LWEC Pilot Review

Catchment planning and the Ecosystems Approach

Progress towards application

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Executive Summary

Approaches to environmental decision making at the catchment scale are an important focal point for discussions of holistic and integrated responses to environmental change, and are considered by Defra as broadly consistent with the needs of an Ecosystems Approach (EsA).

Though synergies between these two domains of natural resource management are alluded to in the policy literature, there is a need to substantiate, in a systematic and critical way, *in what ways* and *to what extent* catchment based approaches to environmental decision making can be seen to embed the principles of an EsA.

Taking the key principles of Defra's *Ecosystem Action Plan* as its analytical starting point the pilot study develops a framework in which catchment scale approaches to environmental decision making could be assessed according to the needs of an EsA. In particular, drawing on a process of expert review, this report describes an iterative process in which the principles of the action plan were translated into two viable areas of review questioning, namely:

- *Is catchment scale decision making effective in managing ecosystems for their cross-sectoral benefits?;*
- *What decision making techniques are effective for the valuation of ecosystem services at the catchment scale?*

The review goes on to describe a search process in which the evidence underpinning both these questions was identified using the *Web of Science* (WoS) search engine. By experimenting with different combinations and structures of key words and phrases it presents two overall search strings that could be used to interrogate these questions based on a manageable literature.

As the preliminary step in a wider review process, the report goes on to make an assessment of the volume and quality of materials identified in the literature. This assessment describes some of the key thematic concerns of this evidence and suggests that the quality of assessable material is generally strong.

Initial results suggest any subsequent review is likely to reveal significant bodies of evidence that, proceeding from issues of water quality and quantity, demonstrate *how* decision making at the catchment scale might foster multiple – cross sectoral – benefits particularly through the use of novel decision support and appraisal tools.

Equally, full systematic review of approaches to valuation is likely to yield a significant body of evidence evaluating how participatory and deliberative processes can be embedded into good practice at the catchment scale, often working in combination with these decision support technologies. However, based on the published record, the case for evaluating economic valuation techniques is notably much weaker. This volume of relevant literature is very modest and its scope uneven.

It is suggested that patterns and themes of research are likely to focus more directly on material outcomes when the grey literature is incorporated in to the search process. However, this literature may not be accessible in ways envisaged by the protocols of systematic review. Nonetheless, the overall conclusion is that a body of evidence exists that can begin to amplify the relationship between catchment scale decision making and the EsA in meaningful and pragmatic ways. Two draft protocols that can take this work forward are described.

1. Introduction

Devising 'scale-appropriate' approaches to environmental decision-making has been a longstanding, and largely vexed, concern of policy makers, planners and environmental scientists. 'Effective' geographical scales of environmental management vary greatly according to the scientific problem in hand, and rarely coincide with the territorial jurisdictions that underpin and drive change at the level of policy delivery. And yet, out of this political and scientific 'messiness' agendas for action, often based on spatially explicit frameworks of action, do emerge. The concern under investigation in this pilot review - that of '*catchment scale planning'* - is one example of this process. Indeed, in the idea of 'catchments', 'watersheds' and 'river basins', a scale of environmental decision making is emerging as an important focal point for discussions of holistic and integrated responses to environmental change (Keirle *et al.*, 2007; Blackstock, 2009). In the UK the political momentum for this development is undoubtedly driven by the looming mandates of the Water Framework Directive (WFD) where the idea of **'**integrated river basin management' provides the practical and conceptual starting point for creating sustainable land and water systems. The England Catchment Sensitive Farming Delivery Initiative (ECSFDI), for instance, which is concerned to mitigate the problem diffuse pollution from agriculture given the regulatory implications of the WFD[1], is one example of the way catchment based thinking is being embedded in to decision making. No less significantly, policy developments in the arena of flood management, most notably those emerging in the context of the Government's "Making Space for Water" initiative, make clear the case for whole catchment planning to enhance preparedness[2].

The purpose of this pilot review is to provide a basis for reflecting empirically on these developments given the concerns of LWEC objective B, that is, *to manage ecosystems for human well being and protect the natural environment as the environment changes*. In the context of fostering wider cross-sectoral approaches to environmental decision making across government it is

[1] www.defra.gov.uk/FARM/environment/water/csf/delivery-initiative.htm
[2] www.defra.gov.uk/Environ/Fcd/policy/strategy.htm

notable here that the recent publication of Defra's (2007a) *Ecosystems Action Plan* suggests that catchment based approaches to natural resource management are "broadly consistent" (p.14) with what they term an 'Ecosystems Approach' (EsA)[3], and cite the WFD and ECSFI as demonstrating how such an approach might take shape and assert influence according to the wider needs of sustainable development. In essence, this is an approach that seeks to develop a more strategic and integrated framework for environmental decision-making and delivery; one concerned with fostering across Government a concern for:

> *"[M]aintaining healthy ecosystems and ecosystem services through the development of inclusive, cross-sectoral policy and decision-making at appropriate spatial and temporal scales, where environmental limits are respected, and proper account is taken of the value of environmental systems for the well-being of people."*[4]

Taking this policy aspiration as our analytical starting point the purpose of this pilot review is therefore to consider the empirical basis for assessing *how and to what extent applications of 'catchment based approaches to environmental decision making are consistent with the principles of an Ecosystems Approach'*. In particular, following the guidelines for systematic review provided by the Centre for Evidence Based Conservation (CEBC) at the University of Wales (Bangor) (CEBC, 2009), it seeks to establish how this issue might be considered as a set of questions that can be examined in ways that meet the conditions of full systematic review[5] given a critical appraisal of existing evidence – its quality, coverage and relevance. It does so this by:

1. *providing a expert-led assessment of the ways in which the theory and application of catchment based approaches to resource management in the UK can be described and evaluated in different ways given the stated principles and objectives of an EsA;*

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3 According to Potschin *et al.* (2008) the literature contains a number of variations in terminology designed to emphasise different aspects of the idea. Reference is often made to an 'ecosystem-based approach', a term used mainly to promote holistic thinking in the design of specific management strategies for natural resource systems. More commonly the term 'Ecosystem Approach' is employed. The latter originates from the Convention on Biological Diversity (CBD) and emphasises the higher-level or more strategic issues surrounding decision making. In a recent publication Defra (2007a), refer to an 'Ecosystems Approach', using the plural to emphasise that no prescriptive methodology is implied. In this report we employ the terminology used by Defra – but see no substantive difference in the way the two ideas are conceptualised. In this report we also avoid abbreviating the term 'Ecosystems Approach' as 'EA' because it can be confused with the abbreviation for the Environment Agency; the IUCN CEM suggests using EsA as an alternative (written communication, 2007).

4 www.defra.gov.uk/wildlife-countryside/natural-environ/

5 For background and Guidance see: http://www.environmentalevidence.org/index.htm

2. *identifying the types of natural, social-scientific and policy evidence readily available through desk top review for describing and evaluating the efficacy of catchment based approaches given the assessment developed in 1; and*
3. *drawing initial conclusions about the empirical basis for critically examining the relationship between catchment based approaches and the needs of an EsA, providing draft protocols for full systematic review where appropriate evidence exists and identifying where opportunities for future primary research may lie.*

These objectives provide the structure around which the main body of this scoping report are organised. The report begins by outlining the main characteristics of the pilot review methodology given and goes on to describe an iterative - expert-informed - process in which the thematic concerns of the study are translated into a series of questions which meet, in principle, the conditions of full systematic review. As a result of this, the report describes how search strategies were devised to make an initial assessment of the existing evidence pertaining to the relationship between catchment decision making and an EsA, and trials an appraisal of study quality and data extraction. A case is then made for devising draft protocols for full systematic review of two areas of study alongside a more general assessment of the systematic review approach for exploring policy issues of this type and complexity.

2. Approach

In order to meet the pilot review's three key objectives the lead project team for this report have combined desk top study with a process of expert consultation. The desk top study followed the generic protocols developed for evidence based review by the CEBC and, with the Centre's assistance, was implemented according to the specific needs of the LWEC review process. The wider expert consultation that informed this process comprised those with policy and practice interest in the catchment planning process and/or an EsA. This panel was convened twice in the process to help shape reviewable questions and the consequent search strategy employed. It also commented and reviewed this final report, validating its key conclusions and informing the final design of the draft protocols.

The general framework employed for this pilot study is depicted in Figure 1 overleaf. The thematic starting point of the review process was the overall definition of the approach devised by Defra outlined in Section 1, which is effectively a composite version of a more complex set of principles laid down by the *Convention on Biological Diversity*[6].

The first step in the pilot review process encompassed a process of expert panel review in which the principles of an EsA were translated into different areas of potential questioning; ones conforming to the needs of systematic review. The outcome of this process, which is described in the subsequent section, resulted in the creation of two approaches to potential questioning, each representing a key topic area given Defra's policy aspirations, namely: *fostering cross-sectoral benefits from ecosystems* and *developing approaches for the full valuation of ecosystem services*. The second step involved the core project team devising and implementing a scoping search of general literature on catchment management and an EsA for the two areas of questioning. This approach was designed to test the effectiveness of search terms and their different combinations for eliciting literature on the broad topic areas and around which the viability of the two questioning approaches could then be ascertained. Results from this scoping process are documented in *Section 4*. The subsequent step in the review process involved the creation of a set of inclusion/exclusion criteria from which the volume of relevant literature pertaining to the two questions could be assessed,

[6] www.cbd.int/ecosystem/

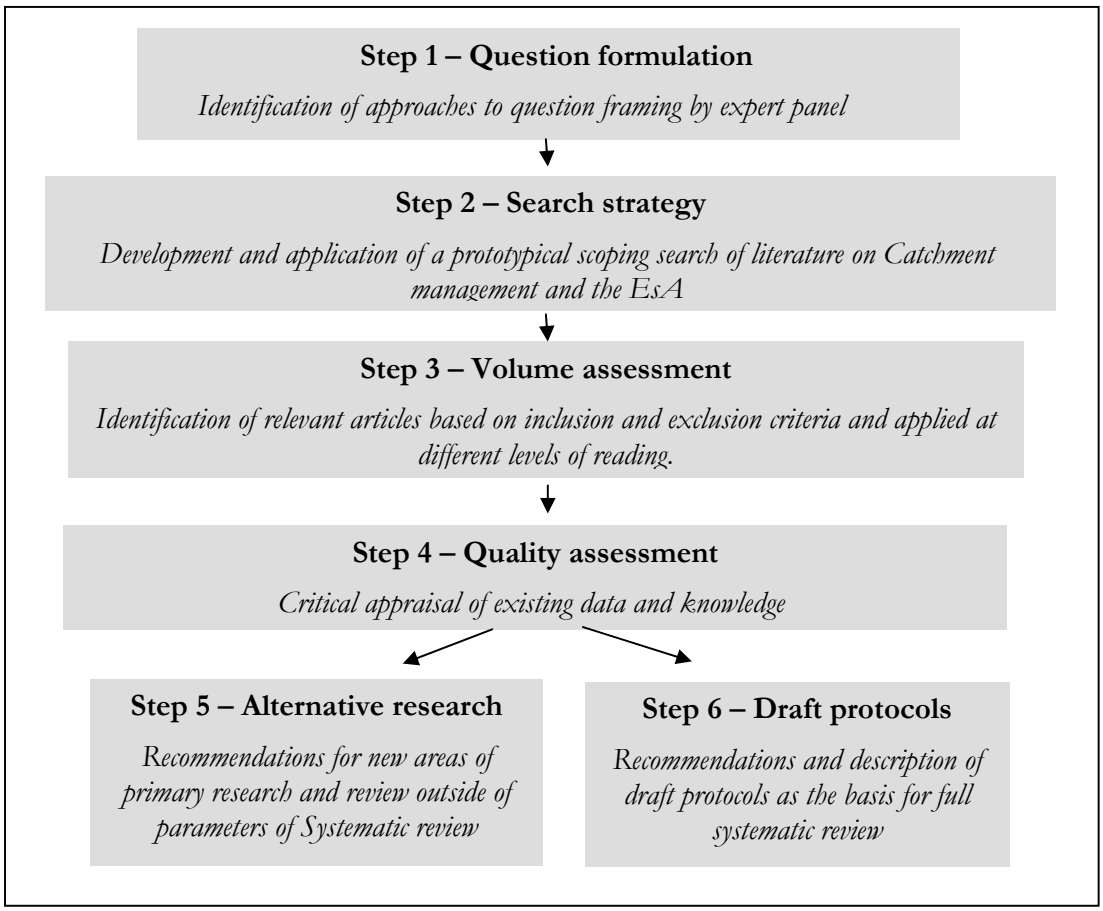

Figure 1: Approach to Pilot Review – Key Steps

the results of which are described in *Section 5*. As a consequence of this an appraisal of a sub-sample of download materials and an assessment of their quality was conducted (*Section 5*). As a result, two draft protocols were developed which the project team advocates for full systematic review alongside a wider evaluation of the systematic review process (*Section 7*).

