

Adaptive management: an overview of the concept and its practical application in the Scottish context

RESAS1.4.3a Deliverable D1: Report on relevant adaptive management approaches for Scotland

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Glossary

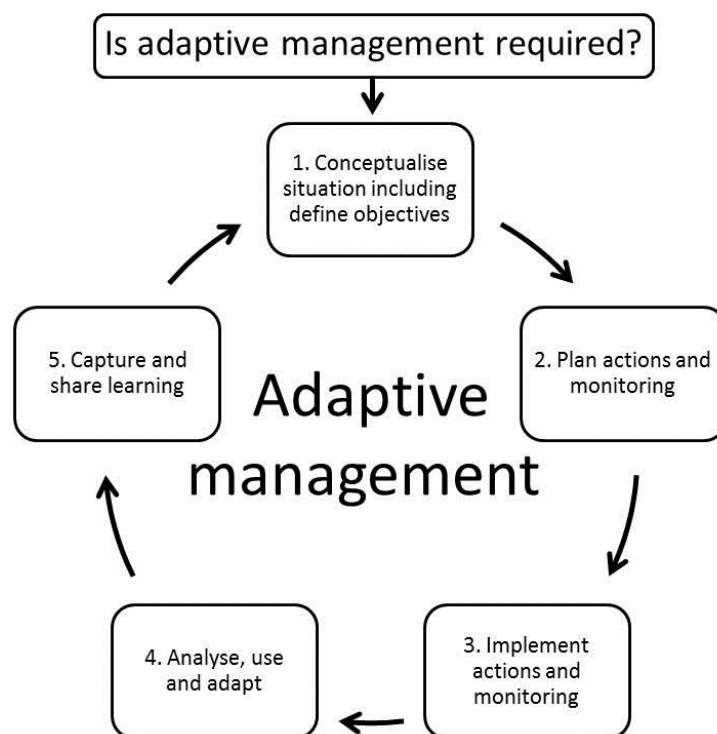
Term	Definition
Adaptive (co-) management	It is the integration of project design, management, and monitoring, to provide a framework to systematically test assumptions, promote learning, and supply timely information for management decisions. It requires involvement of stakeholders and partners.
Adaptive (co-) governance	It is the strategic decision making processes involving multiple stakeholders at landscape-scale in natural resource management decisions in a flexible, dynamic and responsive manner, building on insights from adaptive management.
Evaluation	An assessment of a project or program in relation to its own previously stated goals and objectives.
Indicator	A measurable entity related to a specific information need such as the status of a target/factor, change in a threat, or progress toward an objective. A good indicator meets the criteria of being: <i>measurable, precise, consistent, and sensitive</i> .
Monitoring	The periodic collection and evaluation of data relative to stated project goals and objectives. (Many people often also refer to this process as monitoring and evaluation).
Objective	A formal statement detailing a desired outcome of a project such as reducing a critical threat. A good objective meets the criteria of being: <i>results oriented, measurable, time limited, specific, and practical</i> . If the project is well conceptualized and designed, realization of a project's objectives should lead to the fulfilment of the project's goals and ultimately its vision.
Outcome	The desired future state of a threat or opportunity factor. An objective is a formal statement of the desired outcome.
Programme	A group of projects which together aim to achieve a common broad vision. In the interest of simplicity, this document uses the term "project" to represent both projects and programmes since these standards of practice are designed to apply equally well to both.
Project	A set of actions undertaken by a defined group of practitioners – including managers, researchers, community members, or other stakeholders – to achieve defined goals and objectives.
Stakeholder	Any individual, group, or institution that has a vested interest in or can influence the natural resources of the project area and/or that potentially will be affected by project activities and have something to gain or lose if conditions change or stay the same. Stakeholders are all those who need to be considered in achieving project goals and whose participation and support are crucial to its success.

Executive summary

Adaptive management of natural assets is increasingly called for in policies and plans in Scotland and internationally. It is a structured and systematic approach, involving stakeholders, to support decision making, management action and evaluation of those actions against a set of objectives. Adaptive management is not new; it has been widely discussed over the past forty years, but has only been implemented and evaluated in limited situations.

Once adaptive management has been deemed appropriate and feasible, it involves a series of generic cyclical steps that include: conceptualising the situation including defining objectives; planning actions and monitoring; implementing actions and monitoring; analysing data, using the results and adapting; and capturing and sharing learning (Figure 1). Experience has suggested there is a need for a set of principles to support implementation: involve stakeholders, develop and cultivate partnerships, embrace learning, document your decisions, and adjust as necessary.

Figure 1. Generic steps in an adaptive management approach (based on (CMP, 2013, Rist et al., 2013, Bunnefeld et al., 2015) and other approaches).



The majority of environmentally related adaptive management case studies have focused on single species or single issues. There is a need to apply and test the value of adaptive management for the planning, implementation and evaluation of landscape/catchment scale interventions e.g. Scottish Rural Development Programme agri-environment measures that are increasingly aimed at providing multiple benefits. It is necessary to understand the effectiveness of these actions in a more systematic way taking into account trade-offs and win-wins. There are at least four specific reasons why an adaptive management approach could help improve the evaluation and coordination of

measures to deliver multiple benefits for a more integrated and sustainable management of Scotland's natural assets. These are:

- inclusion of adaptive management in Scottish Government strategies and plans;
- suggestions that it can aid policy integration e.g. across Biodiversity 2020 Strategy, Water Framework Directive, and Flood Directive;
- potential to support management of designated sites as well as the wider landscape for multiple benefits; and
- helping land managers adapt to climate change.

There are several large literatures on the theory and practice of adaptive management and closely related fields of adaptive co-management, adaptive governance, structured decision making, and conservation management. Adaptive management has been influenced by contributions from the decision and management sciences, as well as the need to improve integration between research and management to inform learning.

In our overview we present generic basic steps and principles of adaptive management that are drawn from several reviews and practical guides to adaptive management.

