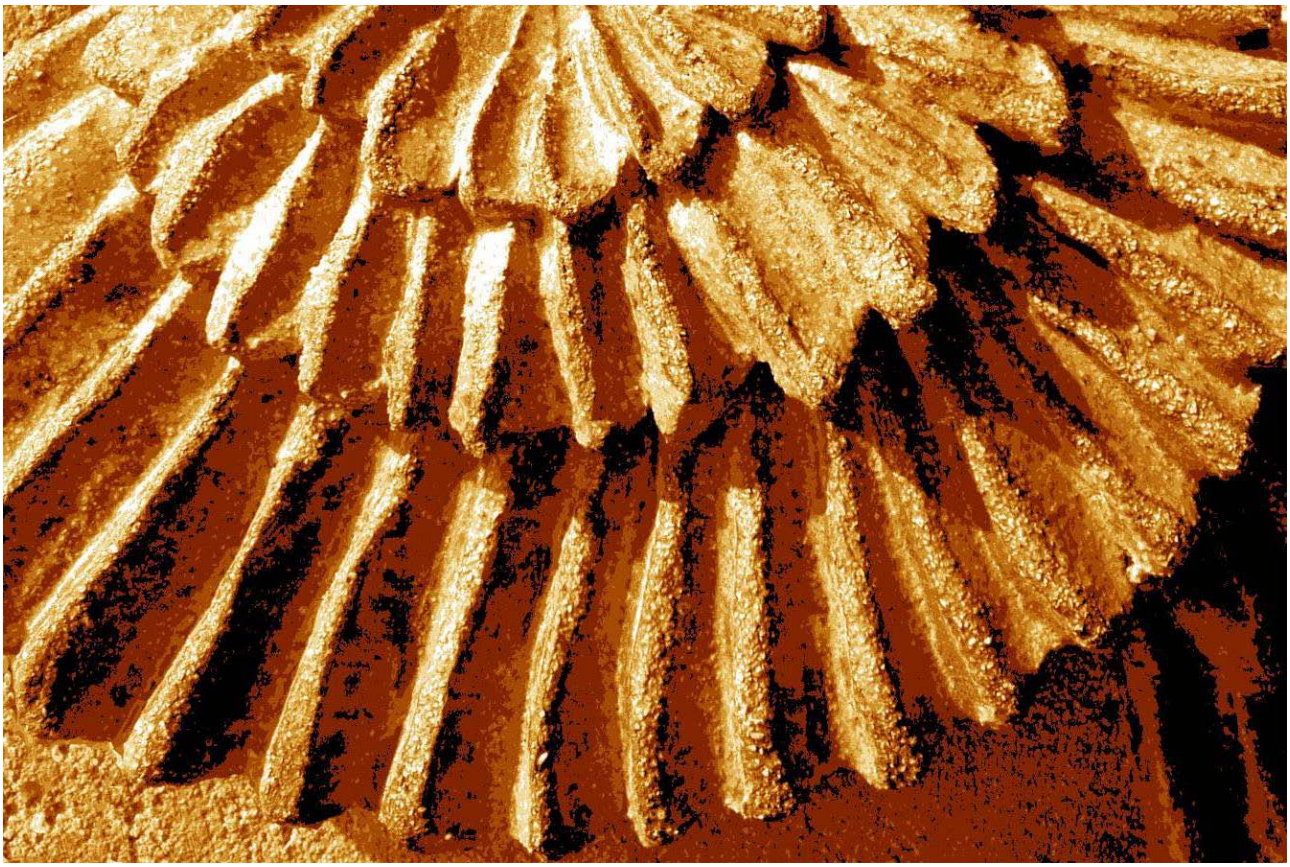
UK National Ecosystem Assessment

Understanding nature's value to society

Assessing User Needs of the NEA Scenarios through Focal Questions



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Executive Summary

Scenarios are an important component of ecosystem assessments that give context to plausible futures driven by different social and environmental factors. A user needs survey, including a meeting with stakeholders and an on-line questionnaire, was conducted to gather the kinds of questions that users wanted to ask of the UK National Ecosystem Assessment (NEA) scenarios and to give relevance to the storylines.

Analysis of these focal questions showed considerable variation in the emphasis of the questions reflecting the different perspectives of the users. Some questions addressed the strategic approaches of the storylines themselves, others were concerned with policy options, responses to changing environmental and social circumstances, particularly climate change, and the relationships and trade-offs between different drivers of change. Other questions needed reframing to meet the context in which scenarios should be used which demonstrated that scenario development is as much about the learning process as it is about the product. There were also significant omissions in the concerns expressed by users, such as lack of questions about impacts on human well-being or cultural services.

In general, the questions did not map directly onto the major axes of interest, global/local and reactive/proactive, that previous scenarios had used, other issues such as risk/security and differing impacts of climate change were also implicated, so suggesting that a new approach was needed for the NEA scenarios. Recommendations from this study are that framing questions for scenario development may be used as a learning process for users to understand how the scenarios may be used; scenarios may be steered through identifying and analysing the types of questions that users want to ask of storylines; omissions in the concerns shown by focal questions, such as lack of focus on human well-being, should also be considered. Finally themes of interest in NEA scenarios may be interpreted on more than two axes therefore a flexible approach to scenario development, such as morphological analysis, is recommended.

1. Introduction

The UK National Ecosystem Assessment (UK NEA) is the first analysis of the UK's natural environment in terms of the benefits it provides to society and our continuing prosperity. Part of the Living With Environmental Change (LWEC) initiative, the assessment began in mid-2009 and will be reporting its findings in early 2011. It is an inclusive process involving individuals and institutions with a wide range of perspectives, in government, academia, NGOs and the private sector. For more information on the NEA in general visit: http://uknea.unep-wcmc.org/.

1.1 The role of scenarios within the NEA

Scenarios are an essential part of the ecosystem assessments. They provide a bridge between the understanding of the current state and past trends in ecosystem services and the likely policy or management responses that might be appropriate given a range of plausible futures. In the context of the UK NEA, the aim is to use them to explore how ecosystems and their services in the UK change in the future, and to identify what the possible effects might be in terms of human well-being and who might be affected most. The timeline to be considered extends to 2050.

A work plan for scenarios was agreed following a meeting with the different NEA interest groups in November 2009 (Haines-Young and Potschin, 2010). Its main elements included taking stock of existing scenario studies and review how useful they might be for the purposes of the NEA, what kinds of question that potential users of the NEA were asking about the future, and how the scenario work can best be integrated with the science and valuation components of the assessment. The purpose of this Interim Report is to describe how the important methodological and practical issues surrounding scenario construction have been approached, and to present our recommendations on how the work might be taken forward to its conclusion. Key issues concern the identification of the questions potential users and how current scientific evidence can help our understanding of what the impacts of the different drivers of change might have. We have also considered how the economic assessment of past changes in the output of ecosystem services can be projected forward to better understand what some of the implications of alternative plausible futures might be, and present a flexible analytical framework that could be used in the discussion of response options by the wider NEA network.

