, Plummer et al. 2013). In theory, the advantages of inclusivity include a reduction in conflict and an increase in the pool of knowledge contributing to solutions (Meinke et al. 2009, Rist et al. 2013) but the disadvantage is that, particularly in situations with low capacity or low organizational buy-in, inclusivity can be very costly and time-consuming (Muriti and Murphy Ives 2007). The costs and disadvantages of inclusivity are expected to decrease as organizational buy-in and the capacity for learning gradually increases, however this does not appear to be experienced in practice because all indications are that the costs of inclusivity currently outweigh the advantages for most managers.

Toward a more dynamic conceptualization of learning in adaptive management
Our analysis raises this question: Why do the majority of adaptive management experiences focus on documenting governance-related challenges in their learning, rather than learning about ecosystem responses to decision making, and why are external stakeholders not participating in the process? Our data indicates adaptive management is dominated by governance concerns, particularly related to capacity issues, and that this provides a barrier to broadening participation.

CONCLUSIONS
Although adaptive management is not a catch-all solution to all natural resource management challenges, it is one of the few practical responses to the management challenges posed by complex systems. Situations in which there is high organizational resistance, the system boundaries are unclear, the issues and scales are numerous, and stakeholders are many, are not conducive to adaptive management (Allen and Gunderson 2011) and should best be addressed using more conventional rule-based approaches.

Our findings suggest a number of key foci for future research into adaptive management. First, there is an increasingly obvious paucity of documented empirical examples of adaptive management. Observing the processes and outcomes of adaptive management in practice is therefore a crucial area of future research. Such research must pay attention to the ecological outcomes of the adaptive management process, as well as to the social outcomes as has been the focus to date. A second key area for future research is on the feedbacks between capacity and inclusivity. Our analysis suggests that there may be value in exploring how stakeholders, or shadow networks, interact with adaptive management processes, and in linking this analysis to existing learning theory such as Lave and Wenger's notion of communities of practice (Lave and Wenger 1991). Third, as we realize increasingly that adaptive management is a social process that appears to be more about learning about and managing human relationships than managing ecosystems, we must start to engage seriously with social theory that has a long history of exploring processes of social change. An obvious starting point here would be the work of sociologists such as Archer (2007) who specifically focus on processes of social change.

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