An example of a practical approach to adaptive management that has been developed, used and refined since 2001; and is based on existing lessons learned from adaptive management for natural resource is the Open Standards approach to adaptive management. It includes five general principles for implementation: involve stakeholders, develop and cultivate partnerships, embrace learning, document your decisions, and adjust as necessary.

It is important to be aware when adaptive management is useful and when it is less useful. Several influential books on adaptive management have highlighted the need for all involved to have a common understanding of what adaptive management is, and that it is needed in a particular management situation. There is useful guidance available from the US Department of Interior (Williams et al., 2009) and Scottish Natural Heritage's review of adaptive management approaches for wildlife management (Bunnefeld et al., 2015) to help guide this decision.

In this report we provide an overview on some of the reported barriers to greater levels of adaptive management. These include limited communication of its implementation and evaluation, and a lack of clarity on what is successful adaptive management. There are also social, political, financial and technical barriers. We conclude by setting out how we are planning to use our selected approach in the Strategic Research Programme case studies on the integrated and sustainable management of Scotland's natural assets.

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1. Introduction

1.1 Aims of this overview of adaptive management approaches

This report has two related aims, the first is to provide an overview of examples of adaptive management “in action from the UK and internationally to select the most appropriate approach for the Scottish institutional context”¹ and to share this approach with CAMERAS² policy and management colleagues. Generally, adaptive management approaches consist of a generic and flexible series of steps (and sometimes principles) that are applicable at any spatial, temporal or programmatic scale. Our suggestion of an adaptive management approach including steps and principles will be shared with the stakeholders in our case studies to support them in their practice of adaptive (co-)management, should they desire this. Our second aim is to draw on these steps and principles, to provide the basis for an evaluation framework for the case studies in our research ‘Practical interventions to realise multiple benefits and manage trade-offs’ (Research Deliverable 1.4.3 of the RESAS Strategic Research Programme (SRP)). The evaluation framework will form a set of questions for Main Research Provider (MRP) researchers to utilise in their SRP RESAS 1.4.3 case studies, so providing a structured integration across the research deliverable and wider work package and ‘Natural assets’ theme. In this way, the adaptive management evaluation framework (based on insights drawn from the overview) should help us compare and contrast across our case studies, thus contributing to the objectives of our wider research on ‘integrated and sustainable management of natural assets.’

1.2. Audiences for this report

This report has been written for two main audiences. The first is policy and management colleagues based in Scotland (and more widely in the UK) with an interest in the application and practice of adaptive management, for example CAMERAS partners e.g. Scottish Natural Heritage (SNH), and regional and local stakeholders e.g. Cairngorms National Park Authority. The second audience for this report is fellow MRP researchers who are interested in learning more about practical approaches to adaptive management of Scotland’s natural assets, and whose RESAS SRP research is relevant to our work on practical interventions to realise multiple benefits and manage trade-offs.

This report is structured around a series of questions that we hope provides an informative and useful overview of adaptive management and examples of its use, along with a recommendation of a generic adaptive management approach that is relevant and useful for policy and management colleagues in Scotland.

2. What is adaptive management and how is it currently used?

2.1 Origins and current use of adaptive management

Adaptive management is a structured and systematic approach to supporting decision making, planning, action and evaluation of those actions. Adaptive management is about connecting the

¹ Scottish Government: Rural Affairs, Food and Environment Portfolio 2016. Strategic Research Programme: 1 April 2016 to 31 March 2021. Submission: Theme 1- Natural Assets. Page 258.

²Coordinated Agenda for Marine, Environment and Rural Affairs Science
<http://www.gov.scot/Topics/Research/About/EBAR/CAMERASsite>

‘doing’ of natural resource management with ‘learning’ about the context of the management situation, and the responses and effects of the management actions. For example, the US Department of Interior Technical Guide on adaptive management says: “adaptive management is a systematic approach for improving resource management by learning from management outcomes” (Williams et al., 2009, 1). Adaptive management differs from a trial and error approach by its structured setting out of objectives, management alternatives, predictions of management consequences, recognition of key uncertainties and use of monitoring (Panel on Adaptive Management for Resource Stewardship, 2004).

Adaptive management of natural resources based on a facilitated modelling process involving stakeholders and technical experts, and driven by the problematic situation and management needs was first proposed by Holling and colleagues (1978). They were influenced by developments in decision and management sciences, for example Keeney and Raiffa’s book on ‘Decisions with multiple objectives’ (Keeney and Raiffa, 1976). They saw potential in how environmental assessment could be improved through integration of environmental, economic and social understanding, all the way from the design of policies to their implementation (Holling, 1978). Their book has influenced several large scientific literatures on the theory and practice of adaptive (co-)management. Some have focussed on the importance of system modelling in an adaptive management approach e.g. (Walters, 1986, Williams, 2011b). Whereas others have focussed on the importance of collaboration and co-management in an adaptive management approach e.g. (Wollenberg et al., 2000, Armitage et al., 2009b, Berkes, 2009).

Closely related to the literature on adaptive co-management (or collaborative adaptive management) is a large and important body of work on adaptive governance (Folke et al., 2005, Chaffin et al., 2014, Schultz et al., 2015). Adaptive governance is an approach which aims to confront landscape-scale problems in resource management in a flexible, dynamic and responsive manner (Chaffin et al., 2014). By governance we mean the structures and processes by which people in societies make decisions and share power, which in turn create the conditions for rules, collective action or institutions for social co-ordination (Schultz et al., 2015). It is argued that an adaptive approach to governance is needed to manage the uncertainties facing socio-ecological systems in terms of climate and land use change. Thus implementing adaptive governance is often identified as one of the objectives of adaptive co-management (Olsson et al., 2007). Adaptive governance involves learning-based collaborations and decision-making processes (often involving government and non-government actors) which aim to adaptively negotiate and co-ordinate management of socio-ecological systems and ecosystem services (Schultz et al., 2015). Adaptive governance, like adaptive management, should be a continuous problem-solving process (Plummer and Armitage, 2007), whereby institutional arrangements (and processes) and ecological knowledge are tested and revised in a dynamic and on-going process.

