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An evaluation of ecological impact assessment procedural effectiveness over time

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Dr. Katherine Drayson (corresponding author) ^{a1}

Dr. Graham Wood^b

Prof. Stewart Thompson ^a

^a Department of Biological and Medical Sciences, Faculty of Health and Life Sciences, Oxford Brookes University, Gypsy Lane, Oxford, United Kingdom, OX3 0BP

^b School of the Built Environment, Faculty of Technology, Design and Environment, Oxford Brookes University, Gypsy Lane, Oxford, United Kingdom, OX3 0BP

katherinedrayson@aol.co.uk, +44 (0)7837 877 714

gjwood@brookes.ac.uk, +44 (0) 1865 483 942

sthompson@brookes.ac.uk, +44 (0)1865 483 253

¹ Currently at the Greater London Authority, City Hall, The Queen's Walk, SE1 2AA

ABSTRACT

Environmental Impact Assessment (EIA) is an important tool to help decision-makers balance the environmental impacts of a proposed built development with its potential economic benefits. Used in most countries across the globe, EIA commonly includes an ecological component (Ecological Impact Assessment, or EclA). However, despite considerable changes in relevant legislation, policy and guidance, there has been no recent review of UK EclA chapter content, with the latest review having been published in 2000.

This study attempts to determine the procedural effectiveness of EclA chapters over time by comparing a new review of 112 English EclA chapters from 2000 onwards with earlier reviews. This was achieved through the novel use of inferential statistics, an approach previously lacking in the EIA and EclA review literature.

The limitations and advantages of the use of quantitative methods are discussed. In general, there has been an improvement in the information content of EclA chapters over time, for example in the percentage of EclA chapters stating the size of the development and estimating the likely effectiveness of proposed mitigation measures. However, the earlier reviews highlighted such severe information deficiencies that the progress seen in the post-2000 EclA chapter review still leaves considerable scope for improvement.

Changes in the EU's EIA Directive in force since May 2014 (and to be transposed into Member State legislation by May 2017) have the potential to encourage the use of inferential statistics in EIA and EclA review: the requirement for Member States to provide central access to EIA information should enable representative samples to be analysed.

KEYWORDS

Biodiversity, Ecology, Impact Assessment, Review, Environmental Statement, EIA

1. Introduction

Across the globe, biodiversity is being lost at unprecedented rates (Millennium Ecosystem Assessment, 2005; RSPB, 2016) and international targets to slow or halt this loss have not been met (Butchart et al., 2010). A key cause of biodiversity loss is land use change (Millennium Ecosystem Assessment, 2005). In England, as across much of the inhabited world, the main drivers of land use change include agriculture, forestry and built development (Foley et al., 2005; Land Use Consultants, 2005; Maxwell et al., 2016). Given predictions of likely population increases and the consequent need for major infrastructure creation and renewal over the next ten years (Fothergill, 2011), a focus on the built environment's impacts on ecology is of importance.

Environmental Impact Assessment (EIA) is a process referenced in the legislation of approximately 180 countries worldwide (Morgan, 2012). It allows the potential environmental impacts of a proposed built development to be assessed, prior to a planning decision being made. Depending on the outcome of the scoping exercise, ecology may form a component of an EIA.

EIA can, in theory, aid decision-making and contribute towards sustainable development (Glasson, 1994). However, the effectiveness of EIA, whether substantive or procedural, has frequently been called into question (e.g. Cashmore et al., 2004). An investigation of an aspect of substantive effectiveness of EcIA (the implementation and success of habitat mitigation measures in completed EIA developments) can be found in Drayson and Thompson (2013).

Procedural effectiveness relates to whether EIA is undertaken according to "established provisions and principles" (Sadler, 1996). This paper examines the procedural effectiveness of the ecological component of EIA (Ecological Impact Assessment, or EcIA) to identify current weaknesses in practice and determine whether there have been any changes over time.

One of the simplest and most cost-effective methods of researching EIA procedure is to review the key EIA documentary output, i.e. the Environmental Statement (ES) by using a checklist (Trewick,

1996). This method does, however, depend on being able to access all the relevant key documentary information, such as technical appendices and planning agreements. Site visits, interviews and questionnaires will provide a richer context and higher level of detail, particularly since not all of the processes and findings from undertaking the EIA are necessarily reported in the ES and its associated documents (Treweek et al., 1993). However, ES review is relatively inexpensive and less time-consuming, allowing for examination of larger numbers of ESs and therefore providing a wider picture of practice. In addition, it allows for detailed and systematic comparisons and the identification of patterns and trends over time and between countries, for example through the use of inferential statistics. This, in turn, can provide an evidence base to help inform environmental policy and legislation. This will be particularly important in the event of the UK exiting the European Union, since there may be future changes in environmental legislation and policy, the impacts of which will require assessment against a reliable baseline.

1.1. Previous EclA chapter reviews

In comparison with reviews of entire ESs, reviews of individual ES technical chapters, such as the EclA chapter, have been conducted relatively infrequently. Yet these disaggregated studies can reveal differences that would otherwise be masked by a whole-ES review. For example, socio-economic impacts tend to be poorly considered within ESs (Glasson and Heaney, 1993) and water impact assessments tend to be less poorly conducted than ecological impact assessments (Badr et al., 2004).

There have been six main published reviews of UK EclA chapters (see Table 1) ranging in publication year from 1992 to 2000 and reviewing EclA chapters from 1988 to 1997. All used study-specific criteria, based on legislation, policy and guidance existing at the time, making comparisons between the reviews difficult.

Table 1. Characteristics of the six main published UK EclA chapter reviews, in publication year order, in comparison with the current review.

Review Authors	Publication Year	EclA Year Range	No. of EclAs	Geographic Distribution of EclAs	Planning Application Status	Comments
Spellerberg & Minshull	1992	1988-1989	45	UK	All	N/A
Treweek <i>et al.</i>	1993	1989-1991	37	UK	All	Road EclA chapters only
RSPB	1995	1988-1994	37	UK	All	N/A
Thompson <i>et al.</i>	1997	1988-1993	179	UK	All	N/A
Treweek & Thompson	1997	1988-1993	194	UK	All	Mitigation only
Byron <i>et al.</i>	2000	1993-1997	40	UK	All	Road EclA chapters only
Current Review	N/A	2000-2011	112	England	Granted permission	N/A

Of those early EclA chapter reviews, all found elements requiring considerable improvement in almost every part of the EclA process (Byron *et al.*, 2000; RSPB, 1995; Spellerberg and Minshull, 1992; Thompson *et al.*, 1997; Treweek and Thompson, 1997; Treweek *et al.*, 1993). These included, for example, lack of consultation, poor baseline survey, lack of quantification (of the ecological baseline and impact predictions), inadequate cumulative impact assessment, vague mitigation measure descriptions, and low levels of commitment to mitigation and follow-up. However, with changes in legislation, policy and guidance, there is potential for some improvements to have been made (changes between 2000 and 2010 are summarised in Appendix B). Yet there has been little recent work evaluating EclA performance. Increasingly strong legislative protection of biodiversity, as well as increased recognition of the importance of ecology in planning guidance and improvements in professional development, warrant a study that builds on these early EclA chapter reviews.