Scenario development has become a fundamental component of ecosystem service assessments. Ecosystem scenarios are neither prediction nor projection but a way to provide decision makers with systematic methods to think creatively about complex, uncertain futures. They incorporate both qualitative and quantitative information and explore linkages between ecosystems and human well-being (Alcamo et al., 2005). There are two key outcomes from scenario exercises: the scenarios themselves and the process of developing the scenarios. The process is important to open up discussion, to gain a better understanding of the system dynamics and to build cooperation between stakeholders (Henrichs et al., 2009).

Building appropriate scenarios and storylines for ecosystem services assessments requires an understanding of how and why the scenarios will be used. According to Jäger et al. (2008:24) "One of the most daunting aspects of any scenario exercise, particularly one that is intended to consider a range of issues in an integrated fashion, is identifying the key issues or problems of concern." There are a large number of components that build scenarios and many possible futures that may be

envisaged, with complex and competing trade-offs between ecosystem services, socio-economic factors and spatially differentiated responses to drivers of change. Therefore, focusing on the components either that most users are concerned about, or that are most illustrative in informing users of future impacts of change, helps to ensure that the scenarios are appropriate for users needs. However, the process of formulating the scenarios is as important as the product as it engages users and provides a sense of ownership of the outcomes. The full involvement of the future users of scenarios ensures that, "Scientific assessments are most helpful to decision makers when the intended users are active in the assessment process and, especially, when the users directly help shape the questions that the assessments will answer" (Carpenter et al., 2006). Involvement of users helps to provide credibility in producing scientifically sound scenarios; saliency through being relevant to user needs and legitimacy as to who developed them and how (Rounsevell and Metzger, in press).

Some preceding ecosystem assessments have explicitly involved users in scenario development through preliminary interviews and discussions that develop the focal questions that guide storylines. The MA (2005) used this process to clarify a single main question "What are the consequences of plausible changes in development paths for ecosystems and their services over the next 50 years and what will be the consequences of those changes for human well-being?" (MA, 2005:149). This was further refined through a series of more specific questions. However one of the key lessons learnt was that communication with stakeholders could be improved to help understand the most important questions to policy-makers and to develop storylines in line with key variables (Nakićenović et al., 2005). Shell International BV? (2008:16) considers scenario building as "a collaborative, conversation-based process that facilitates the interplay of a wide variety of ideas". The shell approach was to use a series of open-ended questions in interviews and within focus group discussion, including, "If you had the chance, what questions would you ask of an oracle about the future?" (Shell International BV 2008:35). The Foresight approach similarly used group workshops to develop scenarios that are "focused on key preoccupations of the group" (Stout, 1999). "The best scenarios dramatise a few key features or events which are of prime concern to the group, because they epitomise the way a sector could change, or because they are the actual trigger events which decide which way things will go."

1.2 The role of focal questions in the NEA scenarios

Henrichs et al. (2009) describe the first stage of scenario development as the formulation of a single focal question that is objective and as unambiguous as possible. The NEA brief for scenario development started with two overarching questions:

- How might ecosystems and their services in the UK change in the future under plausible scenarios?, and
- What are the future possible effects of changes in ecosystems [and their services] on human well-being and who might most be affected?

These are broad in their remit and some refinement was necessary to prioritise the most important issues and to meet the needs of the users.

Apart from the few outlined above, the majority of ecosystem scenarios investigated (Haines-Young et al., 2010) do not explicitly describe this important stage of scenario development. Some mention the need for focal questions to include stakeholders in formalising scenario storylines, but there is

little written within the literature about the methodologies to collect and analyse more detailed questions. This leaves a number of methodological questions regarding how suitable framing of focal questions is encouraged and how the most important issues are then synthesised within scenarios.

This paper describes the methods used to generate a suite of focal issues that were then used to shape the storylines of the NEA scenarios. It then analyses the responses in terms of content, to understand the different viewpoints of users, but also whether the framing of the questions themselves is appropriate in developing plausible questions or whether users are seeking predictions. In the latter case, the discussion process may also help users understand how focal questions are used.

2. Methods used to assess the needs of scenario users

A number of activities were undertaken to include users and experts in the process of scenario development for the UK NEA and three strands of evidence were brought together to build a compendium of questions addressing both over-arching issues and more focused concerns based on broad habitats identified within the NEA remit and the ecosystem services that they provide. These were analysis of the responses to a letter to stakeholders predating the NEA, a participatory exercise with stakeholders and an on-line survey.

First, the material collected together by Defra, following its letter to potential stakeholders for the NEA sent out in November 2008, was reviewed and a number of focal questions 'derived' by rephrasing extracts from the responses (Appendix 1) into questions. It should be noted that the purpose of these responses was to evaluate the case for the National Ecosystem Assessment and not to guide scenario development, therefore the material did not map directly onto the conceptual framework of the target ecosystems and services that were used in the subsequent surveys. However, although the development of focal questions was not the prime purpose of this material, the areas of concern from different users were evident. In the initial phase these 'derived' questions offered a set of surrogate focal questions and gave an indication of the potentially extensive range in interest of users which formed a useful basis for discussion.

Second, at a meeting with stakeholders in February 2010, a participating group of experts tested structuring questions into a simple template: a grid that presented habitats against major types of ecosystem services. Participants were asked to propose focal questions, either cross-cutting across ecosystems or services or more particular question that related to specific ecosystems and their outputs. The workshop session, which included 19 people from a range (Appendix 2) of organisations concerned with science and policy issues, identified 65 questions that have been incorporated into the full list in Appendix 3.

This meeting was a proof of concept of the grid template approach which was then used to form the basis of an internet-based questionnaire designed to elicit further user input on the topics that they felt the NEA scenario exercise should address. The on-line survey consisted of an introductory explanation of the approach followed by:

- A grid of ecosystem services against generalized UK habitats to quantify the broad interests of the respondents and their organization; and,
- A grid of ecosystem services against generalized UK habitats into which respondents input the focal questions that they would like the scenarios to help answer.

The survey materials were set up on the NEA UNEP-WCMC website[1] and participation was invited from members of the wider NEA user and client groups by e-mail. In total, 72 people were invited to respond to the on-line survey from the user group, client group, expert panel and the chapter leading authors. The website was open between 11th April and 31st May, 2010. Thirty six individuals responded; altogether they posed 71 questions (Appendix 3). A further 13 questions were added as the results from conference a call with the Marine Group, July 2010. In total 149 focal questions were submitted from the three sources.

[1] UK National Ecosystem Assessment website: http://uknea.unep-wcmc.org/

The internet-based questionnaire and the grid template framework was a new approach in collecting focal questions for ecosystem assessment scenarios, which in previous scenario exercises seem to have been developed mainly from stakeholder discussions and in terms of the number of responses seems to have been successful in involving a large proportion of the target user group. Preliminary results from this survey, reported in Haines-Young et al. (2010), were subsequently presented at a meeting with the Scenario Steering Group in May 2010 (Appendix 4) which generated further dialogue on storyline content and forms the basis for the following discussion.

3. Results of the user needs survey

The results from the questionnaire were twofold, the quantitative summary of level of interest in different ecosystems and services and the focal questions, of which 139 questions were submitted in total.