In this report our focus is on the literature regarding practical adaptive (co-)management approaches for the delivery of multiple benefits from natural resource management measures, rather than on adaptive governance. Adaptive management literature tends to be directed at those implementing management interventions on the ground, involving operational decision-making. Adaptive governance focusses on the processes by which more strategic decisions are made and considers the wider influences of policies, markets and social norms on the choices about whether to intervene or not. The management of Scotland’s natural assets and their governance are tightly

linked. The case studies associated with this SRP research on natural assets will study both the (co-)management and governance arrangements.

2.2 Limited examples of published studies using adaptive management

There have been many calls for adaptive management by researchers, as “a continuing weakness in applied ecology is the lack of studies that have actually tested management recommendations in the field. Thus, analysing a problem, offering a management solution and then implementing that solution and testing its efficacy in an adaptive management approach” (Memmott et al., 2010, 2). A review of over 1300 scientific papers that referred to adaptive management, found that only 61 claimed to use an adaptive management approach and of those, only 13 provided monitoring data, which is fundamental for adaptive management (Westgate et al., 2013).

Published examples of where adaptive management has successfully improved management of natural resources in Scotland (Perkins et al., 2011) and internationally (Nichols et al., 2015) have tended to focus on single species. For example, Perkins *et al.* (2011) demonstrated that the adaptive management of agri-environment schemes (AES) resulted in an increase in corn bunting *Emberiza calandra* compared to farms without targeted AES. In the U.S. and Canada, Nichols *et al.* (2015) described how the U.S. Fish and Wildlife Service use of adaptive management over the past 20 years for the annual sport hunting regulations of mallards (*Anas platyrhynchos*) led to large reductions in uncertainty and increase in the transparency and defensibility of annual decisions. Their approach of comparing predictions with estimates of system response resulted in an increase in the confidence of system models and their influence on subsequent annual decision making process (Nichols et al., 2015).

These single species approaches are not particularly suitable for current thinking about integrated delivery of multiple benefits at the landscape or catchment scale, as promoted by international conventions e.g. Ecosystem Approach (Convention on Biological Diversity, 2000) or Scottish policy e.g. Land Use Strategy (Scottish Government, 2016).

3. Why might we need adaptive management?

Adaptive management is needed for the planning, implementation and evaluation of interventions (management actions) that are aimed at providing one or more benefits e.g. individual or multiple measures in the Scottish Rural Development Programmes (SRDP). There is a need to understand the effectiveness of these actions in a more systematic way, taking into account trade-offs and win-wins. There are at least four specific reasons why an adaptive management approach could help improve the evaluation and coordination of measures to deliver multiple benefits for a more integrated and sustainable management of Scotland’s natural assets. First, there have been recent calls for adaptive management in Scottish Government strategies e.g. Scottish Biodiversity strategy (Scottish Government, 2013), and plans e.g. National Marine Plan (Scottish Government, 2015), and in international approaches e.g. Ecosystem Approach (Convention on Biological Diversity, 2000). Second, there is an increasing recognition that diverse policy sectors need a more integrated or coordinated approach e.g. as set out in the Scottish Land Use Strategy (Scottish Government, 2016). For example, policy makers in the UK and internationally are looking for synergies between existing legislation that spans land, biodiversity and other water policy objectives (Hardiman and Cathcart, 2013). Third, there is increasing pressure for more effective management of designated sites and the

wider countryside, at the landscape scale, when there are a number of competing objectives for the management of land and water resources; which can lead to disagreement and conflict over managing these resources if different stakeholders prioritise conflicting objectives. Finally, there have been calls for adaptive management to aid adaptation to climate change in Scotland and internationally e.g. Scottish Climate Change Adaptation Programme, (Scottish Government, 2014).

3.1 Adaptive management in Scottish Government strategies and plans

Adaptive management is increasingly referred to in Scottish Government, SNH and Scottish Environment Protection Agency (SEPA) strategies and plans. Scotland's Biodiversity strategy states that "we need to adopt a more adaptive approach, learning from experience and trying to tackle the causes of biodiversity loss" (Scottish Government, 2013, 4) where "indicators for healthy ecosystems will help us to guide adaptive management at the catchment/landscapes levels" (Scottish Government, 2013, 9). In terms of action for habitats, species and protected places, two of their priorities are "in the face of climate change, take forward an adaptive management programme for key habitats and species" (Scottish Government, 2013, 47), and "use NNRs to promote best practice for conservation and adaptive management". Where they defined adaptive management as "management based on regular monitoring, then modifying management to meet agreed objectives" (Scottish Government, 2013, 83). The Scottish Biodiversity Strategy demonstrates support for the Convention on Biological Diversity, and has adopted an ecosystem approach which involves "embracing adaptive management principles"(Scottish Government, 2013, 13). Adaptive management is prominent in SNH's management and decision making related to individual species e.g. wild geese adaptive management pilots³, and increasingly at the ecosystem level e.g. management of National Nature Reserves and other protected sites (SNH, 2016). SEPA's recent Natural Flood Management Handbook refers to the need of monitoring to "guide adaptive management of the site" (SEPA, 2016, 113).

3.2 Adaptive management to aid policy integration

Since Holling *et al.*(1978) suggested adaptive management could aid policy integration there has been a lot of academic interest in the role of adaptive management in policy integration e.g. (Norton, 1998, Pahl-Wostl, 2007). More recently, the Defra funded Synergies project looked at identifying opportunities for the integrated delivery of outcomes across the Biodiversity 2020 (B2020), Water Framework Directive (WFD) and Flood and Coastal Risk Management (FCRM) Programmes for England, and found: "the inclusion of explicit targets for managing biodiversity using an adaptive ecosystem approach provides a vital link between B2020, WFD and FCRM programmes" (Hardiman and Cathcart, 2013, 18).