3. Developing reviewable questions

According to the CEBC (2009) guidance literature a reviewable question should contain three key characteristics:

Subject:	*unit of study (e.g., ecosystem, habitat, species) that should be defined in terms of the subject(s) to which the intervention will be applied*
Intervention:	*proposed management regime, policy, or action*
Outcome:	*all relevant objectives of the proposed management intervention that can be reliably measured.*

…and involve a permutation of…

'Does intervention x on subject y produce outcome z'?

Or

'What is the effect of intervention X on the 'measure' of 'subject' Y?

This general framework guided the design of review questions in this pilot process. An expert panel was convened twice to assist the project team in identifying and evaluating subject areas for review, developing an framework for linking these to the process of question formulation and advising on the nature of the subsequent search strategy.

3.1 Identifying subject areas

As the CEBC guidance literature (CEBC, 2009) suggests, while the formal task of systematic review is to examine evidence for the effect of an intervention within a precise, and tightly defined, subject area, the process relies on making wider *a priori* judgments about what constitutes an interesting or worthwhile question. In many cases these judgments reflect wider organisational and political priorities and in accepting Defra's (2007) Action Plan as our starting point, this review process is no different.

Defra's overall policy vision is interesting for our purposes for in seeking to understand '*whether and how catchment based policy processes are consistent with the principle of an Ecosystems Approach*' potentially

varied avenues of inquiry are open to this study. Indeed, the expert panel in our review process shared the view that, as conceived by Defra, the principles of an EsA offered a range of quite different topical concerns around which pilot review could be pursued, and advised that the task of the project team was to disentangle what these precise subject areas were. As one panel member suggested:

> *"By identifying the different types of subjects or topic areas in Defra's Action plan you will be able to define quite different sorts of question. So in one you might want to look at ecosystem functioning, another might be around the supply of ecosystem services or valuation".*
>
> *[Panel Member A]*

Alongside this general recommendation the expert panel also critically examined the objectives of Defra's action plan and raised some concern that its overriding concern with '*maintaining* healthy ecosystems and ecosystem services' potentially missed a wider dimension of relevant activities based on 'restoration' and 'enhancement'. One panel member suggested that an important underlying question for the review process might be "*What is the evidence for catchment planning as an effective mechanism for delivering ecosystem services?*", but added:

> *"The word 'maintenance' is crucial in this [Defra definition] and I wonder if it is limiting in a way. A lot of ecosystem based management is about restoration. If we simply focused the review on maintenance are we going to miss literature and evidence which is more about restoring significantly degraded sites?"*
>
> *[Panel Member B]*

There was broad agreement for this view. The idea of 'maintenance' was considered unnecessarily restrictive and it was suggested that any given review should incorporate more dynamic environmental praxis as an aspiration of the EsA, regardless of whether this was stated interest of Defra itself. The project team accepted that this broader interpretation of environmental outcomes should therefore be an underlying concern of any subsequent protocol, and as a first step in the process of question formulation, proceeded to disaggregate the substantive elements of Defra's policy mission into five corresponding objectives, namely:

1. *to foster cross-sectoral approaches to policy and decision making;*

2. *to develop inclusive approaches to policy and decision making:*
3. *to respect environmental limits in the context of ecosystem functioning;*
4. *to take decisions at the appropriate spatial and temporal scale; and*
5. *to incorporate the full value of ecosystem services into policy and decision-making.*

Of the five objectives, it is objective 4 - *taking decisions at appropriate scales* – that is an overriding issue of interest for this pilot review, given its concern with a particular scale of decision making (i.e. catchments). However, the view of the project team was that it is the remaining four objectives that provide the starting point for evaluating this scale of decision making given the needs of an EsA. That is to say, through systematic review we would be able to come to judgments about the 'appropriateness of catchment scale decision making' if evidence could be marshalled for:

- *fostering cross-sectorality;*
- *respecting environmental limits;*
- *developing inclusiveness; and,*
- *incorporating valuation.*

3.2 *Evaluating potential topics for review*

The consensus among both the project team and expert panel was that the **issue of cross-sectorality should be the primary concern of this review process**. In particular, the view was taken that, while catchment based management processes were first and foremost about managing issues of water quality and quantity, in the context of an EsA there was a need to understand the extent to which catchment practices fostered multiple benefits within catchment systems. This point was emphasised twice by *Panel Member C*:

- *"Presumably all catchment based research is going to be about some aspect of water. If it was going to be delivering an Ecosystem Approach it should be cross-sectoral, so you want to be finding all the papers where water has been the focused but other things have been delivered. Now whether people called them ecosystems services is really an historical accident. The question is 'has catchment based planning led to in integrated land use planning that has implications for other things?', such as water*

abstraction setting limits on development. So focusing on that. The water aspect almost comes by default. It's the added value. The holistic aspect".

- *"The essence of the question is whether, by going down the route of an Ecosystems Approach, you capture the cross-sectoral benefits. It's about the nature of interactions between services within particular catchments. So it might be that you find examples where forest cover is managed which obviously has outcomes in terms of water quantity and quality but in terms of the services that a piece of catchment land offers it also might maximise biodiversity outcomes or recreational outcomes and so on. So it's to do with the interactions: Does catchment planning look beyond managing the hydrological issues? Does it look for the linkages? So we would look for studies to see whether they factored in these additional dimensions other than, say, the water quality benefits".*

The need to respect environmental limits (in the context of ecosystem functioning) was considered an integral element of a review that assessed evidence for these cross-sectoral benefits and as such could be considered a secondary question within any subsequent draft protocol. Overlaps between the remaining objectives – the process of developing inclusive processes of decision making and incorporating techniques that led to the full valuation of ecosystem services – were also recognised. Indeed, according to Defra's current interpretation of valuation, approaches to non-economic valuation are equated with deliberative and participatory methods, ones that stand alongside economic techniques underpinning the cost and benefits of environmental decision making for ecosystem services (Defra 2007b). The development of inclusive approaches was also highlighted as an area where good practice may be examined in the context catchment based studies, and one where the expectation of evidence base was considered potentially high. The project team concluded that the second key avenue of inquiry should therefore be based around the organising theme of 'valuation', and that, alongside the issues of economic valuation, this should encompass the issue of participatory processes within it.

3.3 Linking topics to the policy process

Accepting these as topics as potential starting points the expert panel further suggested there was a need for the review process to be clear about which aspects of the policy 'cycle' or 'delivery chain' it was focusing upon. As one suggested:

> *"There is a difference between catchment scale planning and catchment based approaches. You have a process, be it catchment scale planning or river basin planning, but you also have the mechanisms or the approaches such as river basin management plan or actions; catchment flood management plans with associated programmes of measures and actions. So what is it best to look at it? The policy or the effectiveness of the mechanisms?"*
>
> *[Panel member D]*

Thus, it was argued that, as a basis for review distinctions need to be drawn between:

1. *Interventions at the strategic level of catchment planning; that is the setting of aims, objectives and aspirations;*
2. *Interventions within policy delivery frameworks, that is the putting in place of methodologies and techniques to deliver on overarching aims and objectives; and*
3. *Interventions at the level of policy outcomes; that is the effectiveness of approaches on decision making and material changes to catchment environments.*

The view was taken that the concerns of the EsA might best be understood as relating to different parts of the policy 'delivery chain' and that deciphering how questions related to these was the basis for focused types of review question, and with it, discernible forms of outcome. The overall result of this feedback and its implications for the process of question formulation are summarised in Figure 2 below. It takes each of the three identified concerns and describes the particular subject areas that flow from each. It then emphasises the different scales of policy intervention that are relevant to the subject areas under consideration, and how particular types of outcome could be attributed to them.

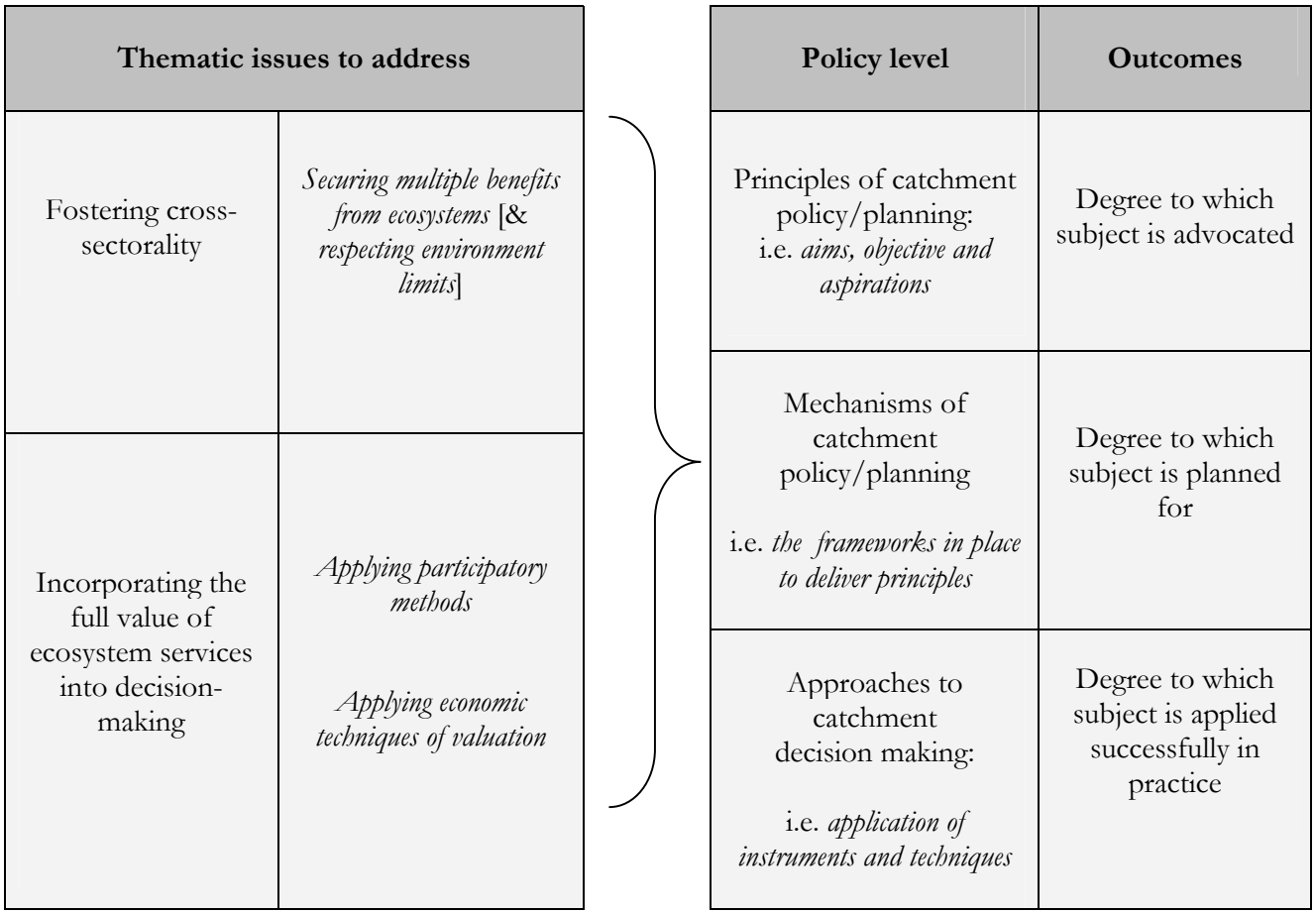

Figure 2: Conceptual approach to question development

3.4 Approaches to question formulation

As a result of this conceptual development different approaches to question formulation were considered. It was suggested, for instance, that the review process might take each thematic issue in turn and then consider whether and how each was reflected at different policy levels: i.e. from principles to practice. For instance, we may wish to consider where fostering cross-sectoral benefits from ecosystems was advocated at the level of policy principles, planned at the level of policy delivery, and reflected in forms of policy implementation. However, the final conclusion drawn by the project team was that while this would provide a comprehensive basis for evaluating the effect of catchment policy process on each subject area, the aim of systematic review as it is currently envisaged in environmental science is to examine evidence primarily, if not exclusively,

for applied outcomes. Whilst accepting the need to be clear about the way subject areas were being examined in relation to the policy process, the conclusion was that ***questions should be focused at the implementation end of catchment based policy process in order to be consistent with the needs of systematic review***. In other words, following the framework depicted in Figure 2 above the view was taken that each of the two subject areas should be examined in the context of one policy level only, that is, *with the effects of catchment scale decision making*: on the adoption of approaches (such as methods of inclusion) and material changes to the environment (such as securing multiple benefits from ecosystems). It is with this emphasis in mind that the project team finalised two primary questions for subsequent searching consistent with the 'subject', 'intervention' and 'outcome' parameters of systematic review (Figure 3).