1.2. Use of the quantitative approach in ES research

1.2.1. Difficulties

The lack of inferential statistics in the literature on this topic is partly due to the subjective nature of ES research. For example, whether an ES or EclA chapter is deemed to have met particular criteria in

checklist-based reviews often depends on the reviewer (Pöder and Lukki, 2011). In addition, each ES is subject to a different array of constraints and contexts (such as the likely controversy of the proposed development and the development type), making comparisons between ESs and assessments of changes over time less reliable. One way to overcome this problem is to use matched pairs of ESs (i.e. each ES assigned to one time period is 'matched' to an ES in another time period by development type, development size, etc.), as demonstrated by Glasson et al. (1997). Another method is to ensure the sample size (i.e. the number of ESs reviewed) is large (e.g. Ryan, 2013, p. 298).

The use of the results of previous reviews of EclA chapters to quantitatively examine changes over time also presents several difficulties. For example, some of the assessment criteria may have been slightly different in different reviews, making comparisons difficult. In addition, previous reviews may have expressed their findings as percentages of EclA chapters. If these are expressed to one or fewer decimal places, determining the actual number of EclA chapters may be less accurate (for example, 14.8% of 37 EclA chapters could be either five or six EclA chapters, depending on the rounding method used. All of these issues make the use of inferential statistics more challenging.

1.2.2. Advantages

However, whilst another analysis of EclA chapters using purely descriptive statistics would be timely given the decade since the last review, it would miss an important opportunity. That opportunity is the secondary analysis of results from the earlier reviews in order to address the new question of whether there have been changes over time. There are, as described above, several issues with statistically comparing the results of previous reviews. However, whilst simple comparisons of percentages across reviews may be illustrative, a statistical analysis across reviews (whilst making attempts to minimise, and clearly stating, the limitations of such an approach) may prove more informative (Burstein, 1978). With regard to checklist-based reviews of ESs and EclA chapters, there does seem to be a legitimate research gap in the use of inferential statistics.

1.3. International EclA chapter reviews

Many countries using EIA also experience deficiencies in the information provided within EclA chapters (e.g. Mandelik et al., 2005; Naser et al., 2008; Oscarsson and Kjellander, 2004; Samarakoon and Rowan, 2008; Wegner et al., 2005). There have also been several attempts internationally to standardise reviews of EclA chapter procedural effectiveness (e.g. Atkinson et al., 2000; Khera and Kumar, 2010; Soderman, 2005), thereby allowing inter-country comparisons. This study, whilst focused on EclA in England, therefore has wider applicability to the international context in attempting to compare EclA chapter reviews over time, rather than spatially between countries.

2. Method

2.1. EclA chapter sample

112 ESs were obtained from a variety of sources, including the Oxford Brookes University Planning Department's Resources Centre, local authority websites, internet searches and environmental consultancies. The ESs included all relevant technical appendices. Post-consent documents, such as decision notices, planning agreements and management plans were not considered in this analysis to ensure comparability with the previous EclA chapter reviews.

To ensure that only the current status of the planning system as a whole (as opposed to, for example, simply flaws in the approach used by ecological consultants) was investigated, this review was restricted to ESs for developments that were granted planning permission (including those for which appeals against refusal or non-determination were upheld).

To avoid any potential for including ESs that had been analysed in the previous published reviews, a submission year of 2000 was used as the earliest from which the sample could be drawn. Since 1998, devolution has created subtle differences in the legislative, policy and guidance framework for EclA in England, Wales, Scotland and Northern Ireland, presenting difficulties in direct EclA comparison

(UKELA et al., 2012). As a result, only ESs for developments within England were included. Aside from these three criteria, no further restrictions were made.

It is not possible to determine how representative this sample is of the ESs submitted and granted planning permission across England during that time period, due to the lack of a centralised EIA planning application database. However, an earlier study noted that a sample size of 100 ESs was sufficient from which to draw meaningful conclusions (DETR, 1997). Given the wide variety of sources from which ESs in this study were obtained, it is assumed that a sample of 112 can be considered to be representative. Their details can be found in Appendix A.

2.2. Data collection

A review of the previous EclA chapter review studies was conducted to identify those checklist questions that the different EclA chapter reviews had in common. The previous EclA chapter reviews did not include lists of the questions asked, or the thresholds used for answering each question. As a result, the questions and how they should be answered had to be inferred from the main text of the reviews.

These questions were then used on the current sample of 112 EclA chapters (where necessary, also consulting the technical appendices and introductory chapters of the ES). Wherever possible, questions (and the range of possible answers to each question) were phrased such that the results would be as comparable as possible to those of the earlier reviews. To aid analysis, the range of possible answers to each question in the list was identified and standardised. For example, the majority of questions could be answered from amongst the following range of possible answers; 'Yes', 'No', 'Partly/Some', 'Unknown' and 'N/A' (Not Applicable).

2.3. Data analysis

2.3.1. Assumptions

In the majority of the earlier studies, the reviewed ESs were not named (RSPB, 1995; Spellerberg and Minshull, 1992; Thompson et al., 1997; Treweek and Thompson, 1997), and so whilst an assumption is made regarding independence in the data analysis, this may not necessarily be the case. The assumption is also made that the current review's restriction to English ESs will not affect the analysis or interpretation of the results. It is also assumed that previous reviews' restrictions to ESs for particular development types will have a minor impact on the results in comparison with the large changes in legislation, policy, guidance and professional practice over the study period. For example, it might be expected that modern wind farm EclA chapters (relatively unusual in the previous EclA chapter reviews) would be more likely to include bat surveys and so could skew the fauna survey results. However, similar percentages of the wind farm and road EclA chapters reviewed in the current study conducted bat surveys. This is likely due to stronger legislation with regard to European Protected Species, and also greater recognition that roads can also have significant impacts on bats.

2.3.2. Statistical tests

To compare EclA chapter frequencies in answering certain questions (e.g. whether or not development size had been stated) across multiple studies, the Pearson chi square test was used. In order to ensure accuracy, the exact two-tailed P-value of the Pearson chi square test was calculated. This also enabled tests to be performed where expected cell counts were below five or where observed counts were zero (Mehta and Patel, 2010). All analyses were carried out using SPSS (IBM SPSS Statistics 19).

Use of null hypothesis significance testing is not without its problems (e.g. Cumming et al., 2007; Fidler et al., 2006; Fidler and Loftus, 2009). As a result, 95% confidence intervals for proportions have been included in the figures.

2.4. Replicability study

Commonly, ES review packages recommend that the reviews are conducted by more than one person, to reduce the effects of personal subjectivity (e.g. Lee et al., 1999). However, given the length of time required for each review, several studies have involved ES review by only one person (e.g. Canelas et al., 2005; McGrath and Bond, 1997), with a sample of the reviewed ESs being re-reviewed and the results compared. The latter approach was used in this study.

