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Adaptive biodiversity management of semi-natural hay meadows: The case of West-Norway

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ABSTRACT

Worldwide semi-natural habitats of high biological value are in decline. Consequently, numerous Agri-Environment Schemes (AESs) intended to halt biodiversity loss within these habitats have been implemented. One approach has been the application of "adaptive management", where scientific knowledge is applied alongside the traditional ecological knowledge (TEK) of stakeholders in order to establish an integrated approach that is adjusted as outcomes are assessed. In this paper we examine the effectiveness of the adaptive management approach of Norway's Action Plan for Hay Meadows (APHM). Twenty-nine hay meadows from fourteen farms in the county of Møre og Romsdal were ecologically surveyed over a 2 year period. Interviews were also conducted with owners and land managers to explore TEK and management issues. The interdisciplinary study found that the disembedding of hay meadow management from its initial commercial purpose (in particular the loss of much of the livestock from the region) has contributed to a significant loss of TEK – which is now largely limited to knowledge of how the fields were managed recently. While, the APHM is limiting biodiversity decline by promoting traditional practices there were indications that the standardisation of management actions might negatively affect species composition in the long term. More critically, continued farm abandonment within the region means that without alternatives to management by farmers many of these meadows are likely to disappear in the next couple of decades. We conclude that adaptive management provides an effective short-term means of preserving hay meadows, but long term conservation will require a means of addressing the continued decline of local farming communities.

1. Introduction

Since the 1950s the intensification and mechanisation of agriculture has resulted in the worldwide loss of many natural and semi-natural habitats (Emanuelsson et al., 2009; Foley et al., 2005; Sala et al., 2000). In areas of high agricultural value intensive and mechanised production has replaced low impact management while in marginal areas land-abandonment and under-utilisation have also contributed to significant habitat loss (Emanuelsson et al., 2009; Plieninger et al., 2016; Stoate et al., 2009). In the early 1990s international concern for biodiversity loss brought 150 countries together to sign the Convention on Biological Diversity (UN, 1992), a document that detailed national strategies, plans and programs for conservation and sustainable use of biological diversity (Article 6). Since then, numerous Agri-Environment Schemes (AESs) have been implemented throughout the world with the intention of maintaining, conserving and even recreating threatened habitats (see Henle et al., 2008 for a review).

Within Europe, one of the most species rich ecosystems is that of semi-natural grassland (Billeter et al., 2008; Veen et al., 2009) where high biodiversity results from a long history of locally adapted, low intensity, agricultural land use (Küster and Keenleyside, 2009). Of these grasslands, those managed as semi-natural hay meadows contain some of the most species-rich plant communities and provide a key habitat for several species including invertebrates and bird species (Cizek et al., 2012; Pywell et al., 2012). Hay meadows have evolved over the centuries through an intricate management regime of regular mowing, the turning and drying of grass, only light applications of manure and no or only infrequent ploughing (Dahlström et al., 2008; Norderhaug et al., 1999; Norderhaug et al., 2000). While they are now highly valued for their biodiversity, in the past these meadows played a crucial economic

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role in farm management as often the only source of winter feed for livestock. High meadow biodiversity was partly by design as farmers were aware that hay from biodiverse meadows was more nutritious (e.g. Bradley, 1727; McClure, 1909), but predominantly resulted from a shortage of manure in remote areas meaning meadows distant from the farmhouse were rarely fertilised.

Since the 18th Century European hay meadows have been declining as a result of changing agricultural practices such as the advent of the plough culture, increased drainage, and an increasing preference for the production of silage rather than hay. More recently, mechanisation and the increasing availability of cheap mineral fertilisers have resulted in dramatic declines in hay meadow management – particularly the semi-natural meadows that are highly valued for their biodiversity (Halada et al., 2011; Ostermann, 1998). In Norway, the management regimes that were responsible for creating high species diversity are being abandoned, leaving the meadows vulnerable to forest encroachment and biodiversity loss (Norderhaug and Johansen, 2011). Where meadows are managed, new techniques, large machinery, more frequent cutting of the grass and the application of artificial fertilisers – which are potentially damaging to biodiversity in meadows – have meant that the traditional means of meadow management have been largely abandoned (Øien and Moen, 2006). Norway's semi-natural hay meadows are therefore threatened and regarded as endangered (EN) in the Norwegian Red List for Ecosystems and Habitat Types and require conservation (Norderhaug and Johansen, 2011).