Results from the quantitative survey asking about general, cross cutting issues revealed that provisioning and regulating services were of interest to more respondents than cultural services. In terms of habitats or ecosystems, semi-natural grasslands and enclosed farmland received more attention than the other habitats (Tab. 1); marine and coastal issues seem under-represented. While this pattern of responses mainly reflects the interests of the people who were willing to contribute to the survey, the sample was considered large enough to begin to gauge the types of question that users were asking of the NEA.

Table 1: Results of internet-based questionnaire survey asking for expressions of interest in specific ecosystems and services

	Provisioning	**Regulating**	**Cultural**
Cross-cutting issues across all services (Provisioning, Regulating and Cultural)	16		
Issues cross-cutting habitats	19	20	0
Mountains, moors, heaths	10	11	7
Semi-natural grasslands	17	16	12
Enclosed farmland	11	13	8
Woodland	10	11	7
Rivers, lakes, and lowland wetlands	11	12	10
Urban	9	9	9
Marine, coastal, estuarine	7	7	6

A content analysis of the responses (Tab. 2) suggested that in terms of the drivers of change, the most frequently cited issue in the questions related to the implications of climate change on ecosystems and services (23 questions), followed by the impacts of demographic factors (12), management interventions (9) and policy (9). In terms of the services, the most frequently asked questions concerned issues related to food (16), water (13) and energy (13).

The questions posed through the internet-questionnaire were consolidated with those identified in the earlier workshop session and from subsequent conference calls for further analysis (Appendix 3). An inspection of this material suggests both a wide range of interests in terms of topics, and most importantly, quite different types of perspective in relation to the kinds of outputs that scenarios might be expected to deliver. The questions listed in Appendix 3 have been reviewed and coded according to subject and theme and it is clear that some general patterns emerge.

Table 3: Results of content analysis of internet-questionnaire. Note that multiple questions entered into the online form as one response were treated as a single question to avoid double counting.

	Keywords	Number of references
Drivers / responses	Climate change	16 (23 with GHG)
	Greenhouse gases (GHG)	7
	Policy (ies), CAP	9
	Management	9
	Market, pay, payment, cost, trade	6
	Technology	2
	Population (human), people	12
Services	Energy	13
	Food	16
	Water	13
	Carbon sequestration, storage, etc	9
	Biodiversity, species richness	6
	Recreation, leisure	5

The questions posed through the internet-questionnaire were consolidated with those identified in the earlier workshop session and from subsequent conference calls for further analysis (Appendix 1). An inspection of this material suggests both a wide range of interests in terms of topics, and most importantly, quite different types of perspective in relation to the kinds of outputs that scenarios might be expected to deliver. The questions listed in Appendix 1 have been reviewed and coded according to subject and theme and it is clear that some general patterns emerge.

The variation in emphasis of the focal questions submitted reflects the different perspectives users hold and the use that they will make of the scenarios. Users were prompted to pose questions in the context of constructing scenarios and many questions could map directly into the way storylines construct plausible accounts. However it is apparent that while most were thinking about 'the future', some of the issues they posed are not easily answered via 'scenarios'. Some needed reworking to address the topic of interest in more appropriate ways, other questions would be better redirected to other areas such as the NEA response group or to scientists as the answer is currently unknown. Some questions therefore helped define the broad scenario structure, such as those exploring strategies that outlined different 'futures' and relationships between futures or those that asked about policy options and implications of change, while other questions were more specific in their concerns.

First, questions such as "What happens if you implement all the sustainable management option chapters in the NEA?" or "What will be the consequences of recasting biodiversity targets in terms of ecosystem services?" were focused on the **strategies** that the scenario storylines could adopt and comparisons that could be made between them. Comparing a future in which ecosystem services are given a high priority with one in which biodiversity is emphasised was to become a popular choice in later discussions with the scenario steering group. The use of more specific questions to refine scenarios through strategic development of alternative storylines was explored in the MA (2005:149-150). They help by defining what type of future users would like to consider.

Second, the impacts of specific **policy options** were examined, such as in "What would a shift towards managing BAP habitats and SSSIs for complexity and heterogeneity deliver in terms of ecosystem services?", "How could CAP reform help delivery of services other than 'provisioning' from farmland?" or "Will the implementation of marine conservation zones successfully conserve and

restore marine biodiversity and ecosystem services?". To address these kinds of question the suite of scenarios will allow for the impact of 'policy on' and 'policy off' worlds to be thought through based on our assumptions about the different kinds of relationship between services outputs and factors that influence them.

Third, many questions were concerned with the impact of **changing circumstances**, as in: "What would 70% food security mean for UK's ecosystems?" or "What are the implications of climate change, increasing water stress and a growing population on the productivity of farmland?" These questions are clearly of a kind that can be explored in scenario studies, providing that the framework adopted includes reference to the appropriate drivers of change which allows impacts to be compared in different situations. Climate change was a particular popular focal topic and some consideration as to how it could be addressed in the scenarios ensued. Many questions accepted that some change in climate is inevitable and there was evident concern in understanding the future effects under a range of climates. For instance, "What would be the impact of a specific set of UK climate change predictions… on the continued delivery of provisioning and regulating services across a range of UK broad ecosystems?" Users were interested in the relationship between emission reduction strategies and climate change and phrased questions asking about multiple drivers and/or policy options to tackle the effects of changing climate such as "How can we integrate climate adaptation strategies, energy needs and waste management together with maintenance of quality habitats to ensure continuity of ecosystem regulation?" Questions were also linked to different social and economic contexts. The conclusion to be drawn from the way these questions about climate change were framed is that in any set of scenarios, 'moderate' and 'extreme' climate change versions of the narratives constructed around other drivers would address a number of user concerns. Rather than focus on the impacts of climate per se, the scenarios could explore how different mitigation or adaptation strategies might play themselves out in different circumstances, or how different policies or trends on other areas might support or undermine them.

Fourth, other questions focused on the nature of the **relationships** between various combinations of biophysical and social variables, for instance, "What are the synergies and trade-offs between different services?" or "Under different scenarios what balance will be achieved between the different drivers of change in marine ecosystem services: energy from marine renewables, requirement for food from fish and aquaculture, sustainability of food production, conservation of biodiversity, recreation and leisure, shipping etc.?" The issues of trade-offs and synergies are clearly ones that will be addressed in the scenarios but will be highlighted in comparisons of alternative plausible futures which have to be based on some understanding of underlying relationships.

In contrast to these questions, a number of other types of question were posed that focused on more specific concerns. The themes of the questions were important and valid for storyline development although the questions in their original form often required too much precise detail from the scenarios rather than looking at the broad implications and plausible futures. They needed restructuring into a form which scenario storylines can address so that the relationships and contrasts between scenarios can be explored.

Some questions focused on **value judgements**; questions such as: "What kind of woodland do people prefer and value culturally?" or "Is there a conflict between public perception of culturally valuable habitats and landscapes, and those habitats required for other services such as biodiversity and carbon storage?" While such questions may be important in a decision making context, they may be covered in detail through the evidence based review elements of the NEA and the analysis of the past impacts of drivers. In this case, understandings are perhaps best developed through the analysis

of past or current evidence, rather than through a scenario exercise that would only track the implications of the insights and assumptions we currently hold. These types of questions also need addressing through a deeper understanding of human well-being.