In Scotland, during the design of the current SRDP 2014-2020, the Royal Society for the Protection of Birds (RSPB) highlighted the importance of an adaptive approach, and that it should be based around seven key principles: balance and cohesion, integration, prioritisation, regionalisation, targeting, support, and learning. Where "monitoring and evaluation aspects of the programme, particularly in the agri-environment and forestry elements, as key mechanism in ensuring robust and adaptive approaches to scheme content and management agreements" (Corrigan, 2012, 2).

³ <http://www.snh.gov.uk/land-and-sea/managing-wildlife/managing-geese/>

3.3 Adaptive management supporting the management of designated sites and wider landscape for multiple benefits

Protected areas are by definition areas where a public interest in natural heritage features of that area have been identified, so there are clear conservation priorities. However, the wider countryside outside these protected areas, also has many of these features present but existing alongside other objectives and interests relating to food or fibre production and recreation. In the wider countryside, management actions for one objective e.g. food production, may impact negatively on another objective e.g. terrestrial and freshwater biodiversity (Pilgrim et al., 2010). Yet often the evidence for these trade-offs is weak so that potential outcomes are based on opinions which are often contested. Adaptive management can help as a process to identify potential actions that can be tested through monitoring and learning from these, to devise better options in the future. Particularly in Scotland (and the UK) private ownership rights are strong relative to public regulation. However, there is increasing recognition that land under private ownership is also important in delivering public benefits. Thus an adaptive management approach is clearly relevant to the process of testing out management actions that attempt to reconcile legitimate private objectives such as food and fibre production with wider public benefit such as recreation, flood management and carbon sequestration. Therefore adaptive management has the potential to help inform a more collaborative approach to managing the wider countryside outside areas with particular priorities, such as designated areas. Furthermore, Bridgewater (2002) concluded his chapter, in the book 'Adaptive management: from theory to practice', saying that to fully respond to climate change, managers of protected conservation areas needed to implement an integrated adaptive management framework for those landscapes, and view protected areas as part of the wider landscape, and not as isolated islands of biodiversity.

3.4 Responding to climate change with adaptive management

Folke *et al.* (2002) suggested that (active) adaptive management and structured scenarios were two useful tools for building adaptive capacity to deal with climate change. Adaptive management of a communities' natural resources has been shown to increase adaptive capacity to climate change (Tompkins and Adger, 2004). More recently, the UK Climate Change Risk Assessment highlighted that increasing government and corporate adaptive capacity to deal with the risks and opportunities of climate change was a key cross cutting issue (Committee on Climate Change, 2016). Though adaptive management has been suggested as a useful approach for climate change adaptation (Ogden and Innes, 2009), Rist *et al.* (2012) suggested this still needed to be tested. Adaptive management's potential depends on the "the time required to learn and the ability to detect the effects of management against a broader background of change" (Rist et al., 2012, 14). There has been increased policy and management interest in adaptive management in support of climate change adaptation (SNH, 2016, Natural England and RSPB, 2014). For example, Natural England and the RSPB (2014) recently produced a Climate Change Adaptation Manual, based on collaboration with a wide range of other nature conservation organisations, including SNH. The purpose of the adaptation manual was to develop a decision making framework and a set of four principles, including application of adaptive management, for a more sustainable approaches to adaptation. Another example is the recent international report on 'Water and climate change adaptation in transboundary basins: lessons learned and good practice' that highlighted the requirement for adaptive management (UNECE and INBO, 2015).

Here in Scotland, the Scottish Climate Change Adaptation Programme (Scottish Government, 2014) states that the inherent uncertainty in some aspects of climate change means that adaptation policies need to be flexible and change, based on new information. One of the programme's three themes is focussed on the natural environment, with the stated outcome of "a Scotland with a productive, healthy and diverse natural environment which is able to adapt to change". Under this theme, adaptive management was explicitly mentioned in the context of two policies: Demonstrate adaptive management in National Nature Reserves (N2-3), and Assess and manage coasts, promoting adaptive coastal management that works with natural processes (N2-20) (Scottish Government, 2014). SNH see the need for an adaptive approach due to environmental change, particularly climate change. This is set out in their sixth adaptation principle: "take an adaptive approach to land and conservation management e.g. by changing objectives and management measures in response to new information" (SNH, 2016, 17).

4. What has influenced the development of adaptive management and related approaches?

Over the past forty years there have been, at least, three major influences on the development of the theory and practice of adaptive management. These are lessons learned from research on co-management and the governance of the commons, good practices from the decision and management sciences, and the integration of research and management to inform learning.

4.1 Lessons learned from co-management and governance of the commons

Adaptive management emerged from the literature of applied ecology, whereas co-management is most closely associated with the commons literature on management and governance of shared natural resources e.g. marine fisheries. Berkes suggested that "adaptive management without collaboration lacks legitimacy, and co-management without learning-by-doing does not develop the ability to address emerging problems" (2009, 1698). Adaptive co-management therefore integrates the dynamic learning nature of adaptive management (Holling, 1978) with inclusive stakeholder collaboration in management (Wollenberg *et al.*, 2000). Although Holling *et al.* (1978) stressed the importance of focussing on stakeholders and their management needs in their adaptive management approach, Wollenberg *et al.* (2000) suggested that adaptive co-management differed from the original approach of Holling *et al.* (1978) due to its bottom-up orientation and focus on stakeholders. The core features of adaptive co-management and conditions for success include: innovative institutional arrangements and incentives across spatiotemporal scales and levels, learning through complexity and change, monitoring and assessment of interventions, the role of power, and opportunities to link science and policy (Armitage *et al.*, 2009a).

