Journal of Applied Ecology

British Ecological Society

Journal of Applied Ecology doi: 10.1111/j.1365-2664.2011.02055.x

Securing the future of the natural environment: using scenarios to anticipate challenges to biodiversity, landscapes and public engagement with nature

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Summary

1. Maintaining and protecting biodiversity for the future under changing environmental and socio-political conditions is a major challenge. Scenarios are used as decision-making aids for natural resource management at local to global scales. Scenarios are underutilised by conservationists at a local level, where they can be highly effective for anticipating change.

2. People's values and attitudes are crucial in determining the future, yet they are rarely placed at the centre of scenario exercises. Novel methods have been developed to fully integrate people's worldviews into scenario planning. The ethnographic futures framework focuses on how changes occur through human agency and how they will be felt by society in the future. The three horizons approach considers how different ideas and paradigms become more, or less, dominant in society over time.

3. Natural England (NE), the statutory adviser to the UK Government on the natural environment in England, carried out a scenario planning process using these novel approaches. The scenarios consider a wide range of global and local factors and investigate their impact upon the natural environment in England, to 2060.

4. A set of four contrasting scenarios was produced. Despite their differences, nature was always highly valued in some form; ultimately, the state of the natural environment was determined not by natural forces but by societal choice.

5. *Synthesis and applications*. Scenario planning allows the development of key visions for the future. These can be used to establish, and influence, the direction of future trends and their impacts on the natural environment, particularly in the context of a shifting basis for conservation policy that seeks to enhance ecological resilience. The scenarios are being used within NE to help local communities shape the future of their natural environment; this process can be utilised by governments or environmental agencies elsewhere. This study demonstrates that across a range of scenarios the future state of the natural environment is very much a matter of societal choice. Decision-making frameworks for environmental conservation must take proper account of ecological knowledge, societal values, foresight and complexity.

Key-words: climate change, conservation planning, decision-making, ecosystems, ethnographic futures framework, futures, global environmental change, land-use change, society

Introduction

The natural environment faces multiple threats (UNEP 2007). With the current extinction crisis (Baillie, Hilton-Taylor & Stuart 2005; Vie, Hilton-Taylor & Stuart 2009), uncertainty over the impacts of climate change (IPCC 2007), increased human consumption of natural resources and the growing global population (United Nations Department of Economic and Social Affairs Population Division 2009), setting out and delivering successful strategies for landscape and nature conservation is increasingly complex. Links between research and nature conservation, such as the use of hard evidence to inform conservation decisions (Pullin & Stewart 2006), adaptive management (Walters & Holling 1990 but see Walters 2007) and

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communication between researchers and practitioners (e.g. Hulme 2011), have increased. However, these techniques aid effective conservation only under current conditions, as they are generally based on data from the present or recent past. Attempts to ensure the resilience of conservation efforts under future, unknown conditions have been made, but they often assume that the world is either static or set on a linear course based on extrapolation of the recent past. However, surprises are inevitable (Schwartz 2003), and the past is not always a reliable guide to the future.

'Scenarios' (structured accounts of possible futures; Peterson, Cumming & Carpenter 2003) can be used to try to anticipate the future and thus test plans and strategies against unexpected changes. As the future is uncertain, a set of scenarios is usually developed to try to encompass the full range of plausible outcomes. Scenarios can be classified as 'product'-driven (e.g. the global level greenhouse gas emission scenarios created by the IPCC; Nakićenović & Swart 2000) or 'process'-driven (e.g. WBCSD 2006), or both (O'Neill *et al.* 2008). The success of using scenarios to develop innovative thinking was demonstrated by Shell in the late 1960s, when scenario developers envisaged a world where oil was in short supply (then considered unlikely by oil companies), allowing them to anticipate the 1973 oil crisis (Van der Heijden 1997). This success may, in part, have been responsible for the boom in the use of scenarios in the late 1970s (Bradfield *et al.* 2005).