To determine the replicability of the current review of 112 EclA chapters, the first five chapters were re-reviewed (approximately one year after their initial analysis) using a separate spreadsheet. The number of identical versus different answers between the two reviews was calculated for each of the five EclA chapters. To determine whether the level of replicability was acceptable, the alternative (one-tailed) hypothesis that the proportion of identical answers is greater than 95% was tested. A one-sample binomial test procedure in SPSS was conducted for each re-reviewed EclA chapter.

3. Results and discussion

3.1. Replicability study

The null hypothesis that the proportion of identical answers is equal to 95% was rejected for each of the five re-reviewed EclA chapters in favour of the alternative hypothesis that the proportion of identical answers is greater than 95% ($p < 0.05$). The study therefore shows high replicability of EclA chapter analysis.

3.2. Comparisons with previous review studies

A summary of the comparisons between the current EclA chapter review and the earlier reviews can be found in Table 2. A selection of these comparisons will be explored in detail in this section.

3.2.1. Development sector

A comparison between the current review and the two earlier reviews that considered ESs from multiple development sectors can be found in Fig. 1. The categories from the Thompson et al. (1997) review were taken, being the broadest of the three reviews (it is easier for narrow categories to be combined into a broader category than vice versa). Of note is the significant reduction in the percentage of ESs in the current review drawn from industrial developments, such as power stations, mineral extraction, open cast mining, landfill, and waste treatment (see Table 3 rows 1–5, respectively, for the Pearson chi square test results). This contrasts with significant increases in the percentage of ESs for wind farms, mixed developments and ‘other’, which included residential, business parks, park and ride facilities and railways, etc. (see Table 3 rows 6–8, respectively, for the Pearson chi square test results).

Aside from a gradual decline in industry in the UK since the 1980s, other contributing factors are likely to include changes in policy towards mixed-use developments (e.g. University of Westminster et al., 2002) and changes in energy policy encouraging renewable electricity generation (e.g. DTI, 2003). The significant increases in the ‘other’ category are potentially due to a greater number of less easily classified developments being proposed, such as business parks, retail developments and park and ride facilities.

Table 2: Summary of the changes observed over time in comparison with earlier EclA chapter reviews.

EclA Chapter Section	Question	Question asked in earlier EclA chapter review?						Significant change over time in comparison with current review?	Direction of change over time
		Spellerberg & Minshull 1992	Treweek <i>et al.</i> 1993	RSPB 1995	Thompson <i>et al.</i> 1997	Treweek & Thompson 1997	Byron <i>et al.</i> 2000		
General	Ecological consultancy involved in EclA?	x	x	x	✓	x	x	✓	+
Baseline – Desk Study	Development size stated?	x	✓	x	✓	x	✓	✓	+
Baseline – Desk Study	Linear development length stated?	x	✓	x	✓	x	✓	✓	+
Baseline – Desk Study	Ecological consultation conducted?	x	x	x	✓	x	x	x	N/A
Baseline – Desk Study	Natural England (or equivalent) consulted?	x	x	x	✓	x	✓	✓	/
Baseline – Desk Study	Wildlife Trust consulted?	✓	x	x	✓	x	✓	✓	/
Baseline – Surveys	New ecology surveys conducted?	✓	✓	x	✓	x	✓	✓	+
Baseline – Surveys	Ecologists named?	x	x	x	x	x	✓	x	N/A
Baseline – Surveys	Provision of survey methodologies	x	x	x	x	x	✓	x	N/A
Baseline – Surveys	Quantitative survey results present?	x	✓	x	x	x	✓	✓	+
Baseline – Surveys	Surveys conducted over more than one year?	x	x	✓	x	x	x	✓	+
Baseline – Surveys	Fauna surveys conducted?	x	x	x	✓	x	x	✓	+
Evaluation	Geographic context of habitats stated?	x	x	x	x	x	✓	✓	+
Impact Assessment	Ecological impacts considered?	x	✓	x	x	✓	✓	✓	+
Impact Assessment	Assessment method stated?	x	x	✓	x	x	x	✓	+
Impact Assessment	At least one impact quantified?	x	✓	x	✓	x	✓	✓	+
Impact Assessment	Land take quantified?	x	x	x	x	x	✓	✓	-
Impact Assessment	Area of habitat types to be lost quantified?	x	x	x	x	x	✓	✓	+
Impact Assessment	Other ecological impacts quantified?	x	x	x	x	x	✓	✓	+
Impact Assessment	Duration of ecological impacts stated?	x	x	x	✓	x	x	✓	+
Impact Assessment	Impacts stated as being direct or indirect?	x	x	x	✓	x	✓	✓	+
Impact Assessment	‘Do nothing’ scenario considered?	x	x	✓	x	x	x	x	N/A
Mitigation	Mitigation descriptions included?	x	✓	x	✓	✓	✓	✓	+
Mitigation	Detailed mitigation descriptions provided?	x	✓	x	✓	x	✓	✓	+
Mitigation	Likely success of mitigation measures stated?	x	✓	x	✓	✓	✓	✓	+
Mitigation	Time required for mitigation effectiveness stated?	x	x	x	x	✓	x	✓	+
Mitigation	Modifications for unsuccessful mitigation proposed?	x	✓	x	✓	✓	x	x	N/A
Mitigation	Commitment to mitigation indicated?	x	x	✓	x	x	x	✓	+
Follow-up	References to follow-up made?	✓	✓	✓	✓	✓	✓	✓	+
Follow-up	Commitment to any follow-up made?	x	✓	✓	✓	✓	✓	✓	+
Follow-up	Follow-up programme provided?	x	✓	✓	x	x	x	x	N/A
Presentation	Designated sites maps included?	x	x	x	x	x	✓	x	N/A
Presentation	Phase 1 habitat map included?	x	x	x	x	x	✓	✓	+