Dietz *et al.* (2003) coined the term 'adaptive governance' to mean managing diverse human-environmental interactions in the face of extreme uncertainty. Recently, Chaffin *et al.* (2014) reviewed the adaptive governance literature, concluding that it recognised the complexity of ecological systems and provided a link to the social actions taken to manage ecological resources. It develops organically and is never the same in two places, and exists across gradients of: rigid to flexible, local to global, and bottom-up to top-down. Schulz *et al.* (2015) reviewed three case-studies where a move to adaptive governance was caused by realisation of an ecological crisis. The three cases they observed all built system wide knowledge and understanding of the ecological dynamics;

supported coordination, collaboration and negotiation across institutional levels and landscapes and seascapes to enable holistic approaches at effective scales; and harnessed informal means of governance that were beyond government based incentives and regulations.

4.2 Contributions from decision and management sciences

Developments and best practice from the decision and management sciences have influenced the development and application of adaptive management approaches to natural resource management from its origin (Holling, 1978). For example, the concept of results based management has influenced the practice of adaptive management e.g. (Salafsky et al., 2001), and more recently results-based payments for biodiversity agri-environment schemes (Keenleyside et al., 2014). The importance of results based management for public policy was highlighted in Osborne and Gaebler's (1992) influential book 'Reinventing Government'. Where results-based management is a "strategy aimed at achieving important changes in the way government agencies operate with improving performance (achieving better results) as the central orientation" (Binnendijk, 2001, 6).

Two related approaches to natural resource management that integrate adaptive management, applied ecology and decision science are Structured Decision Making (SDM) (Gregory et al., 2012), and conservation planning (Groves and Game, 2016). SDM was defined as "the collaborative and facilitated application of multiple objective decision making and group deliberation methods to environmental management and public policy problems" (Gregory et al., 2012, 6). The steps in SDM are: clarify the decision context; define objectives and measures; develop alternatives; estimate consequences; evaluate trade-offs and select; implement, monitor and review (Gregory et al., 2012, 8). Groves and Game (2016, 11) defined conservation planning as "a systematic process that is primarily focused on identifying, developing, and implementing strategies to conserve specific features of biological diversity, the ecological processes that sustain this diversity, and the ecological (ecosystem) services that are provided by it." In their recent book on Conservation Planning they set out three major components of any planning process: framing conservation planning problems, solving conservation planning problems, and implementation (including monitoring and review) (Groves and Game, 2016, 28-29).

4.3. Integration of research and management to inform learning

Embracing learning through monitoring and research to inform management is a key principle for adaptive management (Holling, 1978, Lee, 1994, CMP, 2013, 6). The importance of social learning was stressed by Kai Lee: "...nature as experiments, so that we may learn efficiently from experience. Second, we need to grasp far more wisely the relationships among people. One name for such a learning process is politics; another is conflict" (Lee, 1994, 8). Another early example of the value of collaborative learning to improve public deliberation in ecosystem management was demonstrated in the planning for the Oregon Dunes National Recreation Area (ODNRA) in the US (Daniels and Walker, 1996). The participants reported that collaborative discussions were better than other processes e.g. lobbying, litigation or letter writing, for delivering the ODRNA management goals.

There is a discussion around differences between 'passive' and 'active' adaptive management (Walters, 1986, Salafsky et al., 2001, Williams, 2011b). The US Department of Interior Technical Guide on adaptive management highlighted there was ambiguity in how 'passive' and 'active' adaptive management were used in the literature (Williams et al., 2009). Williams (2011b) illustrated the distinctions between passive and active adaptive management, through practical examples;

setting out the main difference between passive and active adaptive management was the degree to which management objectives focussed on the reduction of uncertainty through management interventions. Where “all passive approaches are characterised by the use of management to pursue resource objectives, with learning a useful but unintended by-product” whereas “with active adaptive management, decision making focuses on learning, with management strategy anticipating the influence of interventions on learning as well as resources” (Williams, 2011b, 1373).

5. When is adaptive management useful and when not?

Several authors have stated the need to start from an open question of whether adaptive management is needed and for what purpose (Lee, 1994, Williams et al., 2009, Doremus, 2010, Bunnefeld et al., 2015). Adaptive management can help overcome a number of common barriers to the process of decision making by building support from stakeholders, through understanding the system and the reasoning behind decisions. It can provide a framework for action in the face of uncertainty. But there is also a need for clarity about what adaptive management cannot do: it can inform decisions, but not make them; and it does not provide an easy solution, as engaging in adaptive management requires time and effort (Argent, 2009). Lee (1994) in his appraisal of adaptive management highlighted the importance of all involved agreeing that adaptive management was needed. This was reinforced by Doremus (2010) who said adaptive management should be looked at as an information problem, and should only be used when it promises to improve management outcomes to justify the additional costs.

To guide when adaptive management is useful or not, the U.S. Depart of Interior (2009, iv) in their guide to adaptive management included a problem-scoping key to “help in dissecting a particular management problem and determining whether adaptive management is an appropriate approach to decision making“. This included questions such as: is there a management decision to be made, can stakeholders be engaged, can management objectives be stated explicitly, is there uncertainty about management impacts, can management impacts be represented in models, can monitoring be designed, can progress be measured in achieving management objectives, can learning inform management actions, and does the process fit within the appropriate legal framework?

Whereas in their review of adaptive management for SNH, Bunnefeld *et al.* (2015) set out a series of questions and criteria that will help judge when it may be useful or not i.e. to help predict when it is likely to be successful. These focussed on the notion of whether adaptive management (AM) is appropriate, feasible and can it be successful. They suggested that for adaptive management to be appropriate “it is necessary to address the social and ecological obstacles and uncertainties and this can be achieved through further studies and experiments” (Bunnefeld et al., 2015, 5); and for it to be feasible it requires “enough resources are available and whether management flexibility exists to carry out AM” (Bunnefeld et al., 2015, 13).