A number of questions focused on trying to understand **mechanisms** or the way various **drivers of change** impacted on some outcome. Archetypal questions in this category included: “In converting semi-natural grassland to woodland, what are the net GHG emissions…?” or “How do forests and woodland affect water regulation in catchments?” or “How will sea-level rise alter the current coastal defence function provided by coastal margin habitats?” While such questions are important, they are of a kind that is perhaps best explored in the individual service, habitat or driver assessment chapters. Plausible scenarios would have to be based on an understanding of the relationships implied by these types of question, but the emphasis in scenario studies has to be more on the contexts in which such, say, land conversions occur, or the implications of sea defences holding or not.

Some questions expressed an interest in making some kind of **prediction** about future conditions, rather than simply a desire to explore what is possible under a ranger of projections. For example, one respondent asked: “Will the water framework directive [WFD] help the regulating services in wetland systems?” and another, “Does leisure time increase or decrease? Is it spent inside or outside?” Such things are of course unknown, and scenario studies are not going to provide an answer. What scenario studies can do, however, is consider the circumstances under which such things as the WFD might be more or less successful, and suggest what the consequences of these alternative outcomes might be. Similarly, in relation to leisure patterns, scenario studies might help us to think through the implications of increasing or decreasing recreational opportunity.

The trends of the focal questions in this survey did not readily fall into the pattern of other scenario studies (Paterson et al., 2010), such as Foresight Futures (OST, 2003), which mainly conform to two primary axes global-regional and proactive-reactive (Fig. 1).

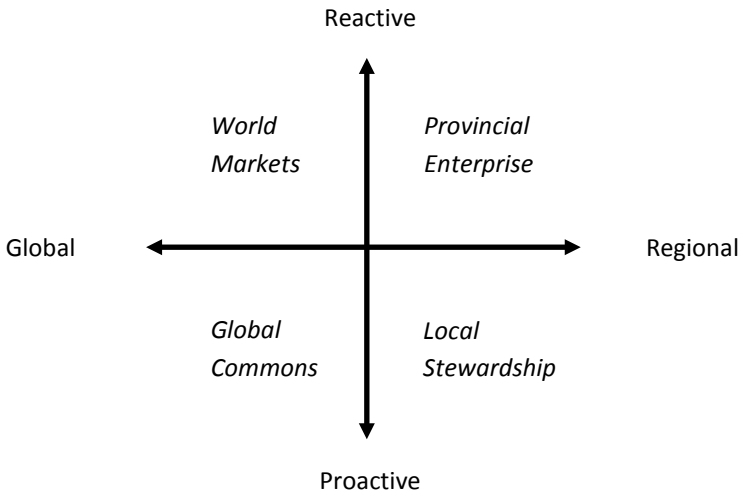

Figure 1: Typical axes used in scenario development such as Foresight Futures (OST, 2003)

In terms of **scale**, most of the questions were UK-centric and only a few questions were country focused or considered global forces, such as, "How will global food prices impact on ecosystem services?” However, some questions were interested in cross-country relationships such as “How do different amounts of habitat per nation affect what is important?” Subsequent to the survey, lead

authors of the country chapters were consulted independently in order that the different conditions and concerns are recognised in England, Scotland, Wales and Northern Ireland.

More apparent were questions that dwelt on a **risk / security** axis. Thus one respondent asked: “How will we prioritise energy verses food security from land?” while others posed questions such as “How will global food prices impact on ecosystem services?” Issues of security are increasingly topical, and in these questions clearly bound up with notions of self-sufficiency. This kind of contrast will be addressed in the overall scenario structure. Risk-related questions included: “What will be the impact of non-native invasive species, including new pests and diseases?” and “How would large scale release of CBRN materials impact on ecosystems?” Risks like these are often included in scenario studies as a ‘wild card’ that could be looked at in relation to all story lines to see if we are more vulnerable in some situations than others. More generally, the scenarios will address these questions by exploring general questions of resilience.

Analysis of the responses also highlighted some significant gaps. Despite **human well-being** being key to the second of the over-arching focal issues addressed by NEA scenarios, few questions had any direct bearing on human well-being, although it could be argued that questions about ecosystem services are implicitly concerned with supplying human needs. However, most questions that referred to people were ones asking how attitudes could be manipulated, such as “How best can we encourage people to value natural ecosystems and landscape when their priorities are on short term crises?” While these views are inherently important in scenarios favouring strong environmental stewardship they are not the overt purpose of the scenarios. Concerns regarding social equity were also lacking.

The diversity of focal questions gathered indicates a wide range of concerns of different users some of which may be addressed in scenario development, whereas others are more appropriately addressed elsewhere within the NEA. Yet the range of concerns shown in the focal questions, and also some of the omissions, lays the foundation for NEA scenario development.

4. Discussion – Lessons Learnt

Scenario building is concerned with both process and product and this is comprehensively illustrated in this study of user needs of the NEA. The types of focal questions submitted indicated that users desired to learn more about mechanisms or relationships rather than just the alternative futures so the scenario products will be of benefit to this on-going learning process. The product from the user consultation, that is, the suite of questions and the subsequent analysis, will ultimately strengthen the appropriate construction of storylines in the NEA. However lessons learnt from the process are important in order to inform future work of a similar nature.