✓ = Yes; x = No; + = positive; - = negative; N/A = Not Applicable; / = variable

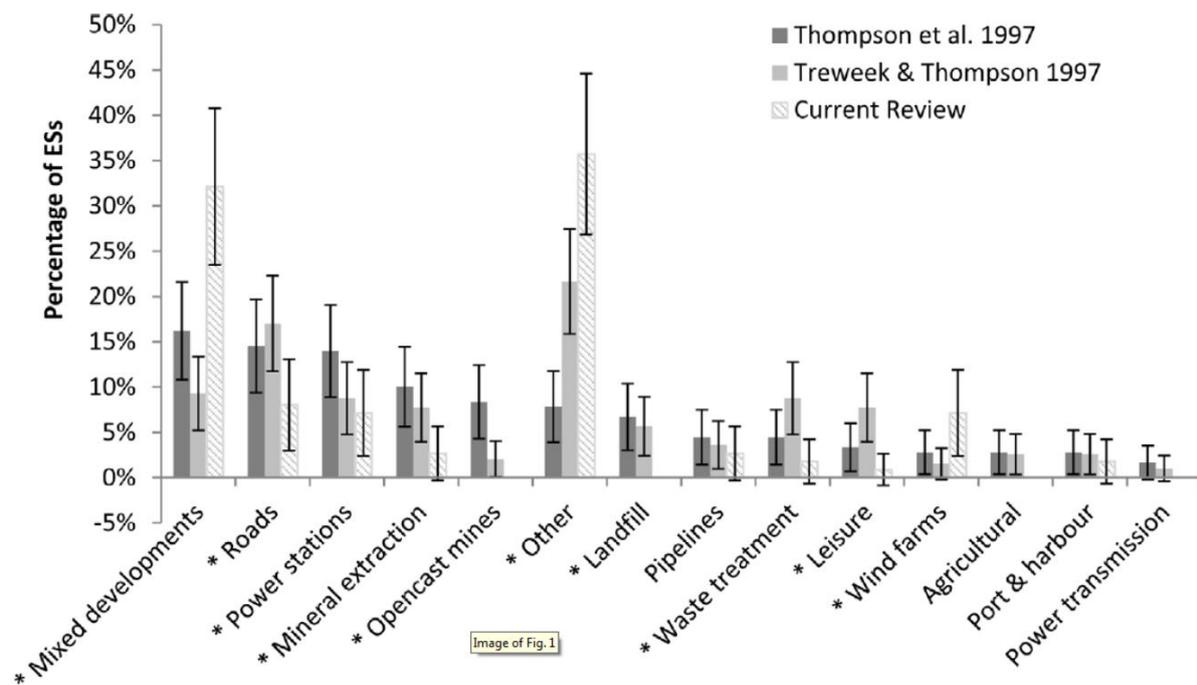


Fig. 1. Change over time in the percentage of EIA chapters in each review from different development sectors. Categories were taken from the Thompson et al. (1997) review. Developments marked with an asterisk show significant changes over time (exact $P < 0.05$). Error bars represent 95% confidence intervals.

3.2.2. Size

The size of the proposed development is the most basic and easily provided information requirement of the EU's EIA Directive (Council of the European Union, 1985, as amended). It provides a broad-brush indication of the scale of the impacts that could arise from the proposed development; larger sites are potentially more likely to result in significant environmental impacts. Whilst not as specific as actual land take, overall development size is a useful indicator of potential biodiversity loss and should be included in all ESs.

Almost 12% (11.61%) of the 112 ESs in the current review failed to state the size of the proposed development (Fig. 2). However, there has been a significant improvement over time in terms of specifying size, both for linear and non-linear developments (see Table 3 rows 9–10, respectively, for the Pearson chi square test results). The highest rates of failure to state the size of the proposed development were found in the two studies that focused on road developments (Byron et al., 2000; Treweek et al., 1993). This is likely due to roads being linear developments, for which it may be easier to state the length rather than the overall size. However, this approach could lead to

significant underestimates of the ecological impact of such schemes, since the width of such schemes can be considerable.

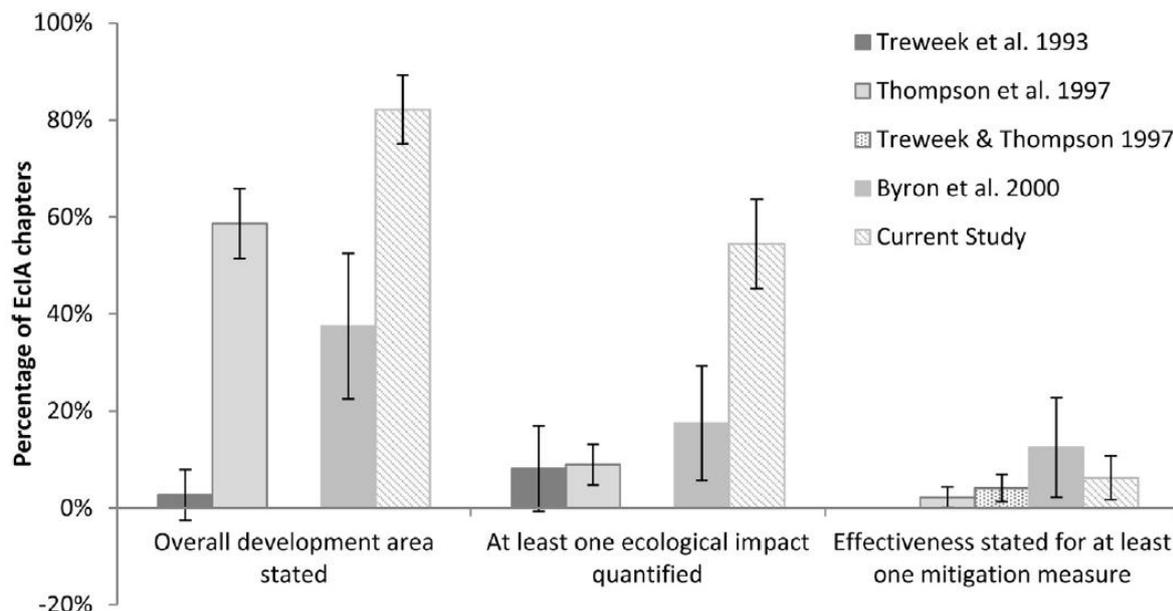


Fig. 2. Changes over time in the percentage of EclA chapters:

- stating the overall area of the development;
- quantifying at least one ecological impact; and
- indicating the likely effectiveness of any of the proposed mitigation measures.

All reviews asked all three questions, with the exception of Treweek and Thompson (1997), which only asked whether mitigation effectiveness had been stated for at least one ecological impact.

Error bars represent 95% confidence intervals.

3.2.3. Flora and fauna surveys

Phase II vegetation surveys were conducted for 49 EclA chapters (43.75%) and included National Vegetation Classification (NVC), river corridor, bryophyte & lichen, hedgerow and other specific habitat surveys. Ninety (80.4%) EclA chapters included fauna surveys, which is a significant increase on the Thompson et al. (1997) review finding of 20% (see Table 3 row 11 for the Pearson chi square test result).

Comparison with the Byron et al. (2000) review reveals some interesting changes over time in the percentage of EclA chapters including certain survey types (Fig. 3). Surveys of the majority of vertebrates have increased, with the increases being significant for bats, amphibians, and birds (see Table 3 rows 12–14, respectively, for the Pearson chi square test results). Surveys also increased for aquatic invertebrates such as white-clawed crayfish (*Austropotamobius pallipes*).