6. What are the basic steps and principles of adaptive management?

There is a vast amount of literature on approaches to adaptive management of natural resources, including several books (Holling, 1978, Walters, 1986, Lee, 1994, Allan and Stankey, 2009), guidance manuals e.g. (Williams and Brown, 2012), and reviews (Keith et al., 2011, Williams, 2011a, Runge, 2011, Rist et al., 2012, Bunnefeld et al., 2015). In addition, there are large literatures on adaptive co-

management e.g. (Armitage et al., 2009b), and adaptive governance e.g. (Chaffin et al., 2014), and other approaches e.g. (Gregory et al., 2012) that relate to adaptive management. Several of these publications focus on presenting adaptive management approaches as complete series of steps and/or principles, for example (Rist et al., 2013), government agency handbooks e.g. (Williams and Brown, 2012), and nature conservation organisation guidance e.g. (Nature Conservancy, 2016, WWF, 2012).

A recent review of 187 papers that referred to adaptive management and published in natural resource management and conservation journals in 2009, found only 15 (8%) reported implementation of adaptive management, and only 18% had defined adaptive management (Rist et al., 2012). Rist *et al.* (2012) examined these 15 studies for their inclusion of standard components of an adaptive management approach based on Holling *et al.* (1978, 20) and Walters (1986, 9) (Table 1). Participation as well as systems modelling, identification of uncertainty and alternative hypotheses, and iteration of the management cycle were most commonly absent from the 15 studies (Rist et al., 2012). For some this was due to the study focussing on only the assessment and planning phases of adaptive management. Nine of the 15 studies reported using adaptive management successfully, one study said implementation had been a failure, and the other five made no mention of the outcome (Rist et al., 2012).

Table 1. Assessment of adaptive management components included in 15 papers reporting implementation in 2009 (Rist et al., 2012, 10).

Adaptive management component	Number of papers
1. Participation of those outside the management institution in order to manage conflict and increase the pool of contributions to potential management solutions	8
2. Defining and bounding of the management problem, including the setting of management objectives	9
3. Representing existing understanding through system models that include assumptions and predictions as a basis for further learning	8
4. Identifying uncertainty and alternate hypotheses based on experience	8
5. Implementation of actions/policies to allow continued resource management or production while learning (reducing uncertainty)	7
6. Monitoring of the effect of implementing new policies	12
7. Reflection on, and learning from, monitoring results, comparison with original expectation in order to revise models and/or management actions based on what has been learned	13
8. Iterative repetition of this cycle (points 1–6 above) so that management reduces uncertainties and lead to improved management outcomes over time	8

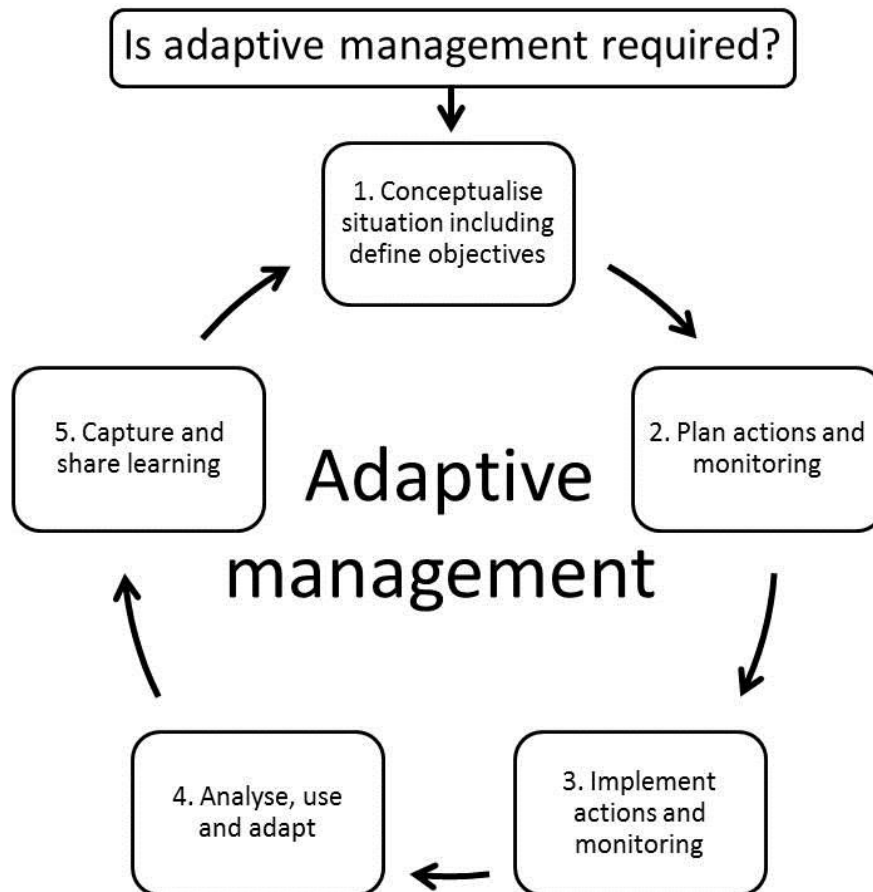
From our review of the literature on the practical application i.e. implementation of adaptive management approaches, it is clear there is a need for a clear definition of adaptive management and description of what it involves to support its use and evaluation. For example, Rist *et al.* (2012) in their review highlighted the need for systematic assessment of adaptive management, as well as clearer definition and description of adaptive management to enable its evaluation.

There is an example of a practical approach to adaptive management that has been developed, used and refined since 2001 by several conservation organisations: the Open Standards approach to

adaptive management (CMP, 2013). Their approach and definition of adaptive management is applicable at any project or programme scale or setting where “it is the integration of project design, management, and monitoring, to provide a framework to systematically test assumptions, promote learning, and supply timely information for management decisions” (CMP, 2013, 38). Therefore, although originally devised for conservation projects, it is suitable for, and relevant to, our focus on managing natural assets for multiple benefits.