Scenarios have been used by environmental managers to explore a number of issues at a variety of spatial and temporal scales, for example increasing migration of people into sparsely populated regions (Peterson *et al.* 2003), invasive plant species (Chapman, Le Maitre & Richardson 2001) and desertification (Kok & van Delden 2009). In the United Kingdom, scenarios have been developed to investigate the pressures on the environment to 2030 (Burdett *et al.* 2006). Local environmental issues are affected by decisions and actions occurring at larger scales, for example regional policies or global processes such as climate change. Regional and global scenario assessments that consider some aspect of the natural environment have included the European Environment Agency PRospective Environmental analysis of Land Use Development in Europe (PRELUDE) scenarios (EEA 2007), the Millennium Ecosystem Assessment (MA) Scenarios (Carpenter *et al.* 2005) and the Global Environmental Outlook Scenarios (UNEP 2004). In global environmental scenarios, the number of stakeholders is high and familiarity or utilisation of the scenarios may vary amongst them (e.g. Reid 2006).

The methods used in the process of scenario building are becoming increasingly sophisticated, employing both quantitative modelling exercises and qualitative narrative exercises, such as the Advanced Terrestrial Ecosystem Analysis and Modelling (ATEAM) scenarios (Schröter *et al.* 2004) and the storey and simulation approach (Alcamo 2008). Participatory methods, which include stakeholders with local or traditional knowledge, can be used to improve the depth and relevance of scenarios to local issues (e.g. Bohunovsky, Jäger & Omann 2010) or to increase community participation in planning processes (e.g. Thongbai *et al.* 2006). While many of the cutting edge techniques involve combining quantitative with qualitative scenarios (e.g. Kemp-Benedict 2010), the techniques for qualitative scenarios themselves are becoming more sophisticated. Qualitative scenarios allow the use of data and processes that are difficult to quantify within models, for example the impacts of sudden shocks or changes to systems once an unknown threshold has been reached (Kareiva *et al.* 2005) or changes in societal norms. The Millennium Ecosystem Scenarios considered that 'Societal responses to change, and the potential for changes in human values, are of central importance in the future' (Cumming & Peterson 2005). Many scenarios consider changes in governments or economies, but fewer consider changes in societal paradigms and how people relate, and connect, to each other.

Ensuring that possible societal and cultural changes are fully considered within qualitative scenarios can be difficult because of the tendency to continue along current norms. One technique for exploring a wide range of social and cultural responses is the ethnographic futures framework (EFF, developed by Michelle Bowman and Kaipo Lum; Schultz 2007). This differs from the more common drivers of change approach (which uses the 'point of origin') by focusing on the 'point of impact' i.e. where the effects of changes are felt in the future. The EFF uses five categories to explore change: 'define' (how will people define themselves, what concepts, ideas and paradigms will emerge to help them make sense of the world?); 'relate' (how people relate to each other and the world around them); 'connect' (what media and technologies are used to connect people and places?); 'create'(how will people create new goods, services and knowledge?); and 'consume' (how people use and dispose of resources). The EFF can be used to analyse details within scenarios already constructed (e.g. Infinite Futures 2007; Schultz 2009); however, using it as a template for discussion ensures that all aspects of human society as described by the EFF are covered.

A further way of considering societal change is to carry out a 'three horizons' analysis (Curry & Hodgson 2008), which considers how different ideas and paradigms become more, or less, dominant in society over time. The current prevailing system is the '1st horizon', which may become a poor 'fit' under changing conditions. The '3rd horizon' contains system structures, which currently are marginal or unrealistic but may be more appropriate in the future. The 2nd horizon is the space where transmission between first and third horizons occurs, characterised by instability and clashes of values between actors proposing alternative paths into the future. Utilising an EFF and three horizons approach enables cultural and societal change to be considered within scenarios.

Here, we report on a scenario planning process which used both the EFF and the three horizons approach, carried out by Natural England (NE). NE is the statutory adviser to the UK Government on issues affecting the natural environment in England and is tasked with securing the environment for future generations (Natural England 2008). The scenario planning exercise was used to help fulfil this objective. The scenarios consider the effects of global-scale changes but investigate their impacts on a national and sub-national scale: in particular,

how we might live in England in 2060 and the implications for biodiversity, landscapes and public engagement with the natural environment and various geographic zones (e.g. upland, urban and coastal areas) within England. In this paper, we report the scenarios developed and an analysis of the main issues arising.

Materials and methods

Natural England undertook the scenario planning exercise in the period October 2008–September 2009. The aim was to develop a set of scenarios which considered how the natural environments within NE's remit (marine, coastal, urban, uplands, lowlands and wetlands) might look and function in the next 50 years.