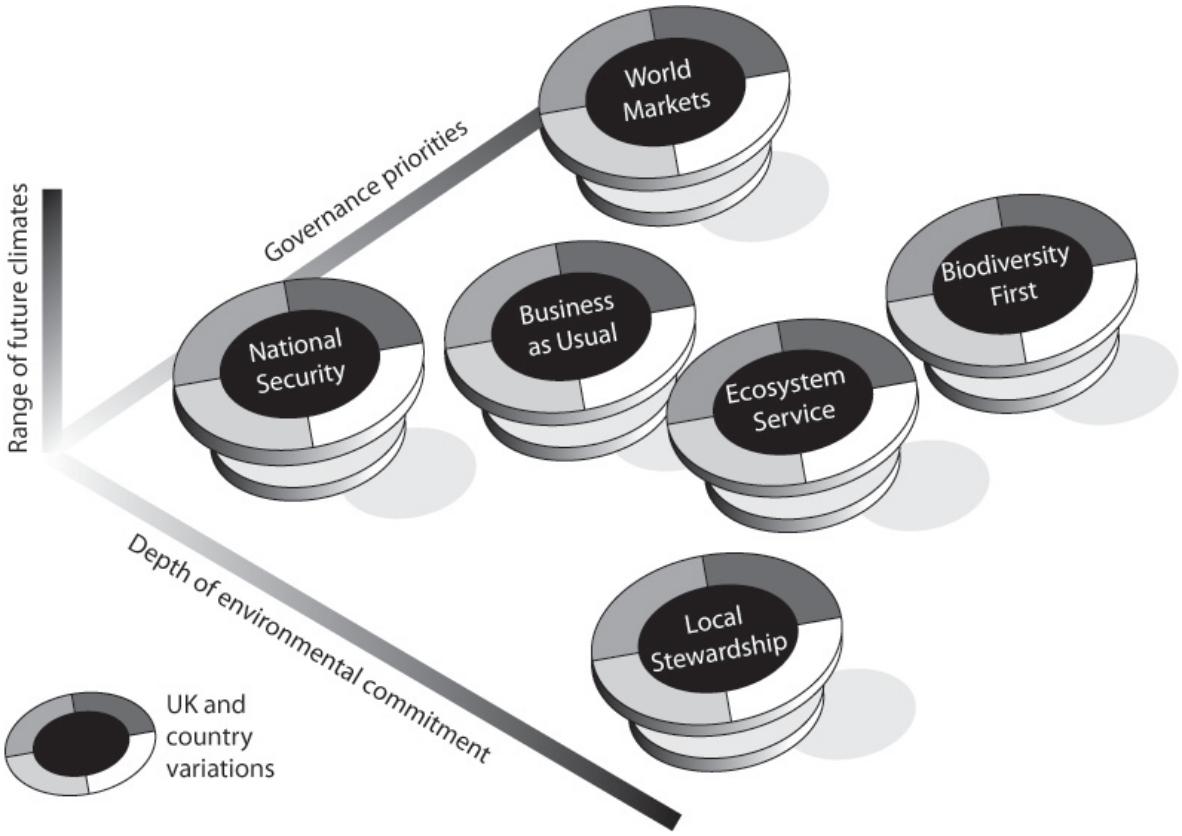

Figure 2: Scenario set implied by range of focal questions (adapted from Haines-Young et al., 2010)

A number of interpretations may be made of the issues and themes in the survey responses. What seems clear is that multiple axes should be considered in the scenarios that can address the key structures such as all UK/nation, risk/security, range of climate futures, and environmental commitment. Haines-Young et al. (2010) proposed that two principal axes could be environmental commitment (security and world markets versus 'green' priorities) and governance priorities (global engagement or self sufficient) (Fig. 2). Additionally contrasts in country responses will be written into the storylines after consultation with users from England, Scotland, Wales and Northern Island. 'Moderate' and 'extreme' climate futures will be addressed in the storylines with reference to other drivers of change. Given the range of concerns of the users and the adoption of multiple structural axes that conceptually position NEA scenarios, a flexible approach is being developed for the NEA scenarios. A 'morphological analysis' approach will construct a set of candidate scenarios based on direct and indirect drivers of change. This is appropriate to adapt storylines to meet the

requirements of users. This is supported by Bayesian Belief Network (BBN) analysis (Haines-Young et al., 2010) that attempts to make transparent the beliefs and assumptions about the mechanisms linking drivers of change that underpin scenario development. The BBN is also able to give a measure of risk and security through the probability of a particular scenario producing a given outcome under different drivers of change but again it must be remembered that scenarios are not predictions. Unforeseen risk, or wildcards such as a large scale pollution event, may also be modelled in this way. Using the BBN an indication of resilience to change due to different drivers and under different scenarios is plausible however the level of trade-offs will also have to be considered.

Scenario development is an iterative participatory process that should involve stakeholders in different capacities throughout scenario development. The collection and analysis of the suite of focal questions gathered from NEA scenario users were a useful mechanism to garner interest and involvement of users in the production of the scenarios. Presentation of the preliminary analysis of the survey results at the scenario steering group meeting in May 2010 received positive feedback of the focal question survey and the morphological approach being taken in writing the scenarios themselves. It was stressed by attendees at the meeting that both process and product were important.

After the focal questions had been analysed a large gap was identified in the lack of social science questions related to human well-being. The emphasis on ecosystem service science research is in danger of concentrating on responses of and between ecosystems because of the predominance of representatives from environmental governance institutions, the agricultural community and environmental scientists within the stakeholder group. The need for emphasis on human well-being was initially subsumed. These concerns are significantly more than cultural service issues. The question regarding who is most affected by different scenarios is part of the NEA remit and is not solely a spatially defined issue.

The learning process inherent within building scenarios was experienced by both the user group and the researchers as understanding of structure and requirements of the scenarios grew. The lessons learnt from the focal question survey included the methodological issue of how to frame focal questions, identification of gaps in the type of questions being gathered and how the focal questions linked into the scenarios themselves. Helping users frame questions in a suitable way – understanding what scenarios are and what they can do is important (Heinrichs et al., 2009; Jäger et al., 2008) so that future scenarios are appropriate to meet the needs of the user community.

5. Conclusions and Recommendations

Involving users in scenario building is as important for the process of learning about how scenarios are formed and used, as in the product of the storylines themselves. Learning about users' needs of scenarios helps developers create effective and plausible storylines by focusing on issues of concern. Thinking about the questions they want to ask and learning about the shaping of focal questions helps users understand what future scenarios can and cannot address and indicates how they may be used. Therefore it is recommended that users and scenario writers should consider how focal questions may be framed so that they are effective for scenario building and that users should be fully involved in steering scenario development not just to create the most useful storylines but to learn how they may be used most effectively.

Although the results of this survey indicated that the areas that were of most concern to users were the impacts of climate change, security of provisioning and regulating services, relationships and trade-offs between different services and the impact of different policy options under different scenarios there were also significant omissions such as understanding what are the impacts on human well-being and the social equity of such impacts. Concerns were primarily ecosystem focused. Therefore it is recommended that environmental scenario studies and assessments should become more interdisciplinary and include social scientists more fully within ecosystem scenario development as well as including a suite of questions regarding impacts on human well-being within future user needs surveys.

Finally themes of interest in NEA scenarios may be interpreted on more than two axes. Previous scenarios have shown great similarity between plausible futures developed along similar axes of concern (Haines-Young et al., 2010). However the user needs study has highlighted a much greater range of concerns that cannot be fully explored within these constraints. Therefore a flexible approach to scenario development, such as morphological approach together with the BBN as being developed for use with the NEA scenarios is appropriate to explore this wide range of interest and it is recommended that this is developed further.

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Appendices

Appendix 1

Example questions derived from Defra consultation materials on scope of NEA, November 2008

Cross cutting	Ecosystem or service specific	Policy focus
What is the role of biological diversity in the provision of ecosystem services, the resilience of ecosystems and in mitigation against anthropogenic impacts e.g. climate change? How should we respond to both the causes and effects of climate change? How do we achieve multiple benefits from different areas of land and environmental assets? What is the spatial coincidence of service needs and service delivery and where are the areas of service poverty? What is the significance of development impacts on ES?	What is the role of geological diversity and earth system processes in the provision of ecosystem services? How does geodiversity contribute to ecosystem services and what changes may occur (soil landscapes and geology)? What climate regulation service is provided by coastal and marine habitats? What potential exists to reduce flood risk away from the coast by changes to land management? How does land management influence the carbon storage and sequestration service (is carbon in soils stable or decreasing)? How are the services provided by upland freshwater systems being affected by acid rain and what are the effects of catchment afforestation? How do we reinvigorate our landscapes and enhance sense of place? How will climate change affect the features of high natural value in Natural Character Areas?	What are the different futures derived from slow simplification and increasing ubiquity of our landscape as a result of single policy approaches to land use and management (agricultural and forestry policy) versus ecosystem service delivery and multi-purpose land use which provides a way of bringing diversity back into the landscape? How does Environmental Stewardship in England contribute to ES delivery? What ES are provided by Lowland Grassland BAP habitats in the UK and Wales? What are the contributions of the coastal and marine SSSI network and Marine Conservation Zones to the provision of key ecosystem services? What is the impact of rising sea levels on the key ecosystem services provided by England's coastal natural environment e.g. flood and erosion risk management, carbon sequestration, fish nurseries, recreational opportunities? What is suite of ecosystem services provided by both healthy upland moorland and lowland riparian ecosystems? What financial mechanisms could equitably and effectively pay for delivery of such services?