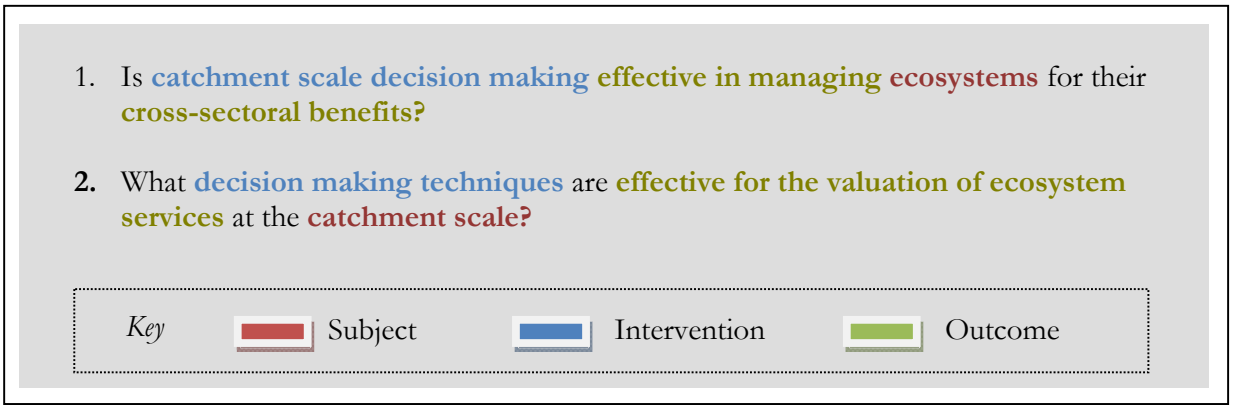

Figure 3: Two Pilot Review Questions

4. Design and application of search strategies

In this section of the pilot review we describe how the search strategy for our topic was designed and applied. Underpinning this work was the research team's use of the **Web of Science** (W of S) search engine. This search engine clearly does not exhaust the available avenues of literature on this topic, and indeed, in the design of the final protocols, a wider search framework is advocated and described. However, the purpose of this pilot process is to establish whether a body of core empirical evidence existed that could underpin the case for wider, and more detailed, review. We judged that the W of S would provide us with a generally comprehensive picture of this evidence base, both in terms of study quantity and quality.

4.1 Establishing an evidence base

Developing an effective search strategy involved an initial assessment of the available body of literature surrounding catchment scale environmental decision making within which more targeted areas of research could then be identified (see Figure 4 below). As our key intervention in this study the idea of 'catchment scale environmental decision making' is characterised by two key elements, each of which may be expressed using different sorts of terminologies within available bodies of evidence. On the one hand, the term 'catchment' is, of course, a **geographical scale of intervention**, and we suggest that any search strategy should therefore be based on the identification of literature that incorporates the word 'catchment' or those equivalent to it. In particular, on the basis of feedback from the expert panel the initial round of the research was designed to include the following catchment terminologies:

Catchment, catchment scale, catchment area, watershed, drainage basin, river basin

Alongside this issue of geographical scale, the idea of "catchment scale environmental decision making" also implies that (**collective) forms of (policy or scientific) action** are

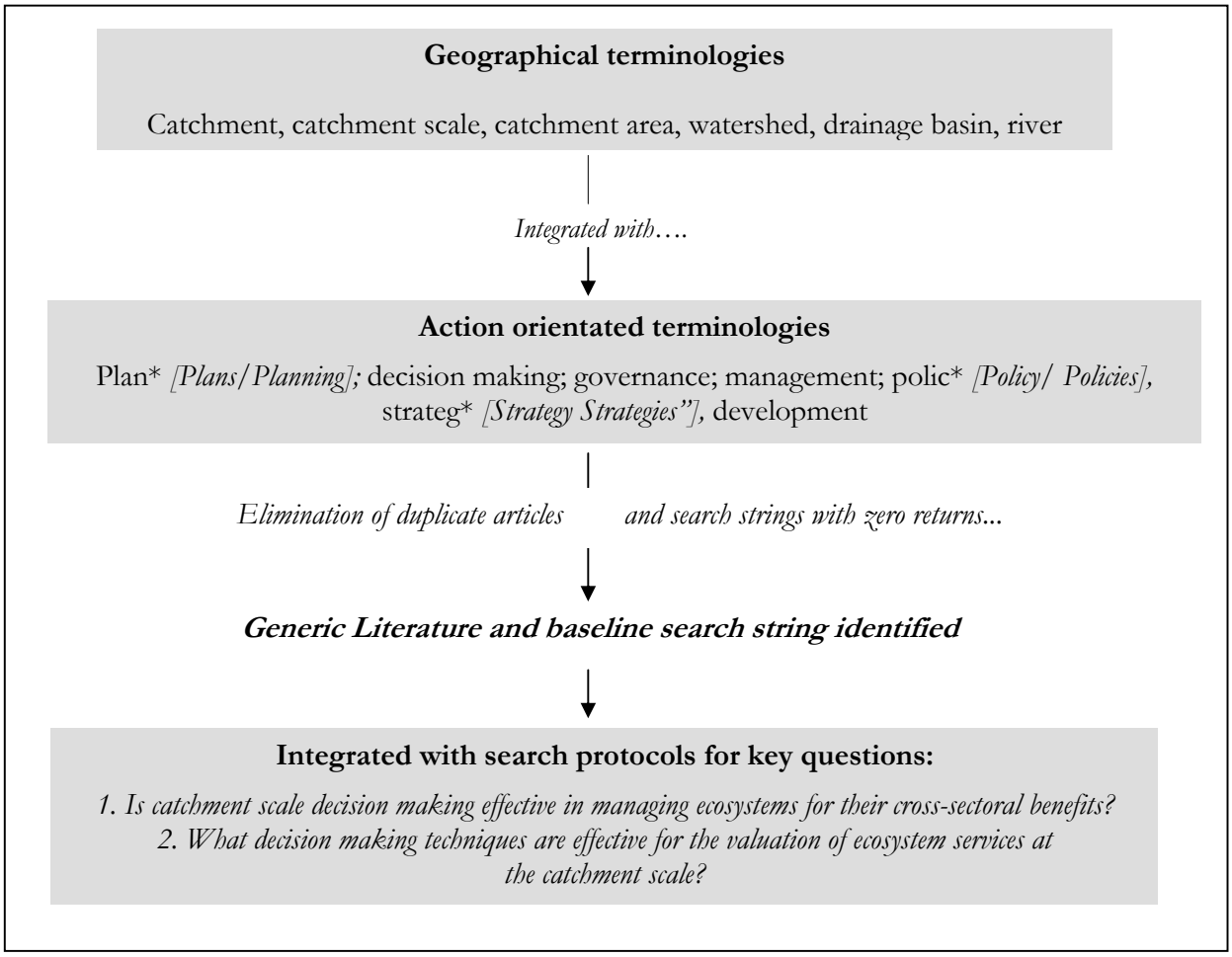

Figure 4: Initial approach to search strategy

taking place. That is to say, the review is not simply concerned with research on 'catchments' *per se* but with its relationship to practical kinds of interventions. Again different terminologies may be used to describe these, which we have sought to reflect in our choice of our initial search terms. These are:

Plan/Plans/Planning; decision making; governance; management; policy policies/Strategy Strategies/ development

The argument is that, by **combining these terminologies of geographical scale and action,** we can begin to grasp the overall breadth of evidence addressing/evaluating catchment based work. This general literature was then subject to more precise forms of searching giving the two key questioning areas devised *a priori* by the research team and

expert panel, the searches for which are described in subsequent subsections. The results of the *initial* round of searching are depicted in Table 1 below.

Geographical units of expression	**Action-orientated terminologies**	
Catchment; catchment scale; catchment area; watershed drainage basin; river basin	plan* *[Plans/Planning];* decision making;governance management;;polic* *[Policy/ Policies];*strateg* *[Strategy Strategies"];* development	
Search strings		**Hits**
1. Topic=("catchment plan*" [52] OR "catchment decision making" [2] OR "catchment governance" [0] OR "catchment management" [495] OR "catchment polic*"[3] OR "catchment strateg*" [4] OR " catchment development" [27])		569
2. Topic=("catchment scale plan*"[3]OR "catchment scale decision making" [1] OR "catchment scale governance" [0]OR "catchment scale management" [8]OR "catchment scale polic*" [1]OR "catchment scale strateg*" [0] OR " catchment scale development"[0])		13
3. Topic=("catchment area plan*" [0]OR "catchment area decision making" [0]OR "catchment area governance"[0] OR "catchment area management" [1]OR "catchment area polic*"[2] OR "catchment area strateg*" [0] OR "catchment area development "[0])		3
4. Topic=("watershed plan*" [159] OR "watershed decision making" [7] OR "watershed governance" [1] OR "watershed management" [1,378] OR "watershed polic*" [11] OR "watershed strateg*" [6]OR " watershed development " [154])		1,660
5. Topic=("drainage basin plan*"[1] OR "drainage basin decision making" [0]OR "drainage basin governance" [0] OR "drainage basin management" [12]OR "drainage basin polic*" [0]OR "drainage basin strateg*" [0] OR " drainage basin development" [7])		20
6. Topic=("river basin plan*" [114] OR "river basin decision making" [3]OR "river basin governance" [5]OR "river basin management" [554] OR "river basin polic*" [4] OR "river basin strateg*" [1]OR "river basin development " [98])		749
Combined string taken forward (i.e. Minus redundant terms/duplications) **7**. Topic=("catchment plan*" OR "catchment decision making" OR "catchment management" OR "catchment polic*" OR "catchment strateg*" OR "catchment development "OR "catchment scale plan*" OR "catchment scale decision making" OR "catchment scale management" OR "catchment scale polic*" OR "catchment area management" OR "catchment area polic*" OR "watershed plan*" OR "watershed decision making" OR "watershed governance" OR "watershed management" OR "watershed polic*" OR "watershed strateg*" OR " watershed development " OR "drainage basin plan*" OR "drainage basin management" OR " drainage basin development "OR "river basin plan*" OR "river basin decision making" OR "river basin governance" OR "river basin management" OR "river basin polic*" OR "river basin strateg*" OR "river basin development ")		2961

Table 1: Results of initial search strategy

In the first round, terms corresponding to a geographical unit of expression were searched alongside action-orientated terminologies and hits for each overall search-string recorded. Search combinations with zero returns were identified and an overall search string created to eradicate duplicate articles. This process question led searching.

4.2 The cross-sectoral benefits of catchment scale decision making: search strategy

The c.3000 pieces of core literature identified by the initial search string were then examined for evidence relating to the first key area of questioning, that is, *"Is catchment scale decision-making effective in managing ecosystems for their cross-sectoral benefits?"* The overall framework for this process is depicted in Figure 4 below.