Table 3: Pearson chi square test results

Table row number	Section number	Section title	Reference	Pearson chi square	Degrees of freedom	Exact P value
1	3.2.1	Development Sector	Power stations	4.305	2	0.035
2			Mineral extraction	5.501	2	0.013
3			Open cast mining	15.811	2	<0.001
4			Landfill	7.470	2	0.007
5			Waste treatment	7.226	2	0.011
6			Wind farms	7.199	2	0.006
7			Mixed developments	26.336	2	<0.001
8			'Other'	34.464	2	<0.001
9	3.2.2	Size	Linear developments	9.166	1	0.003
10			Non-linear developments	52.132	3	<0.001
11	3.2.3	Flora and Fauna Surveys	Inclusion	103.947	1	<0.001
12			Bats	27.934	1	<0.001
13			Amphibians	8.116	1	0.005
14			Birds	13.482	1	<0.001
15	3.2.4	Ecological Impact Quantification	Inclusion	120.772	3	<0.001
16			Land take	21.609	1	<0.001
17			Habitat type loss	7.383	1	0.010
18			Other impacts	4.538	1	0.043
19	3.2.5	Mitigation effectiveness	Inclusion	11.176	4	0.003
20	3.2.6	Follow-up	Inclusion	138.973	6	<0.001
21			Use of IEEM Guidelines	0.006	1	0.939

This is likely to reflect the fact that each of these groups contains species protected by EU legislation and that they are relatively straightforward to survey, with good survey and identification guides available (e.g. Bat Conservation Trust, 2007). The remaining groups appear to be characterised by a lack of European legislative protection and/or by a lack of widely available survey guidance (e.g. for fungi), potentially explaining the reduction in surveys over time (Treweek, 1995).

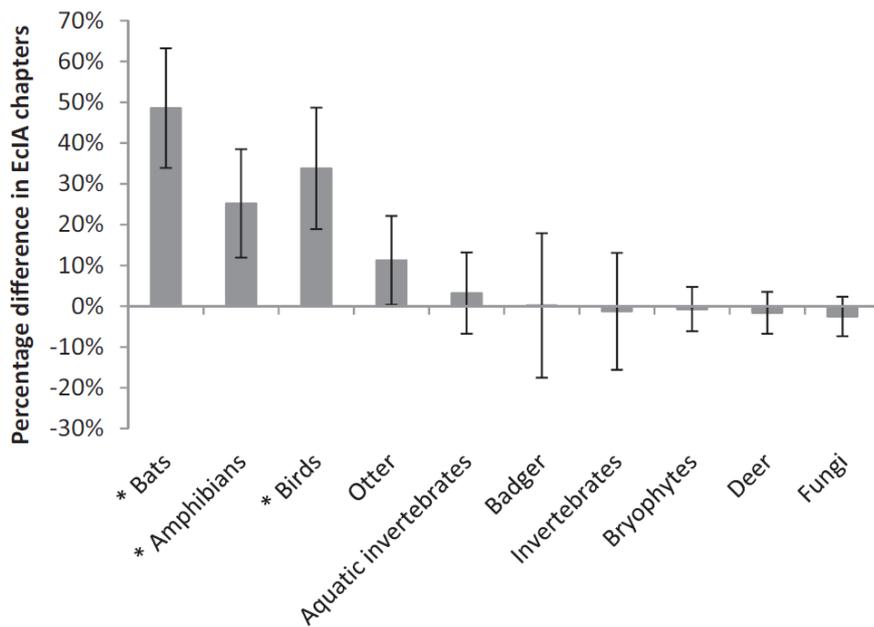


Fig. 3. Percentage difference in EclA chapters including surveys of different groups of organisms since the Byron et al. (2000) review. Survey groups marked with an asterisk have changed significantly over time (exact $P < 0.05$). Error bars represent 95% confidence intervals for the percentage difference.

3.2.4. Ecological impact quantification

Quantifying impact predictions enables follow-up and testing to be conducted, the results of which can further scientific knowledge and inform future EclAs. Historically, impact quantification has been poor (Thompson et al., 1997; Treweek et al., 1993) but there have been significant improvements over time (Fig. 2, see Table 3 row 15 for the Pearson chi square test results).

Byron et al. (2000) noted that the improvement found in their study was primarily due to a higher percentage of EclA chapters quantifying land take (77.5% of EclAs), which is significantly higher than in the current review. The improvement seen in the current review in impact quantification over time is due to significant progress in the quantification of habitat type loss and the quantification of other impacts (see Table 3 rows 16–18, respectively, for the Pearson chi square test results).

Whilst such an improvement in habitat type loss and other ecological impacts is welcome, it should not have come at the expense of quantifying overall land take. Relatively few (17, 15.2%) EclA chapters quantified all of the habitat type loss expected to occur as a result of the proposed development, with 26 (23.2%) focusing instead on important or notable habitat types. Global Positioning System (GPS) devices (particularly smartphones and tablets) are now available at

commercially viable prices and there is a greater choice of commercially available habitat mapping software and applications. As a result, quantifying habitat type areas within a standard habitat survey visit is made cost-effective, rapid and more accurate. Habitat maps based on GPS data should therefore be the norm, rather than the exception.

3.2.5. Mitigation effectiveness

Few studies have examined the effectiveness of mitigation. A recent example found that whilst mitigation implementation was relatively high, effectiveness was low (Drayson and Thompson, 2013). In the absence of detailed ecological follow-up studies available to consultants, the success of mitigation measures in meeting their impact reduction or avoidance targets is uncertain. As a result, the likely success of the proposed mitigation measures should be estimated and stated. There have been significant improvements over time in the percentage of EclA chapters indicating the likely success of their proposed mitigation measures (see Table 3 row 19 for the Pearson chi square test results). However, rates of inclusion remain very low and of the seven EclAs that indicated likely success, only one included this for every proposed mitigation measure (Fig. 2).

3.2.6. Follow-up

There have been significant changes over time in the inclusion of references to follow-up in EclA chapters (see Table 3 row 20 for the Pearson chi square test results). Despite follow-up being considered “good practice” in the EclA Guidelines (IEEM, 2006 p. 48), 60.71% of EclA chapters still do not include any mention of follow-up. In general, however, there has been a trend of increasing percentages of EclA chapters including references to follow-up (Fig. 4).