Appendix 2

Attendance list and agenda for Scenarios Meeting with NEA Client Group, 22nd February 2010

Name	Affiliation	Name	Affiliation
Rosie Hails	Natural Capital Initiative	Sarah Honour	Defra
Mark Everard	Environment Agency	Fiona Lickorish	Defra
Peter Brotherton	Natural England	Peter Costigan	Defra
James Bullock	CEH	John Hopkins	Natural England
Chris Quine	Forest Research	Helen Baker	JNCC
Linda Davies	Imperial College	Dan Osborn	NERC
Steve Albon	Macaulay Institute	Roy Haines-Young	CEM
Russell Elliot	CCW	James Patterson	CEM
Stephen Malcolm	CEFAS	Kate Moore	CEM
Tony Whitbread	Sussex Wildlife Trust	Gabriella Silfwerbrand	CEM
Georgina Mace	Imperial College	Claire Brown	UNEP-WCMC
Giles Golshetti	Defra	Lucy Simpson	UNEP-WCMC
Robert Bradburne	Defra	Jonathan Winn	UNEP-WCMC

Time	Topic
1.00pm	Introduction *Roy Haines-Young*
1.10pm	The morphological approach to scenario construction *James Paterson*
1.20pm	Discussion Indentifying key links between drivers and ecosystem services
1.50pm	Identifying focal questions in framing scenario analysis *Kate Moore*
2.00pm	Break-out session
2.30pm	Feedback from Break-out sessions
3.00pm	Close

Appendix 3

Focal question received from on-line survey and NEA Client Group meeting 22nd February 2010

Topic	Provisioning	Regulating	Cultural
Cross-cutting issues across all services (Provisioning, Regulating and Cultural)	What will be the impact of increased renewable energy production on ecosystem services, eg impact of increased areas of bioenergy crops and increased deployment of marine environments for wind/wave/tidal power and algae farming? What are the possible roles of market-based instruments, such as habitat banking, in biodiversity protection and in the management of species adaptation to climate change? How will our view of the "countryside" from towns change in a changing climate? Landscape, Cultural How will different environmental drivers affect service delivery? What are the synergies and trade-offs between different services? What are the likely impacts on urban biodiversity that could occur as a result of climate change, and could the effects of multiple drivers for change result in cumulative impacts? What will be the impact of non native invasive species, including new pests and diseases? (There are the obvious problem species like Japenese knotweed but there are others that may be lying dormant or still in their population lag phase that may be able to benefit from climate change. Phytophthora is of particular concern and could have widespread impacts as it spreads geographically and taxonomically). How will the management of habitat composition within an area, to maximise service production, be achieved? i.e. balancing extent of habitat according to service provision Impact of changes in habitat extent - how will the proposed expansion of woodland/forest cover in the UK impact of the provision of key ecosystem services ? How do synergies and trade-offs between services vary according to scale/management unit? Climate change scenario - what would be the impact of a specific set of UK climate change predictions (many options to consider) by a specific year (2050?) on the continued delivery of provisioning and regulating services across a range of UK broad ecosystems? Will people be more dependent on ecosystem services and will they be aware of this. What percentage of GBP will be made up by Ecosystem Services Economic Will the coastal defence ability of Coastal Margin habitats be an increasing or a decreasing component of coastal flood defence (for Urban, SNG, Farmland etc.) under predicted rates of sea-level rise? How do we achieve a sustainable reduction in the human population with its concommitent demand for natural resouces nationally and internationally?		

	How do we deal with the waste human population generates, in an uncertain future of global environmental change? How do we ensure the natural environment is allowed to regenerate itself unhindered by destructive forces from the human population ? What are the services we should be getting from elsewhere? Do we make policy that relies on and uses ecosystems or relies on technology and protects the 'best bits' of ecosystems? What happens if you implement all the sustainable management option chapters in the NEA? Will reversal of habitat fragmentation (e.g. through networks) affect services? What will be the consequences of focusing on enhancing only those ecosystem services that we can value economically? How will land use conflict impact on ecosystem services? How do we ensure the natural environment is allowed to regenerate itself unhindered by destructive forces from the human population ? How do we achieve a sustainable reduction in the human population with its concommitent demand for natural resouces nationally and internationally? How do we deal with the waste human population generates, in an uncertain future of global environmental change?		
Issues cross-cutting habitats	How can we change consumer behaviour to recognise the new 'reality' of agriculture in a changing climate and global food shortage situation? How best can we integrate the issues of climate change (adaptation and mitigation), energy security and price and global economic drivers to deliver a viable UK agriculture industry fit for the future? How will food production impact on other services? Will issues of food security and reducing carbon footprint of food prioritise food production above other services? Will impacts be limited to restricted geographical areas and other services prioritised elsewhere? or will a balance between services be attempted generically? Given the predicted challenges of climate change and an increasing population	How can we integrate climate adaptation strategies, energy needs and waste management together with maintenance of quality habitats to ensure continuity of ecosystem regulation? How can we create multi-functional landscapes to promote regulating services alongside provisioning and cultural? Are regulating services considered to be as important as provisioning and cultural to a general audience? If not how can their importance best be communicated? Green Belt provides a wide range of regulating, provisioning and cultural services that contribute to the quality of life in urban areas. Can ecosystem assessment help to inform decisions on future Green Belt use and designations?	How best can we encourage people to value natural ecosystems and landscape when their priorities are on short term crises? What is the role and significance of different habitats (and combination of habitats) in contributing to cultural services? Is there a conflict between public perception of culturally valuable habitats and landscapes and those habitats required for other services such as biodiversity and carbon storage? What is the underlying philosophy driving the ecosystem policy makers? Is it that we are one with the environment or is it an antidiluvian concept of domination and exploitation? What is the impact of public attitude change to environmental issues? Does leisure time increase or decrease? Is it

	creating possible food shortages, the UK appears to be well positioned to play a key role in meeting, not just UK food needs, but also global food demands. What can be done to use land to meet these demands - to produce more but at the same time to have less of an impact on the environment? How do we manage the need for resilient habitats for climate change - should we have thresholds beyond which the objective of conservation of existing ecosystems change to an objective of redefining future ecosystem provision from an area? How do we trade off the impacts on ecosystems overseas against domestic impacts when trying to secure national food, fibre (timber) and bioenergy supplies? What is the relationship between biodiversity and ecosystem services? Does food security prevent change of land use from agriculture? Does global trade in commodities (e.g. food and timber) remain the same, increase or decrease? How will we prioritise energy verses food security from land? What would 70% food security mean for UKs ecosystems? How will global food prices impact on ecosystem services? How should we be producing food without	How would relaxation of green belt regulation and increased urbanisation in these areas affect the ecosystem service provision (of all types) in farmland and grassland - what are the tradeoffs? How will biomass demands in semi-natural habitats, including inshore waters ,impact on biodiversity and other ecosystem services? What will be the consequences of recasting biodiversity targets in terms of ecosystem services? How may new policies such as habitat banking enhance ecosystem services? What would a shift towards managing BAP habitats and SSSIs for complexity and heterogeneity deliver in terms of ecosystem services? Do future climates emerge in line with expectations (projections)? What habitat has most potential to sequester carbon? How will future scenarios impact on the integrity of the ozone layer / protection it brings? How do ecosystems modify atmospheric concentrations of air pollution in the future? What would 'fixing' diffuse pollution deliver for ecosystem services? ESWNI - How do different amounts of habitat per nation affect what is important? (e.g. Wales has little arable)	spent inside or outside? How do people react to a changing landscape? How does its value change? What are the ecosystem service implications of a continuing growth in leisure use of the countryside? How does one 'account' for cultural services in future scenarios (e.g. is forest increase at the expense of grassland good)?