Adaptive management approaches to natural resource management typically comprise several steps and a series of principles (Figure 1). Using the example from the Open Standards for the Practice of Conservation, there are five steps: conceptualise the project vision and context; plan actions and monitoring; implement actions and monitoring; analyse data, use the results and adapt; and capture and share learning (CMP, 2013, 2). Additionally, there are five general principles for implementation: involve stakeholders, develop and cultivate partnerships, embrace learning, document your decisions, and adjust as necessary (CMP, 2013, 6).

Figure 1. Generic steps in an adaptive management approach (based on (CMP, 2013, Bunnefeld et al., 2015, Rist et al., 2013) and other approaches).



The Open Standards are a generic and practice-focused approach to adaptive management for nature conservation, and have become standard practice in several leading conservation organisations from the project to programme levels. For example, The Nature Conservancy’s (TNC) Conservation Action Planning and Conservation by Design (Nature Conservancy, 2016), and World

Wide Fund for Nature's (WWF) standards of conservation project and programme management (WWF, 2012): all state they aim to support adaptive management. The WWF have used their 'standards' since 2005 in the design, implementation, and monitoring of conservation projects and programmes: "they are to help projects practice adaptive management in order to make them more **effective** and **efficient**" (WWF, 2012, 1).

7. What are the barriers to adaptive management and how might they be resolved?

As mentioned above, there are a limited number of published studies that report on practical cases that fully implement adaptive management (Rist et al., 2012, Westgate et al., 2013). In part this reflects that although adaptive management is relatively intuitive as a concept and approach, and the steps and principles are readily agreed by practitioners, there remain a number of barriers to its practical implementation. Furthermore, there is limited evidence that it has led to cost-effective delivery of individual and organisational objectives for the management of ecosystems for multiple benefits. There are large literatures in research papers e.g. (Johnson, 1999, Allen and Gunderson, 2011, Keith et al., 2011), books e.g. (Allan and Stankey, 2009, Williams et al., 2009) and reports e.g. (Bunnefeld et al., 2015, Doswald and Osti, 2011) on the barriers to adaptive management. For example, Rist *et al.* (2012, 8) in their review of 15 studies, identified four main reasons for challenges to implementation: "(1) logistical, financial and staffing constraints; (2) the need for a supportive institutional environment; (3) challenges relating to experimentation within a management framework; and (4) problems relating to spatial and temporal scale." Here we describe some of the barriers mentioned in these literatures, and identify how they can be tackled.

7.1 Limited communication of implementation and evaluation

The main barrier to greater levels of the application of adaptive management (when appropriate) is the lack of communication of successful implementation based on evaluation of adaptive management practice. Despite widespread calls from across research, policy and practice for adaptive management over the past 40 years, the full cycle is rarely carried out and assessed as highlighted by Rist *et al.* (2012). For example in a review of 53 State Wildlife Action Plans in the US, Fontaine (2011) found that although planners were aware of adaptive management only about 25% of the plans set out how adaptive management would be carried out. In Europe, Doswald and Osti (2011) reviewed practical case studies and found that adaptive management projects may fail to achieve the iterative learning due to poor project design or lack of funding so that the monitoring stages are often missing from the project. One way the Conservation Measures Partnership is trying to increase the communication of successful implementation of adaptive management is their recent competition for good examples of adaptive management in conservation⁴.

7.2 A lack of clarity on what is successful adaptive management

Related to the lack of implementation and evaluation of adaptive management is confusion on what an adaptive management approach is, and what a successful adaptive management project, programme or policy looks like. For example Allen and Gunderson (2011) in their review of why adaptive management falls short included that prescriptions are not always followed, learning is not

⁴ <http://cmp-openstandards.org/cmp-ccnet-case-study-competition-deadline-coming-up/>

always used, and there is often a focus on planning not action. Rist *et al.* (2012) found that only 10 out of 187 papers on adaptive management reported the success or failure of their implementation of adaptive management. The development of clear guidance e.g. (Williams *et al.*, 2009, CMP, 2013, Bunnefeld *et al.*, 2015) on when is adaptive management useful, what it involves and where further information can be gained is likely to help inform policy makers and practitioners about whether they should invest time and resource in taking an adaptive management approach.

7.3 Barriers to adaptive management are often social and political

The main challenges to applying adaptive management are social or political. These include the need to integrate stakeholders more effectively into decision making, embrace risk as part of management, and develop institutions that are amenable to adaptive management (Johnson, 1999). Argent (2009) in his review of the components of adaptive management highlighted that the process aspects need to be understood e.g. closed or limited stakeholder engagement; divergent scientific views; competing or incompatible social and bio-physical views; constrained institutional structures or processes; and range of motivations, drivers, distractions, and blockages that can affect those involved. In another study, efforts to implement an adaptive approach in the Northwest Forest Plan experienced several barriers including: an institutional and regulatory environment that stymied innovation, increasing workloads coupled with declining resources that constrained learning-based approaches, and a lack of leadership (Stankey *et al.*, 2003). Doswald and Osti (2011) compiled 101 case studies from across Europe of which 49 were on ecosystem based adaptation to climate change, and a further 39 on adaptation in nature conservation. They suggested there were two key elements that needed to be present for success: adaptive management and monitoring, and stakeholder engagement and communication. Due to poor project design or lack of funding then adaptive management and monitoring are often missing project components.

In addition to practical guides to adaptive management and the increased embedding of adaptive management in organisational guidance, there is a need for clearer guidance on adaptive management in government policies, strategies and plans to overcome social and political barriers. For example, the importance of collaboration and co-management; as Chaffin *et al.* (2014) concluded, we must recognise the complexity of ecological systems and connect to the social actions required to manage ecological resources. Adaptive management is fundamentally a process involving people and requires stakeholder involvement and partnership working (Holling, 1978, Williams *et al.*, 2009, Rist *et al.*, 2012, CMP, 2013).