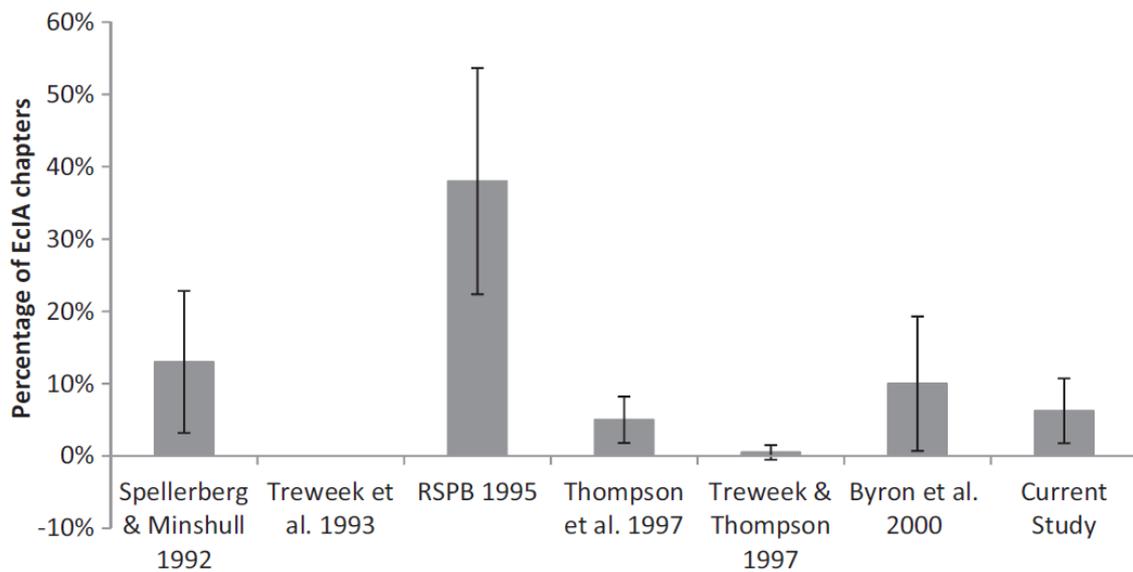


Fig. 4. Change over time in the percentage of EclA chapters including a reference to post-construction follow-up.

An interesting finding is that the current review found no significant difference in whether an EclA included mention of monitoring whether or not the EclA stated the use of the EclA Guidelines (see Table 3 row 21 for the Pearson chi square test results). This may be because the 2006 EclA Guidelines do not place much emphasis on follow-up. Alternatively, it may be that most ESs do not mention follow-up as it is included in the post-consent documentation, such as ecological management plans. For comparability purposes, this was not assessed in the current study, as the methodologies of the previous six reviews did not include assessment of post-consent documents.

The RSPB (1995) review reviewed 37 ESs, half of which were selected by RSPB staff as representative of the cases in which the RSPB were involved. It is therefore possible that early consultation with the RSPB for the latter ESs resulted in the inclusion of follow-up recommendations, which would not perhaps have otherwise been included. If this is indeed the case, this demonstrates the importance of non-statutory consultees in improving EclA chapters.

3.3. Recommendations from previous studies

Previous EclA studies (i.e. not only EclA chapter reviews) have included recommendations intended to improve various aspects of the EclA process and EclA chapter information content. A summary of these recommendations is provided in Table 4. Whilst some of these recommendations are specific to EclA (e.g. development of EclA guidelines and the earlier involvement of ecologists in project design), many can be generalised and have been recommended in studies of EIA. For example, formal review procedures have been recommended by Jones et al. (1991) and Weston (2000), whilst EIA development follow-up has been proposed by Culhane (1993) and Marshall (2005).

4. Conclusions

This checklist-based review of EclA chapters attempted to use inferential statistics to determine changes over time in their information content and procedural effectiveness over time. The main finding that EclA chapters from 2000 onwards have improved significantly in almost every respect in comparison with earlier EclA chapter reviews is encouraging. Of the 33 questions asked as part of the checklist review, 23 saw significant improvements post-2000.

However, the earlier reviews highlighted such severe information deficiencies that the progress seen in the post-2000 EclA chapters still leaves considerable scope for improvement. For example, whilst the size of the development was stated in 82% of modern EclA chapters – a major improvement on the 2.7% found by Treweek et al. (1993) – that still leaves almost a fifth of EclA chapters without this most basic and critically important piece of information.

To our knowledge, this is the only comprehensive comparison of EclA chapter reviews over time for any country. It demonstrates that whilst there are considerable difficulties in comparing studies over time, useful lessons can be drawn from the practice. This is important in the international context, where approaches to standardising EclA chapter reviews are being tested (e.g. Atkinson et al., 2000; Khera and Kumar, 2010; Soderman, 2005).

Table 4: Summary of the recommendations made in earlier EclA studies to improve the EclA process and EclA content.

Category / EclA Stage	Recommendation	Study	Implemented	Comments
Regulation	Establish a professional society	Spellerberg and Minshull (1992)	✓	CCIEEM was established in 1991 through collaboration between its parent bodies; the British Ecological Society (BES), Institute of Biology (IoB), Royal Geographical Society (RGS) and British Association for Nature Conservationists (BANC). CCIEEM now has over 4,000 members and gained Chartered status in 2013.
	Develop a register of biodiversity experts	Bagri <i>et al.</i> (1998)	✓	CIEEM has a Professional Directory on its website, allowing developers to search for professional and qualified ecologists and environmental managers (CIEEM, 2012).
Guidance	Creation of EclA chapter information guidance	Spellerberg and Minshull (1992)	✓	CIEEM published its Guidelines for Ecological Impact Assessment in the United Kingdom in 2006.
	Develop EclA guidelines	Bagri <i>et al.</i> (1998)	✓	
Knowledge Transfer	Create an EclA literature abstracting service	Spellerberg and Minshull (1992)	✗	This is something that CIEEM should consider establishing, particularly with Open Access journals and articles becoming more prevalent.
	Collect and disseminate 'best practice' EclA chapters	Bagri <i>et al.</i> (1998)	✗	This is something CIEEM should consider; creation of a library of EclA chapters written by its members (as practised by IEMA with ESSs) would be a useful first step.
Biodiversity Awareness	Create literature to publicise the importance of ecology in EIA for developers and CPAs	Spellerberg and Minshull (1992)	✓/✗	The importance of ecology in impact assessment has increasingly been emphasised in grey (non-academic) literature (e.g. IAIA, 2005; CBD Conference of Parties, 2006; Byron, 2001). There is a gap, however, for a more targeted and direct approach to CPAs and developers as existing literature tends to focus on higher level organisations, such as governments.
Design	Ecologists should be involved earlier in EIA development design and planning	Treweek <i>et al.</i> (1993)	✓/✗	The situation does appear to be improving, but it is recognised within the environmental consultancy industry that there are still many cases where ecologists could and should be brought in earlier to assist with the design process (Matrunola, 2007). The statutory nature conservation bodies, as well as CIEEM, have an important role to play in ensuring that qualified and experienced ecologists are consulted early in the project design process (Environment Agency, 2012). Ideally, all ecologists involved in the EclA process should be CIEEM members.
Baseline Survey	Official guidance or legislation for standard sampling and survey methods	Treweek (1996)	✓	CIEEM have created a "Sources of Survey Methods" section on their website, providing references and links to published survey guidance (CIEEM, 2012). This gives ecologists the flexibility to choose the most relevant survey methods, rather than a generic survey standard.

Table 4: (cont.)