	destroying ecosystems? What impact will new crops have on UK's ecosystems? What will be the impact of low carbon agriculture? What is the impact of another foot and mouth outbreak? What would a shift to naturalistic grazing/ re-wildling deliver? What impact will loss of single farm payments have on ecosystem services? How will new energy technology affect society (e.g. wind, solar, wave)? How will future UK energy policy impact on ecosystems? How would large scale release of CBRN materials impact on ecosystems? What will the impact of continuing atmospheric N pollution (including methane) be on ecosystem services?		
Mountains, moors, heaths	How do we manage the need for resilient habitats for climate change - should we have thresholds beyond which the objective of conservation of existing ecosystems change to an objective of redefining future ecosystem provision from an area? WALES –How do CAP and Glastir agri-environmental scheme affect upland ecology and services?	Are carbon stock in soil in these habitats increasing, decreasing or remaining stable? Are there land-use trends that are likely to change the current situation with regard to soil carbon stock? What are the net GHG fluxes for these habitats and how can they be optimised?	WALES –For cultural services and recreation what are the renewable energy and 'landscape' tradeoffs?

Semi-natural grasslands	Are semi-natural grasslands becoming more or less productive in terms of meat and milk production per unit of GHG emissions (CO2 equivalence)? What are the reasons for any increase or decrease in production efficiency where production per unit of GHG emissions is used as the measure of efficiency? trends How can other services e.g. wild species diversity, carbon storage be enhanced whilst maintaining appropriate levels of production? Does enhancement require loss of production? Trade-offs How can providing provisioning services help maintain/ improve quality/quantity of semi-natural grassland? Trade-offs	What trends in management practices for semi-natural grasslands are evident if any and what are the primary drivers for these trends? What are the implications of any trends observed for emissions of GHG from grassland and the efficiency of milk and meat production? How do changes in stocking levels impact on regulating services? What are the optimum grazing levels for sheep and cattle for maintaining habitats, yet minimising GHG emissions? How do you overcome the tacit view that 'improved grassland' improves all services? How will continuing loss of species from grasslands (and other habitats) affect other services? Driver	
Enclosed farmland	Is enclosed farm land more or less productive in terms of energy produced in edible output per unit of GHG emission? What are the primary causes of any trends in efficiency of production observed and how are these likely to change over the coming decades? Can long term sustainability be incorporated into valuation of yield? i.e. accounting for regulating and supporting services as well as short term provisioning. What are the implications of climate change, increasing water stress and a growing population on the productivity of farmland? How can we balance domestic food supply versus imports? Should we seek to limit	How is efficient natural nutrient cycling in the soil likely to be affected by temperature increase (1-2 degrees) from climate change? Are GHG emissions from enclosed farmland increasing or decreasing per unit of edible output (in joules) and what is the basis for any trends observed. What will the consequences for GHG emissions be if significantly more land than is currently the case is used for food production as compared to increasing production efficiency? Some options within the agri-environment stewardship schemes are targeted at benefiting ecosystem services, for	What is the impact of increased tree planting on regulating and cultural services?

	domestic production to protect UK ecosystems and rely increasingly on imported food as population grows (and with it food demand) or should we maximise domestic production to protect overseas ecosystems? How will most food be grown after climate change? Does technological change continue to increase farming yields and therefore competition for land? How could CAP reform help delivery of services other than 'provisioning' from farmland?	example in terms of soil quality, water quality, boosting pollinators and natural enemies. Under what (economic or otherwise) conditions is the policy of paying farmers for agri-environment schemes likely to change, or alternatively can it be predicted under what conditions farmers would stop taking the schemes up? And if they were no longer paid for or taken up, will this have a real and calculable effect on regulatory service provision? Payment for water yields and flood regulation in land management?	
Woodland		Taking account of carbon fixation and nitrous oxide emissions, is the overall contribution of UK woodland to GHG emissions in terms of CO2 equivalents positive, negative or neutral - and over what time scales? If positive, what is the annual amount of above and below ground carbon sequestered in UK woodland? In converting semi-natural grassland to woodland, what are the net GHG emissions, and to what extent will they be affected by climate change? Does a market for carbon (or biofuels) develop to shape many land related decisions? How do forests and woodland affect water regulation in catchments? ENGLAND – Does forest cover expand as per policy aspirations?	What kind of woodland do people prefer and value culturally? i.e. dense or well-spaced, coniferous or broadleaved, species-rich or species-poor? Seeing the trees for the wood? What is the impact of increased tree planting on regulating and cultural services?

		SCOTLAND – Does forest cover expand as per policy aspirations?	
Rivers, lakes, and lowland wetlands	What are the implications of climate change and a growing population on the availability of water for agriculture? Given the pressure for more food and more trees, how will future trends in farming practice and land management impact on water resources and flood control? WALES –How should English users pay for the ecosystem service of water production from Wales? Is water abstraction from lowland rivers and wetlands likely to increase and what will be the impact on other services?	When will water quality or quantity become a limiting factor on development in the South East of England? Will the water framework directive help the regulating services in wetland systems?	Helping the public value what lies below water level.
Urban	Urban provisioning services appeared to peak in the 1940s. What are the viable options for increasing urban productivity? Where are the synergies with other ecosystem services and the trade-offs? Could investment in crop production through increased efforts in domestic gardens, allotments, containers on hard surfaces, green roofs etc make a significant difference to all ecosystem service delivery? Ecological connectivity – green or grey infrastructure opportunities?	Are housing densities likely to continue to increase across cities, and what will be the impact on regulating services? Tree planting is cited as a viable option for reducing temperatures and improving air quality. How viable is this option given the cost of planting and maintaining trees. How much would the added benefits to soil regulation, biodiversity and cultural services offset management costs? The extent of impermeable surfaces in urban areas is increasing severely compromising regulating services. How viable are the options for increasing areas of exposed soil and the use of permeable materials in urban centres and what additional benefits How can impermeable surfaces be reduced to	How will our view of the "countryside" from towns change in a changing climate? Given the increasing cultural multiplicity of our towns and cities, how relevant will be the traditional native ecologies of the UK in the future? If future growth is restricted to existing urban areas, is development on green spaces with low recreational value likely to increase, and what will be the impacts on other cultural services, and regulating services? Which would people living in urban areas value more; local environmental services e.g. habitats for recreation which may be of poor quality or services which they have to travel to but may be more numerous and varied?