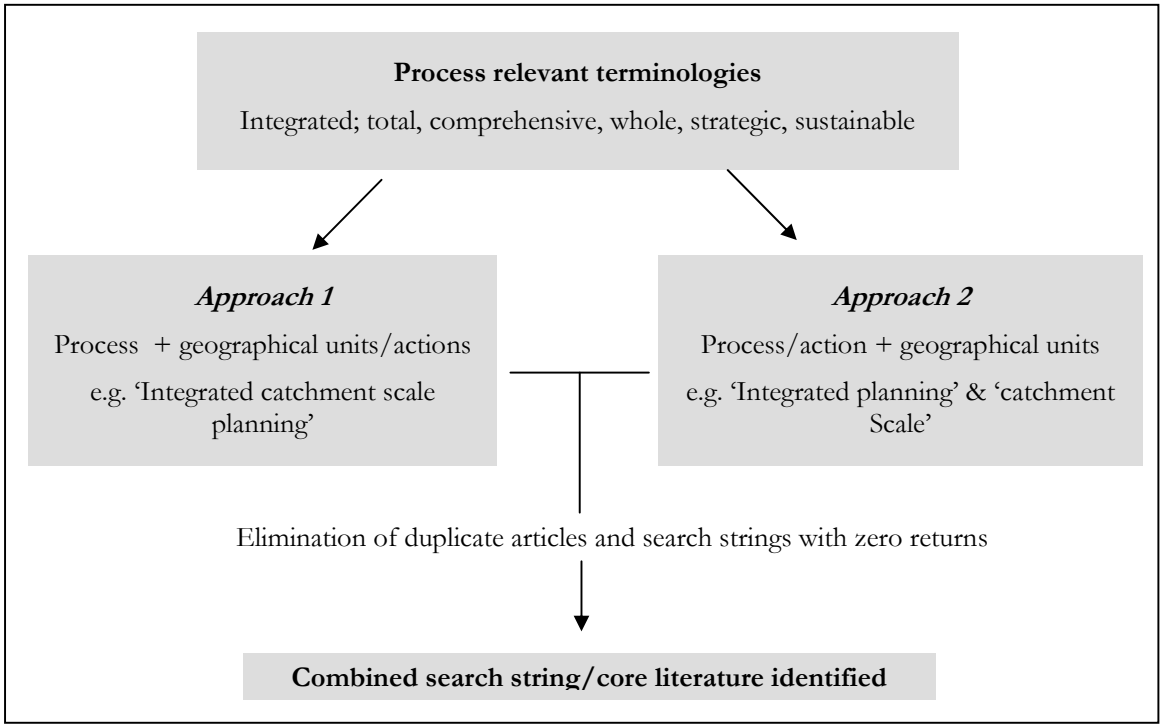

Figure 5: Approach to searching: cross-sectoral benefits

As Figure 5 depicts, at the centre of this round of searching are a series of **process relevant terminologies** that might help identify research examining catchment based decision making in cross-sectoral ways. The terminologies suggested through the consultation process were 'integrated; 'total', 'comprehensive', 'whole', 'strategic', 'sustainable'. These terms were combined with the core search string to form complete phrases such as 'integrated catchment scale planning' or 'total catchment management' around which relevant literature could be determined. The results of this exercise are depicted in Table 3 and 4 below.

1. Search strings based on the term "Integrated"	*Hits*
1. Topic=("Integrated catchment plan*" [6] OR "Integrated catchment decision making*" [0] OR "Integrated catchment management" [121]OR "Integrated catchment polic*" [0] OR "Integrated catchment strateg*"[0])	126
2. Topic=("Integrated catchment scale plan*" [1] OR " Integrated catchment scale decision making" [0] OR " Integrated catchment scale management" [0] OR " Integrated catchment scale polic*"[0])	1
3. Topic=("Integrated catchment area management" OR" Integrated catchment area polic*")	0
4. Topic=(" Integrated watershed plan*"[5] OR " Integrated watershed decision making" [0]OR "Integrated watershed governance" [0]OR " Integrated watershed management" [85] OR " Integrated watershed polic*" [0] OR " Integrated watershed strateg*" [0] OR "Integrated watershed development" [10]	98
5. Topic=(" Integrated drainage basin plan*" [0] OR " Integrated drainage basin management" OR "Integrated drainage basin development" [0])	0
6. Topic=("Integrated river basin plan*" [8] OR "Integrated river basin decision making" [0] OR "Integrated river basin governance" [0]OR "Integrated river basin management" [87] OR "Integrated river basin polic*" [2] OR "Integrated river basin strateg*" [2]OR" Integrated river basin development" [3])	97
Combined String (i.e. Minus redundant terms/duplications) Topic=("Integrated catchment plan*" OR "Integrated catchment management" OR "Integrated catchment scale plan*" OR "Integrated watershed plan*" OR Integrated watershed management" OR "Integrated river basin plan*" OR "Integrated river basin management")	304
2. Search strings based on the term "Total"	
1. Topic=("Total catchment plan*" [1] OR "Total catchment decision making*" [0] OR "Total catchment management" [10] OR "Total catchment polic*" [0] OR "Total catchment strateg*" [0] OR " Total catchment development" [0])	11
2. Topic=("Total catchment scale plan*" OR " Total catchment scale decision making" OR "Total catchment scale management" OR " Total catchment scale polic*")	0
3. Topic=("Total catchment area management" OR" Total catchment area polic*")	0
4. Topic=(" Total watershed plan*" [0] OR " Total watershed decision making" [0]OR "Total watershed governance" [0]OR " Total watershed management" [1]OR " Total watershed polic*" [0]OR " Total watershed strateg*" [0] OR " Total watershed development" 0])	1
5. Topic=(" Total drainage basin plan*" OR " Total drainage basin management" OR "Total drainage basin development")	0
6. Topic=("Total river basin plan*" OR "Total river basin decision making" OR "Total river basin governance" OR "Total river basin management" OR "Total river basin polic*" OR "Total river basin strateg*" OR " Total river basin development")	0
Combined String (i.e. Minus redundant terms/duplications) Topic=("Total catchment management" OR "Total catchment plan*"OR " Total watershed management")	12
3. Search string based on the term "Comprehensive"	
1. Topic=("Comprehensive catchment plan*" [0] OR "Comprehensive catchment decision making*" [0] OR "Comprehensive catchment management" [1]OR "Comprehensive catchment polic*" [0] OR " Comprehensive catchment strateg*" [0] OR " Comprehensive catchment development" [0])	1
2. Topic=("Comprehensive catchment scale plan*" OR " Comprehensive catchment scale decision making" OR "Comprehensive catchment scale management" OR " Comprehensive catchment scale polic*")	0
3. Topic=("Comprehensive catchment area management" OR" Comprehensive catchment area polic*")	0
4. Topic=(" Comprehensive watershed plan*" [4] OR " Comprehensive watershed decision making" [0]OR "Comprehensive watershed governance" [0]OR " Comprehensive watershed management" [10] OR " Comprehensive watershed polic*" [0] OR " Comprehensive watershed strateg*" [0] OR "Comprehensive watershed development" [1])	15
5. Topic=(" Comprehensive drainage basin plan*" OR "Comprehensive drainage basin management" OR "Comprehensive drainage basin development")	0
6. Topic=("Comprehensive river basin plan*" [3] OR "Comprehensive river basin decision making" [0]OR "Comprehensive river basin governance" OR "Comprehensive river basin management" [4] OR "Comprehensive river basin polic*" OR "Comprehensive river basin strateg*"[0] OR "Comprehensive river basin development" [0])	7
Combined String (i.e. Minus terms redundant terms/duplications) Topic=("Comprehensive catchment management" OR "Comprehensive watershed plan*"" Comprehensive watershed management" OR "Comprehensive watershed development"OR "Comprehensive river basin plan*"OR "Comprehensive river basin management")	22

Table 2: Cross-sectoral benefits search strategy one: results

4. Search strings based on the term "Strategic"	*Hits*
1. Topic=("Strategic catchment plan*" OR "Strategic catchment decision making*" OR "Strategic catchment management" [1]OR "Strategic catchment polic*" [0] OR " Strategic catchment development "[0])	1
2. Topic=("Strategic catchment scale plan*" OR " Strategic catchment scale decision making" OR " Strategic catchment scale management" OR " Strategic catchment scale polic*")	0
3. Topic=(" Strategic catchment area management" OR" Strategic catchment area polic*")	0
4. Topic=(" Strategic watershed plan*" [0] OR " Strategic watershed decision making" [0] OR "Strategic watershed governance" [0] OR " Strategic watershed management" [1] OR " Strategic watershed polic*"[0] OR " Strategic watershed development"[0])	1
5. Topic=(" Strategic drainage basin plan*" OR " Strategic drainage basin management" OR " Strategic drainage basin development")	0
6. Topic=("Strategic river basin plan*" [1] OR "Strategic river basin decision making" [0] OR "Strategic river basin governance" [0] OR "Strategic river basin management" [1] OR "Strategic river basin polic*" [0] OR " Strategic river basin development" [0])	2
Combined String (i.e. Minus redundant terms/duplications Topic=("Strategic catchment management" OR " Strategic watershed management" OR "Strategic river basin management" OR "Strategic river basin plan*")	4
5. Search strings based on the term "Whole"	
1. Topic=("Whole catchment plan*" [0] OR "Whole catchment decision making*" [0] OR "Whole catchment management" [3] OR "Whole catchment polic*" [0] OR " Whole catchment strateg*" [0] OR " Whole catchment development"[0])	3
2. Topic=("Whole catchment scale plan*" OR " Whole catchment scale decision making" OR " Whole catchment scale management" OR " Whole catchment scale polic*")	0
3. Topic=("Whole catchment area management" OR" Whole catchment area polic*")	0
4. Topic=(" Whole watershed plan*" OR " Whole watershed decision making" OR "Whole watershed governance" OR " Whole watershed management" OR " Whole watershed polic*" OR " Whole watershed strateg*" OR " Whole watershed development")	0
5. Topic=(" Whole drainage basin plan*" OR " Whole drainage basin management" OR " Whole drainage basin development")	0
6. Topic=("Whole river basin plan*" OR "Whole river basin decision making" OR "Whole river basin governance" OR "Whole river basin management" [2] OR "Whole river basin polic*" OR "Whole river basin strateg*" OR " Whole river basin development")	2
Combined String Taken forward (i.e. Minus redundant terms/duplications Topic = ("Whole catchment management" OR "Whole river basin management")	4
6. Search strings based on the term "Sustainable"	
1. Topic=("Sustainable catchment plan*" [2] OR "Sustainable catchment decision making*" [0] OR "Sustainable catchment management" [11] OR "Sustainable catchment polic*" [0] OR " Sustainable catchment strateg*" [0] OR " Sustainable catchment development" [1])	12
2. Topic=("Sustainable catchment scale plan*" OR " Sustainable catchment scale decision making" OR " Sustainable catchment scale management" OR " Sustainable catchment scale polic*")	0
3. Topic=("Sustainable catchment area management" OR" Sustainable catchment area polic*")	0
4. Topic=(" Sustainable watershed plan*"[0] OR " Sustainable watershed decision making" [0] OR "Sustainable watershed governance" [0] OR " Sustainable watershed management" [20] OR " Sustainable watershed polic*" [0] OR " Sustainable watershed strateg*" [0]OR " Sustainable watershed development" [2])	22
5. Topic=(" Sustainable drainage basin plan*" OR " Sustainable drainage basin management" OR " Sustainable drainage basin development")	0
6. Topic=("Sustainable river basin plan*" [2] OR "Sustainable river basin decision making" [0]OR "Sustainable river basin governance" [1]OR "Sustainable river basin management" [16]OR "Sustainable river basin polic*" [0] OR "Sustainable river basin strateg*" [0] OR " Sustainable river basin development"[2])	20
Combined String Taken forward (i.e. Minus redundant terms/duplications) Topic**= (**"Sustainable catchment development" OR "Sustainable catchment management" OR "Sustainable catchment development" OR "Sustainable watershed management" OR " Sustainable watershed development" OR "Sustainable river basin plan*"OR "Sustainable river basin governance" OR "Sustainable river basin management" OR "Sustainable river basin development")	52

Table 2: Cross-sectoral benefits search strategy one: results (Continued)

Overall Search string carried forward – Zero redundant terms/duplications	*Overall Hits*
Topic=("Integrated catchment plan*" OR "Integrated catchment management" OR "Integrated catchment scale plan*" OR "Integrated watershed plan*" OR "Integrated watershed management" OR "Integrated river basin plan*" OR "Integrated river basin management" OR "Total catchment management" OR "Total catchment plan*"OR "Total watershed management" OR "Comprehensive catchment management" OR "Comprehensive watershed plan*" OR "Comprehensive watershed management" OR "Comprehensive watershed development" OR "Comprehensive river basin plan*"OR "Comprehensive river basin management" OR "Strategic catchment management" OR "Strategic watershed management" OR "Strategic river basin management" OR "Strategic river basin plan*" OR "Whole catchment management" OR "Whole river basin management" OR "Sustainable catchment development" OR "Sustainable catchment management" OR "Sustainable catchment development" OR "Sustainable watershed management" OR " Sustainable watershed development" OR "Sustainable river basin plan*"OR "Sustainable river basin governance" OR "Sustainable river basin management" OR "Sustainable river basin development")	***414***

Table 3: Cross-sectoral benefits search strategy one: overall search string,

Table 2 depicts results for the 'whole phrase' search and identifies redundant combinations within each search string. Through this an overall search strings for each process related terminology were identified. These individual search strings were then combined to form a final search string using this particular search approach (Table 3), one returning 414 unique pieces of information.