Category / EclA Stage	Recommendation	Study	Implemented	Comments
Evaluation	Research on the evaluation of ecological data and development methods	Treweek (1996)	x	The EclA Guidelines specifically move away from the matrix method of evaluation used in, for example, the DMRB Volume 11 (Highways Agency, 1992, as amended). However, there has been no research conducted on the effects of the change in evaluation methodology.
	Introduce an 'ecosystems' perspective into impact assessment	Bagri <i>et al.</i> (1998)	✓/x	There is increasing, though relatively recent, recognition of the importance of the ecosystem approach. Several studies have investigated the approach from an environmental management perspective (e.g. Thompson and Hearn, 2012) but comparatively few have been conducted within the context of EIA. This may be due to the difficulties arising from their independent origins (Coleby <i>et al.</i> , 2011).
Impact Assessment	There should be minimum requirements for quantification of predicted impacts	Treweek (1996)	x	The first edition of the EclA Guidelines stated that quantitative data should be provided "if possible". The second edition now suggests that such data could include "the amount of habitat lost, percentage change to habitat area, percentage decline in a species population"
Review	CPAs should either review, or have reviewed, EclA chapters promptly after submission	RSPB (1995)	✓/x	Some CPAs subcontract EIA reviews to environmental consultancies. However, this is rare and with only 41% of CPAs employing a full-time ecologist (Newey, 2012) the majority of CPAs will rely on statutory and non-statutory consultees for comments.
Follow-up	Research on follow-up ecological change	Spellerberg and Minshull (1992)	✓/x	Globally, there have been increasing numbers of studies monitoring ecological change in response to, for example, deforestation, climate change, etc. However, little research has been conducted on the impacts of built development on ecology. An EIA follow-up scheme that included ecology would increase our knowledge of, and result in improvements to, built development impact prediction and mitigation measures, thereby helping to prevent net loss of biodiversity.
	Establish a national follow-up scheme for EIA projects	Spellerberg and Minshull (1992)	x	
	Post-project follow-up of ecology should be included for every relevant EIA development	RSPB (1995)	x	
	Introduce post-development follow-up	Treweek (1996)	x	
	Project impacts should be formally followed-up	Treweek (1996)	x	
	Introduce field-testing of impact predictions	Treweek (1996)	x	
x = no, ✓ = yes, ✓/x = partly N/A = not applicable				

4.1. Auto-Critique

The use of inferential statistics in this study is challenging for the reasons outlined in Sections 1.2.1 and 2.3.1. Indeed, the use of a quantitative approach to assessing EclA chapter quality could be questioned since decision-making within the context of EIA (e.g. scoping and screening decisions), as well as the 'science' in EIA, are not made in a purely rational context (e.g. Weston, 2000; Cashmore et al., 2004), suggesting that a qualitative approach would be more informative. In addition, checklist-based reviews present several difficulties: for example, they may not include key aspects of ESs in their review criteria (Pöder and Lukki, 2011).

However, the literature of ES and EclA chapter review is dominated by the qualitative approach and descriptive statistics. Whilst this is important, the quantitative approach benefits from being systematic, replicable and generalizable. There is therefore scope for greater use of the quantitative approach, and inferential statistics in particular, to complement traditional approaches (Johnson and Onwuegbuzie, 2004).

4.2. Recommendations and further research

In October 2012, the European Commission proposed a series of changes to its 1985 EIA Directive (European Commission, 2012). Following amendments by the European Parliament, the new EIA Directive (2014/52/EU) entered into force in May 2014; Member States have three years to transpose and apply the legislation (Commission, 2014). Some of the changes to the EIA Directive help to address concerns raised from EIA and EclA review studies. For example, for the first time, biodiversity is mentioned directly in the legislation, together with mention of the EU's commitment to halt biodiversity loss by 2020. There is also now explicit mention of monitoring, or follow-up. In the context of this research, a particularly welcome development is a new requirement to make EIA information easy to access, ideally through "a central portal or points of access" (The European Parliament and the Council of the European Union, 2014). This should help in determining whether a sample of ESs is representative in future research, making the use of inferential statistics more

reliable. These are positive and important legislative changes that are likely to be transposed into national legislation prior to the United Kingdom's potential exit from the European Union.

A further important change has been the release of the second edition of the EclA Guidelines (CIEEM, 2016), a decade after the first edition was published. One of the improvements in the Guidelines is a greater acknowledgement of the importance of follow-up. Instead of a passive reliance on monitoring being included within planning conditions or legal agreements, page 28 of the Guidelines now suggests that the "EclA should identify where monitoring is required for mitigation, compensation and enhancement measures, setting out the methods to be used, the criteria for determining success/failure, appropriate timing, mechanisms for implementation, frequency and duration of monitoring, and frequency of reporting." This is welcome, as several other studies aside from the six previous EclA reviews have also recommended improved monitoring and feedback processes (e.g. Briggs and Hudson, 2013).

It will be necessary to monitor EclA chapters written under the new EIA Directive and Guidelines, and compare their procedural effectiveness with those written under the earlier legislation and guidance. By using inferential statistics, as in the current review, it is possible to achieve this. For example, a regular (e.g. biennial) EclA chapter review could help to address questions such as:

- Will / how will changes in legislation and guidance affect the procedural effectiveness of EclA chapters?
- Is there a lag time between legislative and guidance changes being made and this being reflected in EclA chapters?
- Are there significant differences between countries or development sectors in their EclA chapter content?
- What are the main factors affecting EclA chapter content?

The answers to these questions could help inform future changes in legislation, policy and/or guidance, for example by identifying loopholes and building on best practice.

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Appendix A. List of EclA Chapters Reviewed