Natural England commissioned a team of external contractors (SAMI Consulting 2b Northbrook Court, Park Street, Newbury RG14 1EA, UK) to assist the in-house strategy and environmental futures team in the scenario-building process. An initial framing workshop resulted in the decision to use qualitative scenario planning in preference to trying to predict, project or forecast the future using available data or models. This allows the consideration of a range of complex social, technological, economic, environmental and political (STEEP) factors, over a relatively long time period. The planning process used exploratory scenarios (responding to the question 'what can happen?' Borjeson *et al.* 2006) resulting in a range of plausible alternative futures (Mannermaa 1991), rather than a 'most preferable' or 'most likely' future (Fig. 1).

Interviews were conducted with members of the NE Non-Executive (responsible for ensuring NE fulfils the aims and objectives set by UK government) and Executive Boards (provides strategic leadership for NE), UK Government Department for Environment, Food and Rural Affairs and other external stakeholders ($n = 14$), to establish the focal question, determine the scope and ensure top-level participation in the project. The interviewees were asked seven questions developed from those used by Shell for internal policy reviews: (i) If you could spend some time with someone who knew the outcome of future societal and environmental changes, a clairvoyant or oracle if such existed, what would you want to know? (i.e. what are the critical issues?) (ii) If things went well, how would you expect NE to perform and what would be the signs? (iii) How could the environment change to make things more difficult? How could NE itself go wrong? (iv) From your knowledge of the culture, NE, systems and resources (including people), how would these have to be changed to achieve the optimistic outcome? (v) How did NE get to where it is today? (vi) What decisions need to be made in the near-term to achieve the desired long-term outcome? (vii) If you had a mandate, without constraints, what more would you need to do? Contributions were anonymous. During the interviews, many interviewees felt that the world would be a very different place by 2060, and it was people's values and behaviour which would determine what that future would be. This supported the decision to use an EFF.

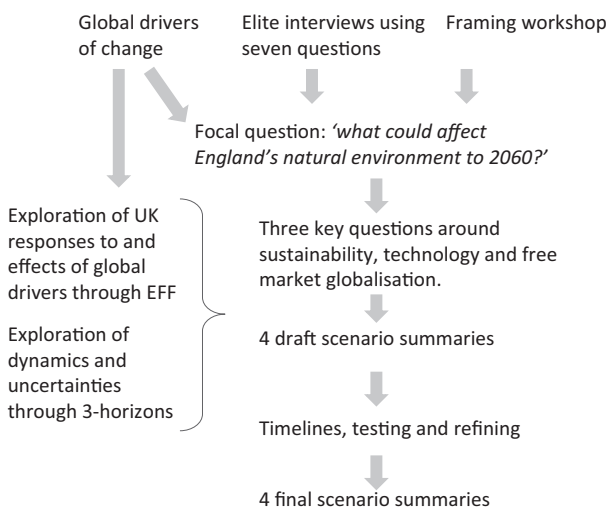

Fig. 1. Flow chart illustrating the scenario development process.

Separately, 14 drivers of global environmental change were identified from a combination of interviews and desk-based research incorporating social technological, economic, environmental and political factors. The drivers selected were those which were relevant to the natural environment, could be envisioned and would extend to 2060 (see Table 1). The drivers of change were explored using the EFF categories, to anticipate what the societal impact in the future could be if a driver progressed along alternative trajectories. For example, exploring the 'Converging Technologies – promises or perils' driver using the 'Define' category of EFF results in a range of responses such as 'back to nature' (rejecting technology as dangerous/unnatural) or 'redesigning life'(using nanotechnology to improve all aspects of human life) (SAMI 2009). The three horizons analysis was used to investigate the dominance and the level of uncertainty associated with each driver over time. The elite interviews, framing workshop and drivers of change lead to the development of the focal question – 'What could affect England's natural environment to 2060?'