7.4 Barriers to adaptive management are also financial and technical

In addition to the social and political barriers, there are financial and technical reasons why there is a lack of communication of successful implementation and evaluation of adaptive management. Several papers have suggested that one barrier to adaptive management is the greater cost compared to other management approaches, but Rist *et al.* (2012) found that none of the studies they reviewed (or the wider literature) provided information on the costs of adaptive management and on alternatives. They went on to say that such information would be useful, as costs and other difficulties of working with stakeholders relate to all forms of effective environmental management. Bunnefeld *et al.* (2015) in their approach to adaptive management included the need to satisfy the feasibility criteria that included the necessary human and financial resources. Rist *et al.* (2012) highlighted that as well as financial there were staffing constraints in the projects they reviewed. This could include expertise on adaptive management and the specific expertise e.g. system

modelling that it requires (Table 1). However, there are an increasing number of networks to share and develop expertise in adaptive management⁵.

8. How are we planning to use adaptive management in the Strategic Research Programme?

As set out in the introduction we will share this report and our suggested generic steps and principles for an adaptive management approach with stakeholders in our case studies to support them in their practice of adaptive (co-)management, should they desire this. This will take place during meetings with those case study partners. Our second aim is to draw on these steps and principles, to provide the basis for an evaluation framework for the case studies in our research ‘Practical interventions to realise multiple benefits and manage trade-offs’ (Research Deliverable 1.4.3 of the RESAS Strategic SRP). The evaluation framework will form a set of questions for MRP researchers to utilise in their SRP RESAS 1.4.3 case studies, so providing a structured integration across the research deliverable and wider work package. In this way, the adaptive management evaluation framework (based on our suggested approach) should help us compare and contrast across our case studies, thus contributing to the objectives of our wider research on ‘integrated and sustainable management of natural assets.’ The evaluation framework is under development and will be discussed at the Ecosystems and Land Use Stakeholders Engagement Group (ELSEG) event on 14th November. When it is completed, it will be appended to this report.

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⁵ <http://adaptivemanagement.net/>; <http://www.ccnetglobal.com/about-ccnet/>

Appendix

Appendix 1: CMP Open Standards approach to adaptive management

Here we elaborate on those generic steps based on the Conservation Measures Partnerships Open Standards approach to adaptive management, since these are practice orientated, grounded in the theory and practice of adaptive management, and have been refined over the past 15 years by a wide range of individuals and organisations involved in conservation (Salafsky et al., 2001, CMP, 2013). In addition to the steps, there are a set of essential principles that are relevant to each of the steps (Table 2). The main steps, sub-steps and examples of outputs for each of these are presented in Table 3. The authors stress that in practice “the entire process is rarely applied in a linear fashion from start to finish. Instead, it is typically a rough approximation of the more complex series of back-and-forth movements through which a project goes” (CMP, 2013, 4). There are also a series of assumptions that were made in developing these steps and principles, and these included that initial priority-setting has been carried out, and these present an “ideal in project design, management and monitoring. It is important to acknowledge that it may not be feasible - for a variety of reasons – to address every component of the *Standards*. What is important, however, is that you use a systematic and logical process for applying the *Standards*” (CMP, 2013, 7).

Table 2. Principles for implementing the Open Standards (CMP, 2013, 5-6).

Principles
Involve stakeholders – In conducting your project, it is important to define and, at every step, involve the appropriate internal and external stakeholders. Stakeholders are individuals, groups, or institutions that have an interest in, will be affected by, or may influence your project’s activities and results. Internal and external stakeholders will vary by project context.
Develop and cultivate partnerships – Similarly, you will need to formalise some of your partnerships and work on cultivating them throughout the life of your project. Successful conservation depends on forging effective partnerships with key stakeholders.
Embrace learning – Teams need to be prepared to embrace learning, recognise and admit mistakes, identify successes, and work to understand why some actions succeeded while others did not.
Document your decisions – For just about every step, you could write down how you decided to proceed, but this could quickly become overwhelming. You must decide what level of documentation is appropriate, but we cannot emphasize enough the importance of documenting the reasons for your decisions at each step.
Adjust as necessary – The steps described in this document generally apply to all conservation projects but should be adjusted to meet each project’s needs. In particular, each project team should go into a level of detail commensurate with the levels of complexity and investment in its project.

Table 3. Summary of steps and outputs of the Open Standards approach to adaptive management (based on Annex 3 (CMP, 2013); note not all steps are appropriate under all conditions).

Steps and sub-steps	Examples of outputs
1. Conceptualise	
1A. Define planning purpose and project team and state current formal and informal governance arrangements	Identification of planning purpose and decisions
1B. Define scope, vision, and targets with actors and stakeholders	Brief description of project scope
1C. Identify critical threats (pressures)	Identification of direct threats (pressures)
1D. Analyze the situation collectively including governance arrangements	Identification and analysis of indirect threats (pressures) and opportunities
2. Plan your actions and monitoring	
2A. Co-develop a formal action plan	Goals for each target
2B. Co-develop a monitoring plan including governance aspects	Audiences and information needs defined
2C. Develop a joint operational plan	Assessment of human, financial, and other resources
3. Implement actions and monitoring	
3A. Develop detailed short-term work plan and timeline	Work plan detailing tasks, activities, and responsibilities
3B. Develop and refine your project budget	Project budget
3C. Implement your plans	Implementation of strategic plan
4. Analyse, use, and adapt	
4A. Prepare your data for analysis	Development and use of systems for recording, storing, processing and backing up project data
4B. Analyse results, with partners if appropriate	Analyses of project results and assumptions
4C. Adapt your strategic plan	Revised project documents - action plan, monitoring plan, operational plan, work plan, and budget
5. Capture and share learning	
5A. Document what you learn	Documentation of key results and lessons
5B. Share what you learn	Identification of key audiences
5C. Create a learning environment	Regular feedback shared formally or informally
Close the adaptive management loop	

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