		improve services and benefits? How will loss of green infrastructure due to increasing housing density in urban centers impact on regulating and cultural services? Arrest and reverse extent of impermeable surfaces – effects on hazard regulation and water quality	How will we value urban green spaces and trees? How much do urban residents know and understand about the 'regulating' ecosystem services they receive from local and more distant nature: eg trees/waterbodies effect as 'natural air conditioning'; where their domestic water comes from, effects of abstraction on landscape, where waste water goes to. How does awareness and appreciation of nature correlate with accessibility of opportunities for contact with nature? How does liveable quality of localities (satisfaction with where you live) correlate with both?
Marine, coastal, estuarine	How will changes in terrestrial ecosystems impact on marine/coastal ecosystems delivery eg shell fisheries Marine renewables and impacts Under different scenarios what balance will be achieved between the different drivers of change in marine ecosystem services: energy from marine renewables, requirement for food from fish and aquaculture, sustainability of food production, conservation of biodiversity, recreation and leisure, shipping etc.? Will fishing and aquaculture be driven by demand for food regardless of sustainability, or by achievement of high value and sustainably resourced food? How much importance will be placed on	What effect will the establishment of a marine conservation zone have? How will sea-level rise alter the current coastal defense function provided by coastal margin habitats? To address ocean acidification and climate change impacts on marine ecosystem services what scenarios of CO2 emissions will we be working to? (i.e. what sea temperatures and ocean pH levels, also affects wave regimes for renewable energy) How will coastal cities develop – will they continue to grow? What implications does this have for hard defence vs soft defence for flood security (this changes biodiversity in the intertidal and shallow	Property rights: Will we develop a need for property rights to allocate space (sea bed, water surface) and biological resource to the increasing number of different users in the marine environment with increasingly conflicting requirements? (e.g. fishing is not compatible with renewable energy devices or conservation zones; socially and economically high value recreational fishing vs commercial fisheries; leisure and recreation e.g. yachting and boating vs marine renewable developments with exclusion zones and no activity conservation zones; areas around renewable energy devices might act as conservation areas, or aquaculture locations)

	maintaining the fishing community culture? (Will there be a requirement to maintain a socially coherent fishing community, or controlled by real economics, without subsidy, or by the need to provide food?) How much emphasis will be placed on sourcing energy from marine renewables? which types of renewable devices will be implemented (wind, wave, tidal barrage, tidal stream) and in which proportions? Will sub seabed carbon capture and storage be implemented? (Renewable energy platforms restrict fishing and also provide stepping stones for invasive species) Will marine protected areas be implemented for restoration of fisheries and will they make any difference?	subtidal area from often sloping and sometimes sedimentary shores to hard and vertical shores with manmade materials)? Will there be further coastal reclamation for ports and land development? Will there be access for commercial vessels such as fishing boats, vessels to service renewable energy developments, oil and gas, aggregate extraction, pipe and cable laying or will the foreshore be given over to accommodation and retail businesses and leisure marinas? Can we assume there will be continuing reduction of most sources of pollutants? Will agricultural run-off of excess nutrients be reduced? (causes localised estuarine and coastal eutrophication.) Will we find that the increasing use and waste emission of nano-particles pharmaceuticals and personal care products have a negative impact on ecosystem services and if it does will we take any (potentially expensive) action to mitigate? Will we be prepared to continue impose increasingly expensive and more efficient ballast water treatment on commercial transport ships? Will shipping continue to increase as a transport mechanism? (danger of maritime accidents and pollution)	What are the scenarios of sea-level rise? What regimes of managed retreat? What storminess and frequency of extreme flooding events? Will there be an increased emphasis on use of the sea for recreation and leisure? How much concern will we have on the human safety of marine derived food, recreation and leisure? (harmful algal blooms, shellfish poisoning, recreational use of water.) Will the marine environment become increasingly important in human health (aka the 'blue gym' to encourage people to exercise and take leisure in the marine environment in a similar way (I think) to 'greenspace') Will the implementation of marine conservation zones successfully conserve and restore marine biodiversity and ecosystem services?

Appendix 4

Attendance list and agenda for Meeting with Scenario Group, 26th May 2010

Name	Affiliation	Name	Affiliation
Albon, Steve (tbc)	NEA co-chair	Moore, Kate	CEM, University of Nottingham
Berry, Pam ECI,	Oxford University	Monk, Kathryn,	Environment Agency Wales
Brown, Claire	UNEP-WCMC	Osborn, Dan	NERC
Golshetti, Giles	Defra, ERG-NESU	Paterson, James	CEM, University of Nottingham
Haines-Young, Roy	CEM,University of Nottingham	Potschin, Marion	CEM, University of Nottingham
Hardiman, Alice	RSPB	Quine, Chris	Forest Research, Centre for Human and Ecological Sciences
Harris, Dai	Welsh Assembly Government	Paul Rose	JNCC
Heathwaite, Louise	Centre for Sustainable Water Management, Lancaster Environment Centre	Russell, Nick	DBIS, Government Office for Science, Foresight Follow-up to Land Use Futures
Kass, Gary	Natural England, Strategy and Environmental Futures	Simpson, Lucy	UNEP-WCMC
Lickorish, Fiona	Defra Evidence Programme, Horizon Scanning & Futures	Silfwerbrand, Gabriella	CEM, University of Nottingham
Malcolm, Stephen	Cefas	Wilson, Alister	Waverley Management Consultants

Time slot	Topic
9.30-10.00	Registration and Coffee
10.00-10.20	Introduction: Update on Scenario Work and Aims for the day *Roy Haines-Young*
10.20-10.35	The review of existing scenario studies *James Paterson*
10.35-10.50	Results of the survey and user needs *Kate Moore*
10.50-11.30	Discussion of focal questions and how to approach them
11.30-12.45	Identification of candidate NEA scenarios using the morphological approach
12.45-13.45	Lunch
13.45-14.30	Linking scenarios to the work of the NEA Science and Economics Teams *Roy Haines-Young*
14.30-15.15	Discussion of scenario methodologies in relation to science and valuation issues
15.15-16.30	Recommendations for NEA scenarios and identification of next steps in work programme
16.30	Close

CEM working papers

CEM working papers can be downloaded under:
http://www.nottingham.ac.uk/CEM/WorkingPapers.htm

No	Title
1	The Development of Scenarios for the UK National Ecosystem Assessment. Interim Report, May 2010.
2	The utility of existing scenario frameworks for the National Ecosystem Assessment. Interim Report, May 2010.
3	Functional relationships of ecosystem services outputs and drivers of change in the Scenarios for the UK NEA. May 2010.
4	Assessing User Needs of the UK NEA Scenarios through Focal Questions.
5	Scenario narratives for the National Ecosystem Assessment. Interim Report. June 2010.
6	Scenarios for the UK NEA (a sub-global MA): A transparent and flexible methodology. Poster Presentation at Salzau/Germany, June 2010.