To prioritise the drivers and draught the scenarios, three sequential workshops were held with a range of NE staff, key stakeholders and experts (from areas such as biodiversity, landscapes, recreation, climate change, economics and science; see Creedy *et al.* 2009). The first (38 participants) discussed the major changes that had the greatest impact on the environment over the past century and how the 14 drivers could affect the future. Participants were asked to use the EFF categories to consider how the future might look if drivers had developed along different trajectories. Three key questions emerged: will the world have found a way to live sustainably? Will technology have provided a 'get out of jail free' card or will lifestyle changes still be necessary? Will the world be dominated by free-market globalisation or not? In the second workshop (37 participants), eight possible combinations of answers to the three questions were considered (i.e. eight scenarios). Five scenarios were selected using an iterative process where groups of participants were asked to choose the top three for further study. Each scenario was considered using the EFF, and outlines were created. In the third workshop (41 participants), the scenarios were fleshed out, using critical uncertainties, their development over time and their importance to the natural environment. Timelines indicating major events within each scenario were created, as were several 'news headlines' used to stimulate discussion of each scenario. Outputs from the second and third workshops also included the dimensions of the scenarios, the names suggested for the scenarios by participants, the impacts on England in 2060 using the EFF, major actors, major sources of tension or conflict and the key dominant drivers shaping the scenario. The final four qualitatively different draught scenarios that explore the full range of factors at play (as described by the EFF) in society were chosen.

The scenarios were then tested and refined through workshops held in locations around England, which included seven staff and stakeholder workshops (90 participants in total) and four 1-day public involvement workshops (rural area, urban area, businesses,

Table 1. Global drivers of change to 2060 and some of the critical uncertainties. This is not an exhaustive list of the factors and directions considered – for the full list see SAMI (2009)

Driver	Possible effects	Direction 1	Direction 2	Critical uncertainties
Climate change	Sea-level rise, higher temperatures, ocean acidification	Early global agreement on limiting emissions	Failure to reach any agreement on emissions	Rate and magnitude and change People's response to change
Converging technologies	Biotechnology – genetic techniques used to include desired traits in existing species and ultimately new life forms Information technology – decreasing cost, increasing capability and pervasiveness Nanotechnology –control of matter on an atomic and molecular scale	Knowledge and application of the nano scale domain mean that all matter (living and non-living) can be integrated	Resistance on grounds of culture, tradition and human integrity	Vast range of potential uses and unforeseeable implications Possibility of a backlash
Demographics	Global population increasing and expected to peak within the range 8·8–10·8 billion	Population increasing owing to population growth in Asia and Africa, followed by increased life span	Lower fertility rates; plagues	Whether the low or high variant is reached
Energy	Oil production falls from 2015	More diverse energy supply, increased energy efficiency	Technological advances in extraction and efficiency along with new discoveries extend peak supply to 2030	Speed of climate change and the timing and level of GHG emission reduction targets New technology may revolutionise energy supply
Food security	Global demand for food projected to increase owing to increasing population, wealth and urbanisation	Business as usual – supply keeps up with demand through industrial agriculture Crisis – food supply fails to keep pace with demand Green revolution – supply increases owing to technological developments Eco-transition – low carbon farming; low impact diets; agro-eco approaches to increase productivity	Reductions in food demand owing to fewer people, less waste and changed diets	Demand – affected by population growth, diet and lifestyle Availability – of land, water, soil, global fish stocks Price of oil Rate of technological advances Impacts of climate change on food producing areas Requirement of land for energy production Developments in aquaculture
Economic power shifts	China and India will have increased economic influence as their economies and populations grow	China's economy predicted to be bigger than America's by 2060 leads to cultural and political dominance of China and India	USA preserves its relative economic performance through better education and innovation Resource constraints limit global growth	Ability of the planet to sustain continued economic growth (but population changes will still mean that the relative ranking of USA and China will reverse)
Governance	Regulation likely to increase to reduce risks of climate change, migration and radicalisation	National governments may not be responsible for enforcing regulations – could be performed by local governments on behalf of international organisations	Fear of the unknown; Protectionism of current national states; ability to police borders	The extent to which protectionism prevents the implementation of global regulation

Table 1. (Continued)