As a further iteration of this logic, the research team also experimented with the relationship between the study's 'action related' terminologies (e.g. management) and the commonly deployed process-related term 'integrated'. In particular, this new line of searching rested on **decoupling process and action terminologies from those relating to our geographical unit of analysis** thus providing an entirely new set of search phrases. For example under this approach the phrase:

"integrated catchment management"

...is now reconfigured as...

"Integrated management" AND "catchment"*

The overall search combinations used for this additional strategy are depicted in Figure 6 below. On the basis of expert panel feedback they include some *new* terminologies that were felt may help identify more focused bodies of cross-sectoral

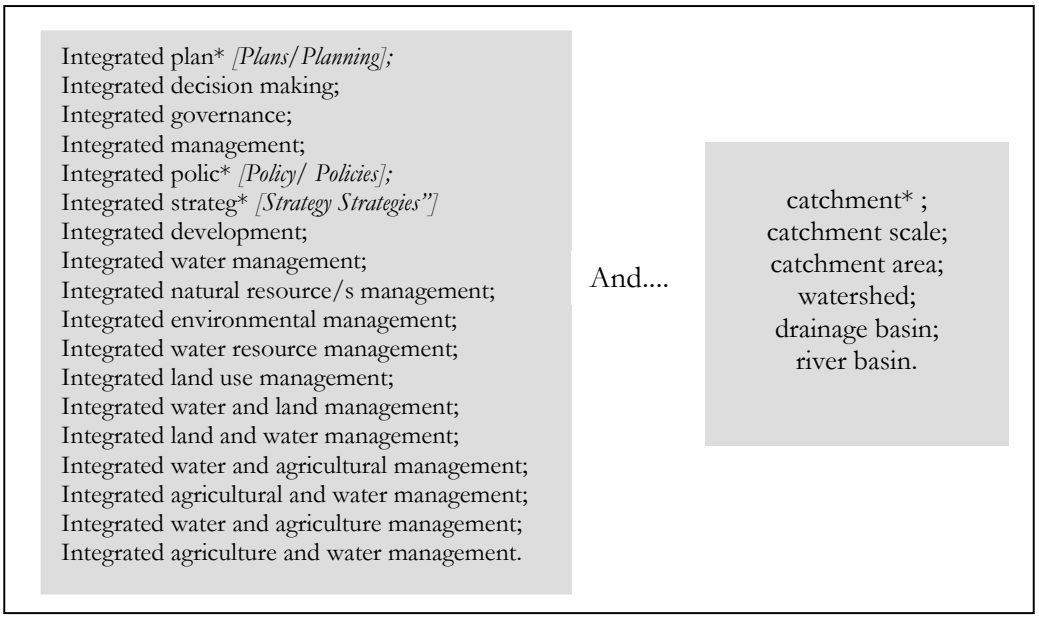

Figure 6: Cross-sectoral benefits search strategy two: overall approach

Final Search String Recommend by Pilot Review	*Hits*
Topic=("Integrated plan*" OR "Integrated Management" OR "Integrated polic*" OR "Integrated Strateg*" OR "Integrated development" OR " Integrated water management" OR "Integrated natural resources management" OR "Integrated natural resources management" OR "Integrated environmental management "OR "Integrated water resource management" OR "Integrated water resources management" OR "Integrated land use management "OR "Integrated land and water management") **AND** Topic=("catchment*" OR "catchment area" OR "catchment scale" OR "watershed*" OR "drainage basin*" OR "river basin*") **OR** Topic=("Integrated catchment plan*" OR "Integrated catchment management" OR "Integrated catchment scale plan*" OR "Integrated watershed plan*" OR "Integrated watershed management" OR "Integrated river basin plan*" OR "Integrated river basin management" OR "Total catchment management" OR "Total catchment plan*"OR "Total watershed management" OR "Comprehensive catchment management" OR "Comprehensive watershed plan*" OR "Comprehensive watershed management" OR "Comprehensive watershed development" OR "Comprehensive river basin plan*"OR "Comprehensive river basin management" OR "Strategic catchment management" OR "Strategic watershed management" OR "Strategic river basin management" OR "Strategic river basin plan*" OR "Whole catchment management" OR "Whole river basin management" OR "Sustainable catchment development" OR "Sustainable catchment management" OR "Sustainable catchment development" OR "Sustainable watershed management" OR " Sustainable watershed development" OR "Sustainable river basin plan*" OR "Sustainable river basin governance" OR "Sustainable river basin management" OR "Sustainable river basin development")	**845**

Table 4: Overall recommended search string – cross-sectoral benefits

Search string	*Hits*
1.Topic=("Integrated plan*") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR "watershed*" OR "drainage basin* OR "river basin*")	30
2.Topic=(" Integrated decision making") AND Topic=(" catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin* OR "river basin*")	0
3. Topic=("Integrated governance") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	0
4.Topic=(" Integrated management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" " OR "river basin*")	171
5. Topic=(Integrated polic*) AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	1
6. Topic=(Integrated strateg*) AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	7
7 . Topic=("integrated development") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	11
8.Topic=(" Integrated water management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	92
9. Topic=(" Integrated natural resource management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	10
10.Topic=(" Integrated natural resources management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	4
11. Topic=(" Integrated environmental management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	13
12. Topic=(" Integrated water resource management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	55
13. Topic=("Integrated water resources management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	157
14. Topic=(" Integrated land use management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	1
15. Topic=(" Integrated water and land management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	0
16. Topic=("Integrated land and water management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	1
17. Topic=(" Integrated water and agricultural management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	0
18. Topic=("Integrated water and agriculture management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	0
19. "Integrated agricultural and water management" AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	0
20. "Integrated agriculture and water management" AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR " watershed*" OR " drainage basin*" OR "river basin*")	0
Combined String Taken forward (i.e. minus redundant terms/duplications) Topic=("Integrated plan*" OR "Integrated Management" OR"Integrated polic* OR Integrated Strateg*" OR "Integrated development" OR "Integrated water management" OR "Integrated natural resources management" OR "Integrated natural resources management" OR "Integrated environmental management "OR "Integrated water resource management" OR "Integrated water resources management" OR "Integrated land use management" OR "Integrated land and water management") AND Topic=("catchment*" OR "catchment area" OR "catchment scale" OR "watershed*" OR "drainage basin*" OR "river basin*")	**492**

Table 5: Cross-sectoral benefits search strategy two: results

research in catchment environments, particularly those relating to work at the interface of land, water and agriculture. Table 5 above depicts results from this second approach to searching. Again, hits for each round of searching are documented, and redundant strings eliminated. When combined with results from search one a final search string is provided for systematic review (Table 4).

4.3 The full valuation of ecosystem services: search strategy

As section three explained, alongside our concern with the issue of cross-sectoral benefits a further question for consideration in this study was examined, that is: *What decision making techniques are effective for the valuation of ecosystem services at the catchment scale?* The development of prototypical strategies for this questioning area was more straightforward than the issue of cross-sectoral benefits, not least because the chosen search terms here are more prescriptive and limited. The overall search approach is depicted in Figure 7 below.

Baseline search string

Topic=("catchment plan*" OR "catchment decision making" OR "catchment management" OR "catchment polic*" OR "catchment strateg*" OR "catchment development "OR "catchment scale plan*" OR "catchment scale decision making" OR "catchment scale management" OR "catchment scale polic*" OR "catchment area management" OR "catchment area polic*" OR "watershed plan*" OR "watershed decision making" OR "watershed governance" OR "watershed management" OR "watershed polic*" OR "watershed strateg*" OR " watershed development " OR "drainage basin plan*" OR "drainage basin management" OR " drainage basin development "OR "river basin plan*" OR "river basin decision making" OR "river basin governance" OR "river basin management" OR "river basin polic*" OR "river basin strateg*" OR "river basin development "

Incorporated with a search for valuation literature using following terms....

Inclusionary processes

"Inclus*" [Inclusiv/e/ion]
"Delibera*" [deliberat/ive/ion
"Participat*" [participat/ion/ory]
"co-management"
"collaborat*"/ive/ion"
"Stakeholder*" [stakeholder/s]
"social capital"
"Consensus-building"

Economic Valuation

"Economic Valu*"[e/ation]
"Economic Appraisal"
"Economic Assessment"
"Ecosystem Valu* [e"/ation]
"Cost-benefit"
"Benefit-cost"
"Cost effectiveness"
"Use value"
"Non use value"

Figure 7: Valuation search strategy

The results of the two searches are depicted in Table 6 below from which overall search string was derived. Like the issue of cross-sectoral benefits the body of evidence for inclusionary processes appears reasonably extensive (with 549 hits), as anticipated by the expert panel. However, it is also initially clear that the basis for review around the issue economic valuation is currently weak (only 79 hits).

Inclusionary processes	
1. Combined search string AND Topic=("Inclus*")	33
2. Combined search string AND Topic=("Delibera*")	20
3. Combined search string AND Topic= ("Participat*")	316
4. Combined search string AND Topic = ("co-management")	3
5.. Combined search string AND Topic=("collaborat*")	116
6. Combined search string AND Topic=("Stakeholder*")	264
7. Combined search string AND Topic=("social capital")	10
8.. Combined search string AND Topic=("Consensus-building")	9
Overall search string (ie minus duplications) **9. Combined Search string AND** Topic=("Inclus*" OR "Delibera*" OR "Participat*" OR "co-management" OR "collaborat*" OR "Stakeholder*" OR "social capital" OR "Consensus-building")	**550**
Economic valuation	
1. Combined search string AND Topic= "Economic Valu*"	22
2. Combined search string AND Topic= "Economic Appraisal"	0
3. Combined search string AND Topic= "Economic Assessment"	4
4. Combined search string AND Topic = "Ecosystem Valu*"	2
5. Combined search string AND Topic= "Cost-benefit"	14
6. Combined search string AND Topic="Benefit-cost"	16
7. Combined search string AND Topic="Cost effectiveness"	24
8. Combined search string AND Topic= "Use value"	1
9. Combined search string AND Topic= "Non Use value"	0
10. Overall search string (i.e. minus duplications) **Combined search string AND** "Economic Valu*" OR "Economic Assessment" OR "Ecosystem Valu*" OR "Cost-benefit" OR "Benefit-cost" OR "Cost effectiveness" OR "Use value"	**72**
Final Search String Recommend by Pilot Review	
Topic=("catchment plan*" OR "catchment decision making" OR "catchment management" OR "catchment polic*" OR "catchment strateg*" OR "catchment development "OR "catchment scale plan*" OR "catchment scale decision making" OR "catchment scale management" OR "catchment scale polic*" OR "catchment area management" OR "catchment area polic*" OR "watershed plan*" OR "watershed decision making" OR "watershed governance" OR "watershed management" OR "watershed polic*" OR "watershed strateg*" OR " watershed development " OR "drainage basin plan*" OR "drainage basin management" OR " drainage basin development "OR "river basin plan*" OR "river basin decision making" OR "river basin governance" OR "river basin management" OR "river basin polic*" OR "river basin strateg*" OR "river basin development ") **AND** Topic=("Inclus*" OR "Delibera*" OR "Participat*" OR "co-management" OR "collaborat*" OR "Stakeholder*" OR "social capital" OR "Consensus-building" OR "Economic Valu*" OR "Economic Assessment" OR "Ecosystem Valu*" OR "Cost-benefit" OR "Benefit-cost" OR "Cost effectiveness" OR "Use value")	**607**

Table 6: Valuation search results

Interestingly, the combined search strings for inclusionary processes and economic valuation results in a overall yield of 607, 15 less that the combined total of the individual search strings. This result suggests that, within these 607 hits, there is a literature, albeit very small, that crosses both strands of valuation.

5. Data assessment: appraisal of volume and quality

In this section of the review we make an assessment of the evidence based on each of the search strings. The overall framework for this aspect of the work is depicted in Figure 8 below.