Conserving the biological quality of hay meadows can, however, be a challenge. Complex underlying ecological mechanisms (Dallimer et al., 2010; Gabriel et al., 2010; Kampmann et al., 2012), a fundamental lack of historical knowledge concerning hay meadow decline (Riley, 2005), and uncertainty regarding the impact of specific management practices on ecological dynamics (Henle et al., 2008) make it difficult to design programs for their preservation. As a result, applied approaches have often been too simplistic (even where knowledge has been available), resulting in counterproductive outcomes (Henle et al., 2008). Further, as the historical management of each hay meadow has been different, there is no "one size fits all" approach to designing suitable management regimes (Kirkham et al., 2014). While ecologists have established a sizeable knowledge base on the impact of cutting and grazing regimes, fertilization, more general disturbances such as spring raking and letting hay dry in the meadow (Jantunen et al., 2007; Lennartsson et al., 2012; Oostermeijer et al., 2002; Svensson and Carlsson, 2005) and the impact of surrounding landscapes on grassland biodiversity (Evju and Sverdrup-Thygeson, 2016; Wehn et al., 2017), there is still a great deal of uncertainty regarding the long-term and combined effects of new management guidelines.

As part of the cultural landscape hay meadows rely upon continued active use and management by people, rather than the extensive, hands-off approach employed to achieve many other conservation objectives (Halada et al., 2011; Ostermann, 1998; Riley, 2006). Hay meadow conservation or restoration can require a considerable effort on the part of the farmer – particularly in cases where farm practices have already been rationalised through, for example, mechanised silage-making or the abandonment of marginal upland meadows. Conserving semi-natural hay meadows, therefore, requires attention to the "human factor" so that the ecological measures "are palatable to farmers and therefore effective at changing farmer behaviour" (Batáry et al., 2015, p.1012).

This paper examines one potential approach to developing appropriate hay meadow management plans – namely the adaptive management approach of Norway's Action Plan for Hay Meadows (APHM). Adaptive management approaches are based on a combination of scientific knowledge of hay meadow management and traditional ecological knowledge (TEK) of the existing land managers in order to develop appropriate management plans for each individual hay meadow. The paper reports on an interdisciplinary study involving ecologists and social scientists to assess the APHM five years after initiation. It is divided into four main sections. First, a literature review of adaptive management. Second, a description of the case study area and methodological approach. Third, the results section combines ecological and social data to address the issue of whether the adaptive management plans are safeguarding the hay meadows or not. Finally, we conclude with recommendations for policies incorporating an adaptive management approach.

2. Adaptive management and Norway's APHM

Developed initially by Holling and Walters (Holling, 1978; Walters, 1986), Adaptive Management (AM) arose from a desire to move beyond traditional "top-down", expert-led, decision making and planning, and its associated limitations in terms of ecological outcomes (Holling and Meffe, 1996). As Callicott et al. (1999) suggest, it has become one of the" normative concepts" in conservation and has "become something of a mantra among conservation ecologists and natural resource managers seeking to establish "place-based" integrated management of ecosystems" (Karkkainen, 2002, p.945). Whilst there has been some debate in the literature over what is meant by the term (see Rist et al., 2013), its overarching aim is towards an iterative consideration within management whereby learning takes place and management strategies are adjusted accordingly (Williams, 2011) and to include stakeholders outside of conservation organisations in order to broaden the knowledge base and to create "experiments" that can be used to gradually improve management (Stringer et al., 2006). Although there are normative reasons for the participation of wider stakeholders – that is, a suggestion that people have a democratic right to participate in management decisions (Stringer et al., 2006), which in turn has advantages of capacity building and power sharing (Kapoor, 2001) – there has been a more applied concern for how different forms of understanding can be brought into conservation management (Berkes and Folke, 2002). Central to this argument is a belief that community-based management has coevolved with resource use and ecosystem dynamics (Olsson et al., 2004) and that Traditional Ecological Knowledge (TEK) forms a central part of adaptive management. TEK is defined in this context as:

"A cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment." (Berkes et al., 2000, p.1252).

TEK, the adaptive management literature suggests, might offer the potential "to improve the knowledge base to respond to change adaptively" (Gadgil et al., 2003, p.90), with the recognition that people "who retain TEK are holders of a body of knowledge crafted for centuries by the specifics of completing tasks in the environment in which they have been living" (Drew, 2005, p.1287). Alongside this, it has been argued that because TEK is developed iteratively – through trial and error – it can reflect changes in specific environments and cultures (Drew, 2005). As such, where TEK is incorporated into conservation schemes, it has the potential to offer location-specific knowledge, increased knowledge of environmental linkages, and local capacity building and power sharing. Thus, there is a potential for historical observations that may be seen as "natural experiments" where land users can see the outcomes of particular practices, and because "it is difficult to systematically conduct properly planned and replicated experiments in complex systems, local observations of such experiments can be of significant value" (Gadgil et al., 2003, p.205).

Research has shown that such an endeavour is complicated, with the way that knowledge-practice-belief become indistinguishable in TEK seen as a weakness for many scientists who are keen to identify verifiable "facts" (Gadgil et al., 2003). Although debate continues about the limitations of TEK, it is recognised that it may offer a "wealth of detailed context-specific observations of the dynamics of complex ecological systems" (Gadgil et al., 2003, p.206). There have been several analyses of the challenges to adaptive management, with the two most notable being the potential "stalemates" when groups with