Driver	Possible effects	Direction 1	Direction 2	Critical uncertainties
Health and well-being	Developed world – health and well-being declining owing to preventable life style diseases, which are also increasing in developing world	Smoking has declined but obesity increased	Drive to greater physical activity via government influenced policies Global patterns of diet change to reflect food scarcity (reduced meat and dairy)	Food availability Technological advances in medical solutions (gene therapy, pharmaceutical food) Government activities and their impacts
Infectious diseases	Infectious human and plant diseases on the increase	Globalisation has allowed spread of disease Diseases becoming resistant to current control techniques	Reversal of globalisation Technological advances in medicine and pharmaceutical areas eliminate major global diseases	Impacts of disease outbreaks on ecosystem services, biodiversity and natural production systems Frequency and virulence of new diseases
Marine	Two key issues Ocean acidification Over-fishing	Oceans become highly acidic – impacts uncertain Potential food shortages in coastal communities if fish stocks collapse	Move to a low carbon economy, reducing CO_2 emissions Increased fish farming and exploitation of fresh water fisheries; marine protected areas used to help biodiversity recover	Impacts and timescale of impacts of ocean acidification Ability of the world to develop sustainable fishing policies
Mobility	Travel increases Migration increases owing to labour mobility and populations shifting following war, environmental degradation or climate change	Travel increases, transport becomes 'intelligent' and no longer carbon emitting	Lack of investment into infrastructure for tourists	Extent to which the infrastructure to support intelligent vehicles is in place
Money, wealth, economy	World economy has been through a period of global growth, until the recent credit crunch	Despite the crunch (or possibly long-term recession), technological advances have resulted in an increase in wealth in terms of the ability of people to do more in fewer man hours Supply of natural resources may be constrained	New model of economic activity that differ from the current Western-free market paradigm	Economic model to be adopted Measures of wealth (growth models or 'happiness') Effects of globalism Changes in values Protectionism leading to reduced consumption
Resources	Increased populations and economic growth leads to a global scarcity of resources	Reduced per capita consumption and increased recycling Technological advances aimed towards exploiting abundant raw materials	Demand for resources continues New finds and extraction techniques increase supply of resources or alternative new resources	Rate of exploitation and conflict over global commons Speed and direction of technological advances Political and social responses to water shortages
Values and people	The next generation ('Net Gen-ers'*) will be the main workforce	Complexity is the transformational scientific paradigm High connectivity results in bottom up organisation and open source, self organising society	Backlash towards the slow and traditional Selfish gene effects Increase in religion may reduce concerns over the environment	Whether the selfish gene view or the open source society prevails What worldviews result from this and how they translate Ability of the education system to adapt to shifts in context

*Tapscott (2009).

secondary school pupils; 111 participants in total). During the seven staff and stakeholder workshops (facilitated by the SAMI team), participants were split into four groups, presented with a draft scenario and asked what current issues (at regional to global scales) could be taking their region towards this scenario. They were then asked who would be the major actors and who (including people, organisations and places) would benefit, or lose out, in the scenario. Finally, participants were asked to create a timeline for their region (Duckworth *et al*. 2009). The timelines created were used to consider the impacts of the different scenarios on the spatial frameworks – regions of England and the six biotopes of interest to NE (uplands, lowlands, coasts, marine, wetlands and woodlands). The global drivers and draft scenarios were sent to a Virtual Advisory Panel consisting of seven representatives working in futures, business and sustainability arenas, and the scenarios were also tested on seven academics with a wide range of backgrounds. Participants found the scenarios to be plausible (they were able to create timelines for the scenarios that were logical and internally consistent), coherent and challenging.

The public involvement workshops aimed to extend the discussion of the scenarios to an external audience and to test their possible use as a communication tool. The workshops involved the presentation of the scenarios using a visualisation CD-ROM followed by a structured discussion. The agenda for the discussion was to cover: what was most surprising; what was most concerning; what participants would expect from government (at local, national and international scales); what aspects of the scenarios participants would not accept; what would be the most important aspects of the environment to protect or manage; and what would participants do to support or improve the environment. Data from these workshops were used in the description, detail and language used in the final scenarios.

Results

Four scenarios resulted from the building process called *Connect for Life*, *Keep it Local*, *Succeed through Science* and *Go for Growth* (see Table S1, Supporting information for main characteristics). The four scenarios were presented as a storey, each told by a different character in 2060 looking back on events over the past 50 years (for an example, see Box S1, Supporting information; for full description of timelines and stories, see Creedy *et al*. 2009). The scenarios were developed along consistent 'narrative threads' in which the stories start out grounded in the present, highlighting current emphasis on certain strategic issues but also pointing out where other emerging trends or issues are ignored or downplayed. The stories then develop along those tracks until a 'response' occurs in which the dominant policies and emphases are challenged and new pathways open. These pathways are then followed through to the outcomes in 2060.