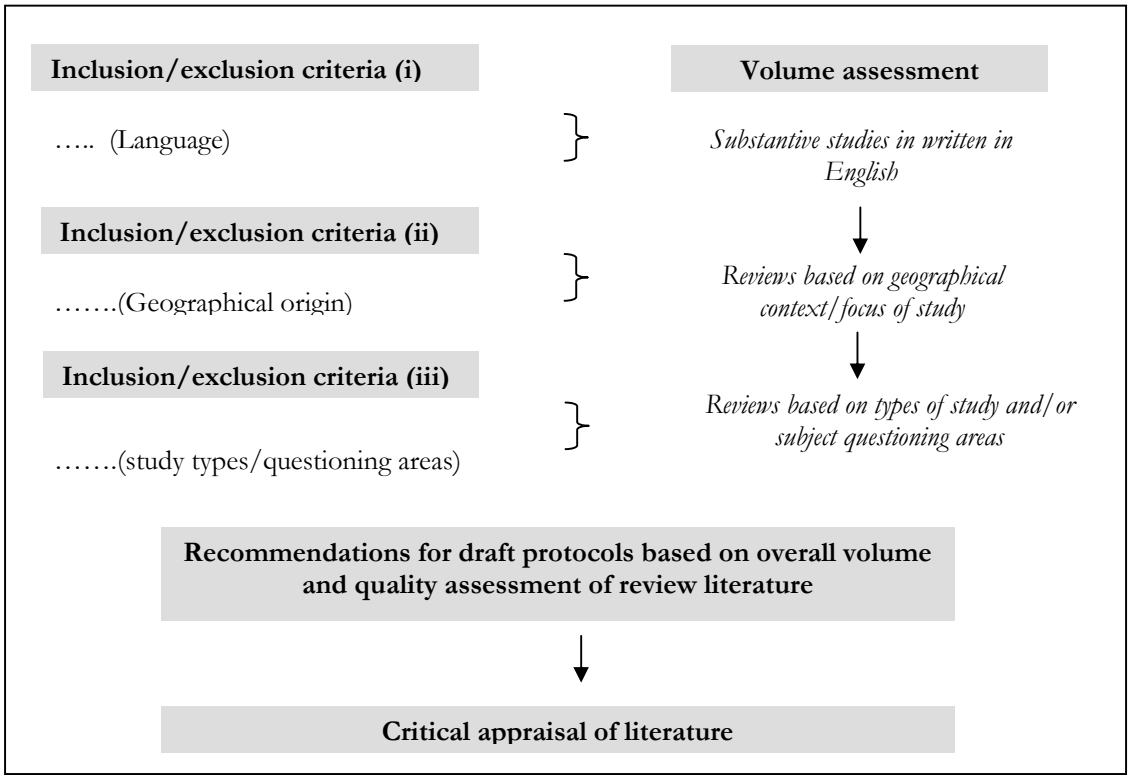

Figure 8: Overall approach to data assessment

5.1 Volume assessment

The initial phase in this process involved making a volume assessment, that is, developing a judgment about the relevance of the evidence independent of an assessment of its quality. Following the protocols of systematic review outlined by the CEBC (2009) this volume assessment involved applying different types of inclusion/exclusion criteria. In our case three levels of such criteria were applied to the evidence. First, we applied exclusion criteria on the basis of language on the assumption that the full systematic review is realistically likely to be conducted on

studies written in English only. As the guidelines for systematic review explain, this can have the effect of biasing the sample of available literature, and in this particular case, potentially reduces the amount of comparative work available for analysis. Even so results suggest that the number of articles 'lost' on the basis of language specificity would be actually very low: approximately 2% of materials were excluded from the cross-sectoral benefits question and 1% from the valuation studies

Second, the volume assessment seeks to draw basic distinctions between the geographical contexts or focuses of study. This is because we acknowledge that formulas for systematic review may be distinguished by the extent to which comparative - i.e. *non UK* - studies are drawn upon. On the basis of expert panel feedback our judgment at this stage is that *no inclusion criteria* should be set here. Results of the volume assessment suggest that, on the hand, a 'global' literature is available for systematic review and further that the UK based literature is rather modest in and of itself with just under 130 pieces of relevant material. Nonetheless, the opportunities do exist to make plausible distinctions (i.e. exclusions) here whilst retaining a comparative element. For instance a review that concentrated solely on the pan-European, North American and Australasian literature would based on over two third of the materials identified from the WoS.

Third, alongside these two inclusion/exclusion criteria we also developed an approximate assessment of the *underpinning themes* of the literature to build a picture of the type of evidence base a review would draw upon. In the context of 'cross-sectoral benefits' an assessment was made of the types of ecosystem services that each paper directly or indirectly addressed and where a direct or implied connection with ecosystem services could be. In the present context no studies were excluded from the review. Likewise, for the question of 'valuation' we reviewed the literature for particular types of approach adopted or discussed, in effect, teasing out what types of economic and non-economic technique are being addressed and in what ways. Again, no studies were excluded as a result of this process. Both these approaches to

assessment allowed us to come to an overall conclusion about the types of evidence that appear to exist when applying the search strategies for each questioning area, and allowed us to begin identifying gaps in knowledge and understanding. A summary of our key messages for each question is summarised below, drawing on the most recent evidence to illustrate our points.

5.1.2 Key messages: Cross-sectoral benefits

Perhaps unsurprisingly, the catchment focus of these studies means that **issues of water management provide the thematic starting point of this literature.** Within this only a very limited number of materials (8 in total) are based explicitly on the study or conceptualisation of ecosystems services (e.g. Everard 2004; Brauman *et al.* 2007; Schluter *et al.* 2009). While analytical difficulties arise in drawing simple connections between the particular concerns of this literature and the conceptual framing of ecosystem services, a number of key themes emerge when assessing this literature for its relevance to review questions and where gaps in evidence currently exist.

In the context of ecosystem services our initial review suggest that the **primary focus of the literature** is on considering associations between the **provisioning services** of fresh water and food (across most sub-categories – crops, livestock, fishers and aquaculture), the **regulating services** of water, natural hazards, water purification and waste treatment, erosion, and the **supporting services** of nutrient and water cycling. A more limited literature exists that would allow a subsequent review to consider links between water management and **cultural services** including issues of recreational benefits of management, education and co-learning in decision making, and the relationship between catchment planning and cultural heritage. A small number of references are made to other important services, such as the provision of fiber services and genetic resources.

Overall, **a considerable body of literature is developed explicitly in the context of policy developments relevant to UK**. We estimate, for instance, that approximately 10% of this work is concerned with the meeting the needs of the WFD. This literature could form a core literature for full systematic review. However, we judge that focusing review solely on this literature would be error. Opportunities exist to draw insight from other policy contexts, both analogous and different to the UK.

It is notable that **the most common strand of research proceeds from a concern with issues of water quality**, with significant bodies of research examining integrated management in the context of nitrogen and phosphorus losses from agriculture (e.g. Zessner and Lindtner, 2005), and a small strand of research emphasising biodiversity outcomes, such as the restoration of habitats (Mouton *et al.,* 2009). A **smaller volume of research develop around issue of water quantity,** typically addressing the regulation of flood hazards (e.g. Nachtnebel and Faber, 2009), but also examining trade-offs between competing demands for water at the river basin scale: such as triangulating the demands of drinking water, agricultural irrigation and aquaculture (e.g. Schluter *et al.,* 2009).

Across this body of literature **a modest proportion of studies encompass basic science based on original primary research**, such as research considering the effects of the basin hydrology on river water quality as a result of runoff from agricultural areas (e.g. Carone, 2009). However, many studies are based on the statistical re-analysis of existing data sets to pursue new policy questions, such as recent UK-based research developing, in the context of the Water Framework Directive, a classification scheme for pollutant natural attenuation potential at the groundwater-surface water interface using national-scale nitrate datasets (Smith *et al.* 2009)

Most commonly, the evidence base is guided by the trialling of decision making methodologies for catchment scale planning: that is, the development of tools and techniques that can be used to guide future policy decisions or appraise outcomes. Varied decision support systems are described and assessed in this respect and include applications of: role playing theory to pathways to decision making (Prat *et al.* 2009); expert elicitation techniques to create surrogate data sets and rules for assessing uncertainty in decisions (Mouton *et al.* 2009); and the application of fuzzy logic and agent-based approaches to modelling (Schluter *et al.,* 2009)

A strong element of this methodological work is governed by a concern to find optimal points in future decision making, such as the development of integrated tools that can for instance: assess risks associated with agricultural management for soil erosion and losses of phosphorus and nitrogen (Bechmann *et al.,* 2009); strike a balance between environmental and economic sustainability in aquaculture by linking water quality data to simulations of the volume and profitability of harvests (Ferreira, 2009); or minimize sediment yield from agriculturally-dominated watersheds using time optimal control methodologies and computational models (Nicklow and Muleta 2001)

A further aspect of this work involves studies that advance frameworks for assimilating and integrating data in ways that might inform rather than lead decisions, such as research outlining in the capabilities of GIS for bring together analysis of spatial, aspatial and multi-layered information in catchment contexts (Chowdary *et al.* 2009) or the development of web-enabled, open source technologies that stakeholders can draw upon as the basis for more integrated decisions (Fulazzaky and Akil, 2009). Most of the work is led by an assessment of case study catchments, but there is evidence within the literature for more general assessments, such as a recent study that sought to model water quality scenarios in 80 catchments given

different programmes of measures employed in the context of the WFD (Crabtree *et al.* 2009)

Alongside this modelling research, **there exist a number of studies explicitly setting out to review the efficacy of policy interventions at the catchment scale**. Some of these studies are qualitative - narrative based - assessments of water policy in discrete environmental contexts, an example being recent work from Southern California, which reviewed how regional decision makers were able to simultaneously improve downstream water quality, promote the infiltration of storm water, and facilitate groundwater recharge (Rupp, 2009). A smaller number of studies develop policy reviews in quantitative terms; that is, integrating data sets to assess cross sectoral *impacts* of approaches to watershed management (Alemayehu *et al* 2009). We have also identified strands of work that develop general frameworks for evaluating cross-sectoral benefits, such as a set of related studies that have sought to review and develop indicators for sustainable development at the catchment scale (Walmsley *et al.* 2001; Walmsley 2002). While this work does not explicitly mention ecosystems services, there are important lessons to be learnt here for how Defra may further embed the ecosystems approach into assessments of catchment policy.

5.1.3 Key messages: valuation

As the search strategy has already revealed, the **primary focus of the valuation literature is on non economic forms of valuation**, with a very small body of work considering both. An important facet of the non economic strand of the literature is on **general review of the efficacy of participatory processes employed at the catchment level**. These can be meta reviews, based on drawing together general insights from the literature, but a common feature is to combine such assessments with more precise - geographically specific - lines of inquiry, often incorporating further empirical analysis of practices through qualitative interview and survey. These can range from **comparative national assessments**, such as a recent study which

sought to evaluate the different the regulatory and culture circumstances that shape effective participatory structures in a UK and French context (Lee, 2009). Or they can be **assessments that link national insight with case study exemplification**. For example, a US based survey analysed the effectiveness of 1145 local watershed groups in managing the issues of soil erosion, nutrients, and agrichemicals and goes on to make an in-depth assessment of the watershed planning process in Illinois (Duram *et al.*, 2008). Another study undertook an ex-post analysis of deliberative techniques employed in five water related projects across Europe (Antunes *et al.,* 2009). **While the conclusions drawn from these studies is often to emphasise and crystallise aspects of good practice, many also document major failings in technique**, and point to the different types of institutional and regulatory barriers that can impede progress towards their application). The development of quality assurance procedures and criteria that can evaluate river basin planning and governance processes is one interesting feature of this work (Pereira and Quintana 2009).

Original studies vary between the piloting of general frameworks for effective participation within and across policy scales, and more precise assessments of participatory techniques 'in action'. In both contexts a common focus is on improving the rigour of decision making by community-based environmental management organizations. A salient feature of this work is on demonstrating the efficacy of techniques in real world decision making contexts, sometimes in direct reference to frameworks widely applicable to UK, even if the geographical context is alien, such as developing participatory approaches to strategic environment assessment in Costa Rica (Sims and Sinclair, 2008). **Techniques assessed can be highly qualitative in approach, such as demonstrating the use of visioning, brainstorming and critical reflection exercises** (Sinclair *et al.* 2009). **However, instances of research exist where these are used, wholly or in part, with the development of decision support tools**. Typically these tools are designed to

enhance how problems are characterised and prioritised by experts, governments, NGOs and publics though techniques such as geographical information systems (Diwakar and Jayaraman, 2007). Some of this work is targeted at particular stakeholder groups, such as farmers, to help them reconcile the implications of management changes on business viability (Ferreira *et al.* 2009). Others are directed at reconciling the views of heterogenous groups of stakeholders. For example, one study documents the use of a causal mapping exercise through participatory modelling techniques around which multiples stakeholders could develop a shared language for collaborative policy design, mutual learning and knowledge integration

A minor strand of the non economic valuation literature develops quantitative based techniques for evaluating the interdependencies of stakeholders in processes of catchment decision making. For example, one recent study in the Netherlands employs mathematical sociology to develop a decision support tool that traces the interactions of stakeholder needs in characterising approaches to catchment management and advocates its use as a way of fostering greater understanding among stakeholders of the policy process in general, and the setting of management priorities in particular (Timmermans, 2009).