Following the storyline, a detailed description of how people in England might live in 2060 was laid out covering factors such as energy, food, population and education (Table S2, Supporting information). The implications of change were derived for three key themes relating to the natural environment – biodiversity, landscape and public engagement with the natural environment (Table 2). For example, in *Go for Growth*, the EFF 'Define' category describes a society where materialism and wealth are afforded highest value (Creedy *et al*. 2009). In consequence, the environment is not valued beyond what is immediately realisable in economic or aesthetic terms, and biodiversity and landscapes are treated as assets. The implications of the four scenarios were also assessed in a similar way for each of the geographic zones of interest to NE (Table S3, Supporting information). For a fuller report of each scenario, including the full description of implications, see Creedy *et al*. (2009).

ANALYSIS AND SYNTHESIS OF ISSUES ARISING FROM THE SCENARIOS

Some issues relating to the natural environment became apparent across all scenarios, despite differences in the futures they describe (Table S2, Supporting information). In all scenarios, there is an increasing emphasis on the instrumental purpose of nature and the material services (provisioning, regulating and supporting) it can provide. The extent to which the cultural services of the natural environment are valued varied widely. Resources become limited across all the scenarios but the response of government, business and civil society to this critical issue varies widely. The spatial scale over which the responses occur also varies with responses occurring in a global context in three of the four scenarios, but in a national and local context in *Keep it Local*.

The response to limited resources, the 'value' of nature and the use of technology results in changes to the natural environment and biodiversity in each scenario (Table 2). Demands on the natural environment increase, and space is at a premium. The distinction between rural and urban areas is blurred by development of the countryside and the greening of urban areas as climate-change mitigation (*Succeed through Science*, *Connect for Life*) and increases in food production (*Keep it Local*). Responses to climate change vary from reacting to events to international co-operation, resulting in reduced emissions and local adaptation to changes.

While the end point of this exercise is 2060, people alive in 2060 will have views of their own future based on the dominant values in play: in *Go for Growth* and *Keep it Local*, the emphasis is on the short term and short to medium term whereas *Succeed through Science* and *Connect for Life* have more emphasis on the long-term future, although again in different directions.

Drawing all the information together, two key related issues become apparent – firstly, the balance between valuing the environment for its own sake and for the social and economic benefits it can bring and secondly, the factors driving decision-making. In the changes outlined by these scenarios, the extent to which the natural environment is taken into account depends on whether society appreciates the broader system of which it is part. It also depends on whether society takes a futures approach to anticipate the implications of changing situations and builds institutions and processes for making choices in the light of possible risks and opportunities. The scenarios demonstrate that the impacts of humans on the natural environment in the next 50 years depend critically on the '..ability and willingness of society to make clear its values

Table 2. Summary of some of the overall impacts of the four scenarios on the natural environment and biodiversity

Scenario	Natural environment	Biodiversity
Connect for Life	Decisions about land-use made according to the ecosystem services the land can provide Space at a premium so land management often focused on delivering more than one objective	Semi-natural habitat has increased Habitats that provide key ecosystem services (e.g. bogs, wetlands and woodlands) are protected Lowland grasslands and heathlands likely to change in response to reduced grazing and increased forestry
Go for Growth	Rapid, unregulated change to the natural environment caused by the market economy Ecosystem services with a monetary value have become commodities, those without have become degraded	Loss of diversity and abundance of species from the wider landscape owing to infrastructure and development, but maintained in privately owned land used as a recreational resource Loosely regulated adoption of biotechnology in agriculture and horticulture has lead to the escape of invasive species and genes
Keep it Local	National drive towards self sufficiency in food and energy production takes priority with space at a premium Lack of technological advances means that the natural environment is being used to help adapt to climate change and for energy	Natural and semi-natural habitat declines as more land used for food and fuel production Area of green space and farmland has increased benefiting generalist species which use these areas Reduction in pesticide use owing to biotechnological advances has benefited many species
Succeed through Science	Advances in biotechnology mean that less space is needed for agricultural production More land used for development and infrastructure Environment managed as a system controlled by technology	Improved management of peat lands, wetlands and woodlands for carbon mitigation Changes in agriculture result in reduced impacts owing to pollution but lower availability of food and habitats for some farmland species Reduction of grazing in upland and low land habitats has lead to changes in species composition Some escapes of tightly regulated invasive species and genes have occurred, but their impacts kept to a minimum by mitigation

for the natural environment and to make choices that consciously reflect those values' (Creedy *et al.* 2009). As such, the scenarios depict a range of possible outcomes that can be summarised as either 'accidental' or 'deliberate' futures for the natural environment. Which outcome we will observe in reality depends on the extent to which natural systems are consciously factored into the structure and functioning of society over the next 50 years and beyond.