A distinct **strand of work pursues critical analysis of the governance structures that underpin river basin management** and these are typically strong advocates of participatory processes because they expose the political and contested basis of decisions (Roberts and Pannell, 2009) A clear emphasis in this literature is to recognise that stakeholder engagement is fundamental to the just allocation of scarce resources (Molle, 2009). However, some of this work is sceptical that techniques of river basin management planning based on fostering the collaboration of multiple stakeholders sits well with policy frameworks that also demand expedient responses, citing tensions that arise between efficiency and inclusion of all voices, quick delivery and implementing best practice (Blackstock, 2009).

Similar distinctions in the literature on economic valuation literature exist. It is particularly notable that within this modest literature **a significant strand of the economic valuation research is concerned with modelling the cost-effectiveness of management interventions specifically in the context of the WFD**. This work includes the development of methodologies to support decisions in precise areas of policy, such the development of cost-efficiency quotients for programmes of measures related to river morphology (Weyand *et al.* 2009); or economic analysis of the costs associated with the number and type of best management practices necessary to achieve *Total Maximum Daily Load* pollution reduction goals (Borisova *et al.*, 2008). Other work provides more **general economic analysis of the preparation of river basin management plans**, on occasion by comparing and contrasting valuation methodologies and evaluating their suitability for WFD implementation. Within this, work there also exist more **novel methodologies for economic valuation,** such as assessing the use of 'choice experiments' methodologies to estimate the economic costs and benefits of improvements to ecological status. Experimentation with these novel valuation methodologies can be found in literature outside of an EU context but our initial conclusion is that they will find value and application in the UK. An example here would be a recent study employing the contingent valuation methodology to estimate the value of improving water supplies in a micro-watershed Nicaragua (Johnson and Baltodano, 2004). Evaluations of these and other techniques sit alongside **bodies of work primarily concerned with general review of challenges associated with developing integrative approaches to socio-economic planning**; ones that seek to document ways of minimising financial burdens on regulators and wider stakeholders (Stemplewski *et al.,* 2008).

5.2 Quality assessment

The final stage of this process involved making a quality assessment of a sub-sample of the materials identified. Here two members of the project team undertook a quality assessment of 50 accessible journal articles for both questioning areas[7] (i.e. 100 in total) which involved ranking papers according to a generic set of quality criteria (See Table 7 overleaf). The quality assessment was undertaken by two persons within the project team, who evaluated 10 articles together (to foster a consistent approach) and 20 articles each, independently. While discrepancies will inevitably arise in making qualitative assessments of this sort we feel this approach offered the review process a 'rule of thumb' guide to the overall study quality. The conclusion drawn from this exercise and which is depicted in Table 10, is that the quality of this literature is generally acceptable with nearly 80% of materials relating to issues of cross sectoral being satisfactory or above, compared to just over 70% of materials for the issue of valuation. In both cases key areas of weakness tend to be in developing comprehensive accounts of the geographical context of study, reflexiveness about limitations and transparency in approach. These results would seem to suggest that there is large volume of literature that could meet the needs of systematic reviews for each question.

Finally it is worth recognising the non-standard nature of this assessment. The materials being considered by this review do not fall neatly into the conventional logic of systematic review, where the concern is to evaluate and summarize evidence around tightly defined material interventions that can be judged according to the protocols of scientific inquiry. Both the review question consider materials across a range of subject areas to examine a more general thematic concern and in many instance considered research that is more interpretative and conceptual than it is experimental.

[7] Since the valuation question has two distinct components, with non economic valuation techniques dominating the literature, only 20% of the literature reviewed for this question was concerned with non economic valuation techniques.

Quality criteria	*Quality ranking (% of literature)*									
	Q1: *Cross-sectoral Benefits*					Q2: *Valuation*				
	NA	Absent	Inadequate	Satisfactory	Good	*NA*	Absent	Inadequate	Satisfactory	Good
Clearly defined research questions/issue				*29*	*21*				*41*	*9*
Policy context explained		*1*	*5*	*22*	*22*		*5*	*5*	*23*	*17*
Geographical context described	*3*	*5*	*8*	*24*	*10*	*8*	*9*	*15*	*6*	*12*
Contextualised in literature		*1*	*5*	*13*	*31*		*2*	*6*	*22*	*20*
Transparent methodology		*8*	*6*	*28*	*8*		*6*	*15*	*20*	*9*
Limitations of study exposed	*3*	*7*	*6*	*23*	*11*		*12*	*11*	*15*	*12*
Clear conclusions drawn		*1*	*10*	*23*	*16*			*5*	*34*	*11*
Generalisability of results explained		*8*	*8*	*14*	*20*		*10*	*8*	*26*	*6*
Total profile (% of Articles in quality categories)	**1.5**	**7.75**	**12**	**44**	**34.75**	**2**	**11**	**16.25**	**46.75**	**24**

Table 7: Overall quality assessment – cross-sectoral benefits and valuation

6. Conclusion: the case for full systematic review

Drawing on the protocols of systematic review this pilot stud has provided a basis upon which the idea of 'catchment scale environmental decision making' can be critically inspected in the context of an emerging EsA. In scoping the potential case for full systematic review of these related policy areas, the report took at its starting point the general principles of an EsA as developed by Defra (2007a) in its *Ecosystems Action Plan*. While these principles were shown to be open to potentially varied types of review, the conclusion of the expert informed consultation was that the guiding objectives of this study could best be served by focusing on two areas of questioning.

First, it was widely agreed that, if catchment scale decision making were to be considered consistent with the needs of the EsA, it must be able to demonstrate capacities to foster cross-sectoral benefits. Identifying and evaluating evidence that could illustrate how, and to what extent, such benefits can be realised was recognised by the group as a primary driver for future review. Second, the need to understand the basis upon which catchment scale policy processes can incorporate into decision making the full (economic and non economic) value of ecosystem services was also judged to be an important area of review questioning.

A prototypical search strategy was developed that could systematically explore the current evidence base for each of these questioning areas. This process revealed a large (and international) body of evidence exists on catchment scale decision making and that workable search strings could be employed to refine this literature for each questioning area. The literature is varied but initial results suggest any subsequent review is likely to reveal significant bodies of evidence that, proceeding from issues of water quality and quantity, demonstrate *how* decision making at the catchment scale might foster multiple – cross sectoral – benefits particularly through the use of novel decision support and appraisal tools. Equally, full systematic review of

approaches to valuation is likely to yield a significant body of evidence evaluating how participatory and deliberative processes can be embedded into good practice at the catchment scale, often working in combination with these decision support technologies. However, based on the published record, the case for evaluating economic valuation techniques is notably much weaker. This volume of relevant literature is very modest and its scope uneven in terms of the framework for valuation outline by Defra (2007b).

It is worth recognising that this assessment is based on an evaluating of material identified by the WoS. Patterns and themes of research will inevitably be broader, and likely to more directly focus on material outcomes when the grey literature is incorporated in to the search process. However, the expert panel expressed some concern that this literature may not be accessible in ways envisaged by the protocols of systematic review. Nonetheless, our overall conclusion is that a body of evidence exists that can begin to amplify the relationship between catchment scale decision making and the EsA in meaningful and pragmatic ways. Two draft protocols that can take this work forward are detailed in the accompanying appendices.

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Annex 1: Draft Protocol One

1. BACKGROUND

Approaches to environmental decision making that maintain and enhance the cross-sectoral benefits of ecosystems is a guiding principle of Defra's (2007) Ecosystems Action Plan. Cross-sectorality encompasses a concern to promote more synergistic and joined-up approaches to natural resource management; exploiting opportunities for integrated delivery where they arise, but also devising ways in which the trade-offs of management can be exposed and potentially reconciled. Cross-sectorality is therefore about recognising the interdependencies that exist between arenas of environmental management historically held separate, and in the context of Defra's Action Plan, is at the heart of how Defra and its partners seek to manage ecosystem services for human well being.

The purpose of this review is to examine, through a critical account of the evidence base, how and to what extent cross-sectorality is reflected in approaches to environmental management with specific reference to management that takes place at the catchment scale. This is important for, alongside strategic calls for embedding an Ecosystems approach (EsA) in to decision making, catchment scale planning remains an important regulatory and legal focal point for the sustainable management of natural resources. This concern finds expression in a range of UK policy contexts, not least in meeting the requirements of the *Water Framework Directive* (WFD), such as through the delivery of the *England Catchment Sensitive Farming Delivery Initiative* (ECSFDI), but also in other strategic policy areas such as the Governments recent *Making Space for Water* initiative. While catchment planning proceeds, first and foremost, through a concern to manage issues of water quality and quantity, these priorities are directly or indirectly associated with a range of ecosystem services. Catchment management is, in principle a context in which the synergies and tensions between, for instance, provisioning, regulating, supporting and cultural services can be realised. This review therefore seeks to understand the ways in which an underpinning theme of an EsA is given practical meaning in an environmental context where the idea of integrated - cross-sectoral- management should be keenly understood, and where models for good practice in an embedding an ecosystems approaches are potentially high.

2. OBJECTIVE OF THE REVIEW

2.1 Primary question

- Is catchment scale decision making effective in managing ecosystems for their cross-sectoral benefits?

2.2 Secondary question

- What methodologies or techniques can be used to underpin cross sectoral management of ecosystems at the catchment scale?
- Do catchment scale decision making processes respect environmental limits in the context of ecosystem functioning?

3. METHODS

3.1 Search strategy

Web-searching: the strategy will combine use of general search engines, and those directly related to the thematic concerns of the systematic review

Agricola (http://agricola.nal.usda.gov/)
All the web (www.alltheweb.com)
CAB Abstracts (www.cabi.org/index.asp)
Countryside Council for Wales (www.ccw.gov.uk)
Defra www.defra.gov.uk
Department of Energy and Climate Change www.decc.gov.uk
Ebsco (http://web.ebscohost.com)
Ecosystem Services Project (www.ecosystemservicesproject.org),
EMBASE (http://www.embase.com/)
European Environment Agency (www.eea.europa.eu)
Environment Agency (www.environment-agency.gov.uk)
Foresight project (www.foresight.gov.uk)
Index to Theses Online (www.theses.com/)
ISI Web of Science (http://apps.isiknowledge.com)
Millennium Protocol Assessment (www.maweb.org),
Natural Capital Project (www.naturalcapitalproject.org),
Natural England (www.naturalengland.org)
Google (www.google.com)
Google Scholar (http://www.scholar.google.com
Science Direct (http://www.sciencedirect.com)
SEPA www.sepa.org.uk
JSTOR (http://www.jstor.org)
Scientific Electronic Library Online (http://www.scielo.org)
Scirus (www.scirus.com)
Scopus (http://www.scopus.com)
Sniffer (www.sniffer.org.uk),
UKTAG (www.wfduk.org)
US Environmental Protection Agency (www.epa.gov)
US Army Corps of Engineers (www.USACE.army.mil)
US Department of Agriculture (www.USDA.gov)

Search Terms:

The search strategy is designed to use different combinations of terminologies which link the geographical scale of decision making (e.g. catchments/river basins) to relevant cross-sectoral processes (e.g. integrated) and actions (e.g. management). The suggested terms are based on a validated procedure that avoids duplicate articles and combinations of terminology where no returns occurred at the time of the scoping processes. Reviewers should revisit all combinations detailed in the scoping report for this protocol to ensure no new literature has emerged around discarded terms. The structure of this approach searching currently conforms to protocols of the Web of Science (WoS) and may need to be adapted.

"Integrated plan*" OR "Integrated Management" OR "Integrated polic*" OR "Integrated Strateg*" OR "Integrated development" OR " Integrated water management" OR "Integrated natural resources management" OR "Integrated natural resources management" OR "Integrated environmental management "OR "Integrated water resource management" OR "Integrated water resources management" OR "Integrated land use management "OR "Integrated land and water management"

AND

"catchment*" OR "catchment area" OR "catchment scale" OR "watershed*" OR "drainage basin*" OR "river basin*"

OR

"Integrated catchment plan*" OR "Integrated catchment management" OR "Integrated catchment scale plan*" OR "Integrated watershed plan*" OR "Integrated watershed management" OR "Integrated river basin plan*" OR "Integrated river basin management" OR "Total catchment management" OR "Total catchment plan*"OR "Total watershed management" OR "Comprehensive catchment management" OR "Comprehensive watershed plan*" OR "Comprehensive watershed management" OR "Comprehensive watershed development" OR "Comprehensive river basin plan*"OR "Comprehensive river basin management" OR "Strategic catchment management" OR "Strategic watershed management" OR "Strategic river basin management" OR "Strategic river basin plan*" OR "Whole catchment management" OR "Whole river basin management" OR "Sustainable catchment development" OR "Sustainable catchment management" OR "Sustainable catchment development" OR "Sustainable watershed management" OR " Sustainable watershed development" OR "Sustainable river basin plan*" OR "Sustainable river basin governance" OR "Sustainable river basin management" OR "Sustainable river basin development"

3.2 Study inclusion criteria

- **Relevant subject(s):**

  Thematic research areas that address the benefits that ecosystems may provide in a catchment context. The use of the MA framework is recommended for disaggregating studies in to particular subject areas: i.e. provisioning; regulating, cultural, and supporting.

- **Types of intervention:**

  All interventions that employ the catchment scale as a framework for actual or potential management.

- **Types of comparator:**

  Studies in which single sector (water based) ecosystem services prevail in catchment based decision making processes.

- **Types of outcome:**

  Water benefits *plus* the delivery of provisioning, regulating, cultural, and supporting benefits residing in other sectors.

- **Types of study:**

  Bodies of literature that: i) specifically develop conceptual frameworks or arguments that can further our understanding of this policy area; ii) demonstrate applications of tools and techniques in applied (i.e. catchment) settings (such as the testing of 'decision support tools'); and evaluations and critiques of policy (such as scientific and social scientific appraisals of policy delivery).

  It is recommended that an English language literature is consulted for this review, but that the scope of review should draw on examples from both a UK and Non UK origin.

3.3 Potential effect modifiers and reasons for heterogeneity:

The comparative basis of review means that lessons for the UK are not always translatable. The biophysical and cultural characteristics of studies may vary markedly limiting the creation of general, and therefore widely applicable, findings.

3.4 Study quality assessment

The range of studies considered in this review and the variegated scientific basis of studies means that quality assessments of literature should be initially based on their generic reporting characteristics. A general framework for this assessment, that ranks the principal characteristics of each study is suggested in Figure 1 below.

Quality Criteria	***Quality ranking***			
	Absent	***Inadequate***	***Satisfactory***	***Good***
Clearly defined research questions/issue				
Policy context explained				
Geographical context described (where appropriate)				
Contextualised in literature				
Transparent methodology (where appropriate)				
Limitations of study exposed				
Clear conclusions drawn				
Generalisability of results explained				

Figure A1-1: Overall framework for quality assessment

3.5 Data extraction strategy

This is a non-standard review protocol to the extent that it considers a range of thematic concerns to answer its primary question. Extractable quantitative data will be a feature of *some* of the material. Where such data exists it will be assembled in a spreadsheet and organised around the cross-sectoral issues addressed (such as studies that link water quality and quantity benefits to those of recreation). Many studies will report on underpinning conceptual and methodological developments in this topic area and in these instances techniques of qualitative coding will be applied.

3.6 Data synthesis and presentation

The synthesis process will be primarily qualitative and narrative based in approach. It will summarise where approaches to catchment based decision making are currently strong and weak in terms of managing cross-sectoral benefits, and where developments in theory and techniques provide pathways to more integrated management processes. Emphasis at this synthesis stage will be on highlighting areas of good practice and where opportunities exist for applying approaches in different types of catchment setting.

4. POTENTIAL CONFLICTS OF INTEREST AND SOURCES OF SUPPORT

None expected

5. REFERENCES

Defra (2007) *Securing a healthy natural environment: an action plan for embedding an ecosystems approach (*accessible at: www.defra.gov.uk/wildlife-countryside/pdf/natural-environ/eco-actionplan.pdf)

Annex 2: Draft Protocol Two

1. BACKGROUND

Recent efforts on the part of the UK policy community to embed an 'ecosystems approach' into environmental decision making natural resource management (Defra 2007a) have argued that that long-term efficacy and acceptability of environmental policy depends, to a significant extent, on underpinning decisions with a combination of economic and non economic approaches to environmental valuation. Developments in the policy literature on valuation have turned primarily on the issue of economic valuation, and a range of methodologies based on real and surrogate markets for ecosystems goods and services have been proposed (Defra 2007b). Non economic sources of valuation, in contrast, refer to a wider set of methodologies designed to engage stakeholders in a more deliberative and interpretive way, and while the academic literature on such participatory techniques is extensive, their precise relationship with an EsA in general, and economic approaches to valuation in particular, is not yet understood.

The purpose of this review is to begin to understand the ways in which these tools and techniques of valuation can be deployed to meet the needs of an EsA in the context of catchment scale planning. Catchment scale planning remains an important regulatory and legal focal point for the sustainable management of natural resources and finds expression in a range of UK policy contexts, not least in meeting the requirements of the *Water Framework Directive* (WFD), such as through the delivery of the *England Catchment Sensitive Farming Delivery Initiative* (ECSFDI), but also in other strategic policy areas such as the Governments recent *Making Space for Water* initiative. These developments are important for a common strand that runs through them all is the need to broker interventions and strategies through partnership working. More generally it is notable that catchment scale environmental management has been an important context in which the idea of inclusive and collaborative management has been critically inspected and tested by academic literature. This review therefore proceeds from idea that building and recognising "full value" in decision making is not only a need of the Catchment Planning given the principles of an EsA, but a context in which the wider application of these techniques for ecosystems based thinking can begin to be distilled.

2. OBJECTIVE OF THE REVIEW

2.1 Primary question

What techniques for the valuation of ecosystem services are effective in the context of catchment based decision making?

2.2 Secondary questions

- What are the characteristics of inclusionary and deliberative processes in a catchment context and what constitutes good practice?
- How are economic approaches to valuation applied in a catchment context and what constitutes good practice?

3. METHODS

3.1 Search strategy

Web-searching: the strategy will combine use of general search engines, and those directly related to the thematic concerns of the systematic review

Agricola (http://agricola.nal.usda.gov/)
All the web (www.alltheweb.com)
CAB Abstracts (www.cabi.org/index.asp)
Countryside Council for Wales (www.ccw.gov.uk)
Defra www.defra.gov.uk
Department of Community and Local Government (www.dclg.gov.uk)
Department of Energy and Climate Change (www.decc.gov.uk)
CSERGE (Water and valuation database) (www.uea.ac.uk/env/cserge)
Ebsco (http://web.ebscohost.com)
Ecosystem Services Project (www.ecosystemservicesproject.org),
EMBASE (www.embase.com/)
Environment Agency (www.environment-agency.gov.uk)
European Environment Agency (www.eea.europa.eu)
EVRI (Environmental Valuation Reference Inventory) (www.EVRI.ca)
Foresight project (www.foresight.gov.uk)
Index to Theses Online (www.theses.com/)
ISI Web of Science (http://apps.isiknowledge.com)
Millennium Protocol Assessment (www.maweb.org),
Natural Capital Project (www.naturalcapitalproject.org),
Natural England (www.naturalengland.org)
Google (www.google.com)
Google Scholar (www.scholar.google.com
Science Direct (www.sciencedirect.com)
SEPA (www.sepa.org.uk)
JSTOR (http://www.jstor.org)
Scientific Electronic Library Online (http://www.scielo.org)
Scirus (www.scirus.com)
Scopus (http://www.scopus.com)
Sniffer (www.sniffer.org.uk),
UKTAG (www.wfduk.org)

US Environmental Protection Agency (www.epa.gov)
US Army Corps of Engineers (www.USACE.army.mil)
US Department of Agriculture (www.USDA.gov)

Search Terms:

The search strategy is designed to link general bodies of literature regarding this geographical scale of decision making (e.g. 'catchment management') to those specifically addressing economic and non economic forms of valuation. The suggested terms are based on a validated procedure that avoids duplicate articles and combinations of terminology where no returns occurred at the time of the scoping processes. Reviewers should revisit all combinations detailed in the scoping report for this protocol to ensure no new literature has emerged around discarded terms. The structure of this approach searching currently conforms to protocols of the Web of Science (WoS) and may need to be adapted.

"catchment plan*" OR "catchment decision making" OR "catchment management" OR "catchment polic*" OR "catchment strateg*" OR "catchment development "OR "catchment scale plan*" OR "catchment scale decision making" OR "catchment scale management" OR "catchment scale polic*" OR "catchment area management" OR "catchment area polic*" OR "watershed plan*" OR "watershed decision making" OR "watershed governance" OR "watershed management" OR "watershed polic*" OR "watershed strateg*" OR " watershed development " OR "drainage basin plan*" OR "drainage basin management" OR " drainage basin development "OR "river basin plan*" OR "river basin decision making" OR "river basin governance" OR "river basin management" OR "river basin polic*" OR "river basin strateg*" OR "river basin development ")

AND

"Inclus*" OR "Delibera*" OR "Particip*" OR "co-management" OR "collaborat*" OR "Stakeholder*" OR "social capital" OR "Consensus-building" OR "Economic Valu*" OR "Economic Assessment" OR "Ecosystem Valu*" OR "Cost-benefit" OR "Benefit-cost" OR "Cost effectiveness" OR "Use value"

3.2 Study inclusion criteria

- **Relevant subject(s):**

  Catchment based environmental management

- **Types of intervention:**

  Techniques that encompass either or both economic and non economic forms of valuation as the basis for decision making

- **Types of comparator:**

  Catchment valuation studies in which barriers to implementation and technique development are documented

- **Types of outcome:**

  Valuation techniques that result in 'socially inclusive' decision making.

  Valuation techniques that result in reasoned assessments of economic costs and benefits.

  Studies in which 'trade-offs' of management have been exposed.

  Studies in which consensus has been built or differences between stakeholders clarified.

- **Types of study:**

  Bodies of literature that: i) specifically develop conceptual frameworks or arguments that can further our understanding of this policy area; ii) demonstrate applications of tools and techniques in applied (i.e. catchment) settings (such as the testing of contingent valuation techniques); and evaluations and critiques of policy (such as scientific and social scientific appraisals of outcomes).

  It is recommended that an English language literature is consulted for this review, but that the scope of review should draw on examples from both a UK and Non UK origin.

3.3 Potential effect modifiers and reasons for heterogeneity:

- The comparative basis of review means that lessons for the UK are not always translatable. The cultural characteristics of the valuation studies may vary markedly.

3.4 Study quality assessment

- The range of studies considered in this review and variegated scientific basis of studies means that quality assessments of literature should be based on generic reporting characteristics of the materials consulted. A

framework for this assessment, that ranks the principal characteristics of aspects of each study is suggested in Figure 1 below.

Quality Criteria	***Quality ranking***			
	Absent	***Inadequate***	***Satisfactory***	***Good***
Clearly defined research questions/issue				
Policy context explained				
Geographical context described (where appropriate)				
Contextualised in literature				
Transparent methodology (where appropriate)				
Limitations of study exposed				
Clear conclusions drawn				
Generalisability of results explained				

Figure A2-1: Overall quality assessment

3.5 Data extraction strategy

This is a non-standard review protocol to the extent that it considers two, generally discrete, basses of valuation. Extractable quantitative data will be a feature of *some* of the material consulted on economic valuation which will be assembled in a spreadsheet and organised around a schedule of revealed and stated preference methodologies Other studies based on techniques of participation and inclusion are likely to be systematic, but not necessary quantitative, in scope, so here an extraction strategy based on the qualitative coding of findings will be deployed.

3.6 Data synthesis and presentation

The synthesis process will emphasise, using primarily qualitative analytical techniques, the conceptual and applied basis of valuation techniques. SWOT analysis of techniques will be developed to read across studies, with an

emphasis on highlight areas of good practice, specifically as these relate to managing particular types or combinations of ecosystem services.

4. POTENTIAL CONFLICTS OF INTEREST AND SOURCES OF SUPPORT

None expected

5. REFERENCES

Defra (2007a) *Securing a healthy natural environment: an action plan for embedding an ecosystems approach (*accessible at: www.defra.gov.uk/wildlife-countryside/pdf/natural-environ/eco-actionplan.pdf)

Defra (2007b) *Introductory Guide to Valuing Ecosystem Services* (Accessible at: www.defra.gov.uk/wildlife-countryside/pdf/natural-environ/eco-valuing.pdf)