Discussion

These scenarios provide a unique perspective in their combination of spatial and temporal scales (looking forward 50 years, covering sub-national regions of England; Schultz 2009). They cover broad topics of global concern, including highly complex, inter-related issues. While the focus is on the natural environment, the scenarios are based on consideration of social, technological, economic and political factors alongside and interacting with environmental issues. The main focus of the project is a much smaller scale, i.e. England, but the scenarios are placed within a global context. This allows a much tighter linkage between stakeholders, the lack of which has been noted as a weakness of many global environmental change scenario exercises (for example the Millennium Ecosystem Assessment Scenarios). However, the scope and quantitative inputs of the NE study are by far smaller than the MA, making it more tractable.

The use of the EFF in this context is novel. The framework was adopted as it focuses attention on human agency as the locus of change. This may help ensure the comprehensiveness, depth and detail of the scenarios; in a review of 35 scenarios related to the future of the natural environment in England, few scenario projects addressed issues of how we connect to each other (Schultz 2009). The EFF also provided a consistent framework that could be used to bridge the divide between developing the scenarios and subsequently developing the strategic vision for NE. The use of the three horizons approach over a 50-year time span challenges current values and

ideologies sufficiently to obtain scenarios that demonstrate a paradigm shift, avoiding the problem of scenarios that deviate only slightly from 'business as usual' (Slaughter 2004). The success of this method was demonstrated in the production of robust, internally consistent scenarios, which are being used in other projects. The structure provided by the EFF and three horizons approach allows comparisons of outcomes, impacts and strategic issues across these scenarios and with other scenario projects.

The four 'reference' scenarios resulting from this process are freely available for use and can be utilised in other planning processes. They are currently being referenced in the development of the UK National Ecosystem Assessment (2009) – expanding their use from England to UK wide and focusing on ecosystem services. They have also been used by NE to develop a vision of a 'preferable' future for England's upland areas (Natural England 2009). Similarly, the scenarios describe life in 2060, but there is sufficient detail in the storylines to enable further elaboration of how the four futures might play out between 2010 and 2060. NE is conducting work to express the scenarios in the shorter term (until 2030), which will allow them to explore how shorter-term strategies and positions might perform, highlighting the risks and opportunities that may occur.

The NE scenarios describe how the future might unfold, the factors that might shape it, how we might live and the implications for the natural environment. By so doing, they have provided a resource to enable challenging and forward-looking debate and discussion on securing the future of the natural environment. Using scenario planning, and other horizon-scanning and futures techniques, provides the opportunity not only to anticipate the future, but to develop a road map towards a preferred future. Attempts to shape the future rather than react to change as it occurs – aiming for deliberate rather than accidental change – are likely to be critical in dealing with the forthcoming threats to the natural environment. This study showed that across a range of scenarios the future state of the natural environment is very much a matter of societal choice and this requires improved decision-making frameworks that take proper account of societal values, foresight and complexity.

Acknowledgements

Our thanks go to the large team involved in the NE scenarios exercise, including John Creedy, Helen Doran, Simon Duffield, Nicola George, other members of the Natural England Strategy and Environmental Futures Team, SAMI Consulting and Wendy Schultz. Kasper Kok, Laurent Mermet and an anonymous referee provided very helpful comments on manuscript drafts. The WildCRU's participation was made possible by generous support by Tom and Dafna Kaplan. Thanks to many people who were involved in the interviews and workshops.

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Received 24 January 2011; accepted 20 July 2011
Handling Editor: Paul Armsworth

Supporting Information

Additional Supporting Information may be found in the online version of this article.

Box S1. Summary of the *Connect for Life* scenario.

Table S1. Summary of the key differences between values and paradigms in each of the four scenarios (from Duckworth *et al*. 2009).

Table S2. How people in England might live in 2060 under the different scenarios (Creedy *et al*. 2009).

Table S3. The possible impacts of the four scenarios on different geographic zones, which include natural and semi-natural habitat (Taken from Creedy *et al*. 2009).

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