EclA name	Development Category	Competent Planning Authority	Year of Submission
110 Bishopsgate (Heron Tower)	Other	City of London	2005
20 Fenchurch Street	Other	City of London	2006
21 Wapping Lane	Mixed development	Tower Hamlets Borough Council	2006
30 Old Bailey	Other	City of London	2007
399 Edgware Road	Mixed development	London Borough of Brent	2006
A11 Fiveways to Thetford	Roads	Secretary of State for Transport	2008
A23 Handcross to Warninglid	Roads	Secretary of State for Transport	2008
Addenbrookes Access Road	Roads	Cambridgeshire County Council	2006
Bathside Bay	Port & harbour	Tendring District Council	2003
Battersea Power Station	Mixed development	Wandsworth Borough Council	2009
Bent Farm Quarry	Mineral extraction	Cheshire East Council	2008
Billingham Biomass Plant	Power stations	Stockton-on-Tees Borough Council	2009
Billingham Mine Waste Management Facility	Other	Stockton-on-Tees Borough Council	2010
Bishopsgate Tower	Other	City of London	2006
Blackburn Meadows	Power stations	Sheffield City Council	2008
Blackstone Edge	Wind farms	Barnsley Metropolitan Borough Council	2008
Brent Cross	Mixed development	Barnet Borough Council	2008
Broadgate	Other	City of London	2010
Broom Hill Quarry	Mineral extraction	Bedfordshire County Council	2005
Burton Wold Wind Farm Extension	Wind farms	Kettering Borough Council	2007
Cambridge Biomedical Centre Expansion	Other	Cambridge City Council	2006
Canley Regeneration Area	Mixed development	Coventry City Council	2009
Charlestown Riverside	Mixed development	Salford City Council	2010
Charlton Road Food Store	Other	Bath and North East Somerset	2008
Coolgardie Keighley Road	Other	City of Bradford Metropolitan District Council	2006
Corby Northern Orbital Road	Roads	Northamptonshire County Council	2007
Docklands Light Railway	Other	Tower Hamlets Borough Council	2006
Drakelow CCGT	Power stations	Secretary of State for Trade and Industry	2005
East Cowes	Mixed development	Isle of Wight Council	2006
East of Kettering	Mixed development	East Kettering Borough Council	2008
Edingale to Drakelow Gas Pipeline	Pipelines	South Derbyshire District Council	2008
Enderby Park & Ride	Other	Leicestershire County Council	2006
Essex University Research Park Extension	Mixed development	Colchester Borough Council	2005
Exeter Gateway	Other	East Devon District Council	2000
Exeter Science Park	Other	East Devon District Council	2009
Fairfield School Sports Pitches	Leisure	Bristol City Council	2005
Fairford Lakes	Mixed development	Cotswold District Council	2009
Felixstowe South Reconfiguration	Port & harbour	Suffolk Coastal District Council	2003
Fullbrook Wind Farm	Wind farms	North Devon District Council	2004
Glyndebourne Wind Turbine	Wind farms	Lewes District Council	2007
Great Western Park	Mixed development	South Oxfordshire District Council	2005
Guest and Chrimes Remediation	Other	Rotherham Metropolitan Borough Council	2007
Hartland Park	Other	Hart District Council	2007
Heart of East Greenwich	Mixed development	London Borough of Greenwich	2008
Heartwood Forest	Other	Forestry Commission	2009
Hellrigg Wind Farm	Wind farms	Allerdale Borough Council	2007
Hewlett Packard	Mixed development	South Gloucestershire District Council	2004
Houghton Quarry	Mixed development	Central Bedfordshire Borough Council	2007
Humber Gateway Onshore Cable	Pipelines	East Riding of Yorkshire	2008
Humber Gateway Substation	Other	East Riding of Yorkshire	2009
Huntsman Drive	Power stations	Stockton-on-Tees Borough Council	2011
Isham Bypass	Roads	Northamptonshire County Council	2005
Jeskyn's Farm	Other	Forestry Commission	2006
King Alfred Sports Centre	Mixed development	Brighton & Hove City Council	2006
King's Cross Central	Mixed development	Camden Borough Council / Islington Borough Council	2004
King's Cross Enhancement	Other	Camden Borough Council	2006
Lakeside, Scunthorpe	Mixed development	North Lincolnshire District Council	2003

EclIA name	Development Category	Competent Planning Authority	Year of Submission
Land at Hill Top Farm	Other	Cheshire County Council	2007
Land West of Becklees Farm	Other	Cumbria County Council	2010
Lewisham Gateway	Mixed development	London Borough of Lewisham	2006
Little Cheyne Court Wind Farm	Wind farms	Shepway District Council	2002
Loampit Vale	Mixed development	London Borough of Lewisham	2009
London Cable Car	Other	Greenwich Borough Council	2010
London Park Hotel	Mixed development	Southwark Borough Council	2007
London Road, Amesbury	Other	Wiltshire County Council	2008
London Wall Place	Other	City of London	2010
Lower Broughton Regeneration	Mixed development	Salford City Council	2006
Lower Broughton Reserved Matters	Mixed development	Salford City Council	2008
Lower Clarence Wharf	Power stations	Stockton-on-Tees Borough Council	2009
Marriott's Walk	Mixed development	West Oxfordshire District Council	2006
Merevale Lane	Power stations	Warwickshire County Council	2008
Mersey Gateway	Roads	Halton Borough Council	2008
Monksmoor Farm	Mixed development	Daventry District Council	2007
New Albion Wind Farm	Wind farms	Kettering Borough Council	2009
North Quay Road	Power stations	East Sussex County Council	2005
Northside Bridge	Roads	Cumbria County Council	2010
Olympic Park Site Preparation	Other	Olympic Delivery Planning Authority	2007
Pebsham HWRS	Waste treatment	East Sussex County Council	2008
Polwell Lane	Mixed development	Kettering Borough Council	2008
Prospect Business Park	Other	Purbeck District Council	2007
Quest Pit	Other	Bedfordshire County Council	2006
Ramada Deansgate	Mixed development	Manchester City Council	2008
Regent's Place	Mixed development	Camden Borough Council	2007
Riverbank House	Other	City of London	2007
Salisbury Park & Ride	Other	Wiltshire County Council	2006
Seager Distillery	Mixed development	Lewisham Borough Council	2008
Second Opening Bridge, Poole	Roads	Secretary of State for Transport	2004
Shepperton Studios	Mixed development	Spelthorne Borough Council	2004
South Winchester Park and Ride	Other	Hampshire County Council	2007
Southall Gas Works	Mixed development	Ealing Borough Council	2008
St Mary Axe	Other	City of London	2008
Stone House	Mixed development	City of London	2010
Teal Park	Other	North Kesteven District Council	2009
Teesside Gas Processing Plant	Pipelines	Stockton-on-Tees Borough Council	2010
The Avenue	Other	Derbyshire County Council	2007
Town Farm Quarry	Mineral extraction	Devon County Council	2009
Victoria Station Upgrade	Other	Secretary of State for Transport	2007
Vopak Terminal	Power stations	Stockton-on-Tees Borough Council	2006
Walton Bridge	Roads	Surrey County Council	2007
Warwick Campus Extension	Other	Warwick District Council	2009
Watchet East Wharf	Mixed development	West Somerset Council	2008
Watermark Place	Other	City of London	2005
Wave Hub	Other	Penwith District Council	2006
Weirside	Waste treatment	West Berkshire District Council	2005
West Quay Marina	Mixed development	Borough of Poole Council	2008
Westgate Centre	Mixed development	Oxford City Council	2006
White Moss Quarry	Other	Cheshire County Council	2008
Whitmoor Phase 2	Other	Cambridgeshire County Council	2009
Wigmore Employment Area	Other	Luton Borough Council	2009
Winchester Silver Hill	Mixed development	Winchester City Council	2006
Wycombe Marsh Paper Mills	Mixed development	Wycombe District Council	2002
Yelvertoft	Wind farms	Daventry District Council	2009

Appendix B. Legislative, Policy and Guidance Changes between 2000 and 2010.

Document Type	Document Title and Reference	Year Issued / Amended	Relevance to EIA /EclA
EU Legislation	EIA Directive (Council of the European Union, 1985, as amended)	2003	Improved public participation and access to justice.
		2009	Expanded list of projects requiring EIA.
	Birds Directive (European Parliament and Council of the European Union, 2009)	2009	Codification of the Birds Directive (1979), as amended.
UK Legislation	EIA Regulations (HMG, 1999, as amended)	1999	Implemented the EIA Directive and its 1997 amendment.
		2006	Incorporated the 2003 amendment to the EIA Directive.
		2008	For outline EIA applications, additional EIA for reserved matters may be required before full planning permission is granted.
	Habitats Regulations (HMG, 1994, as amended)	2007	Increased protection of European Protected Species (EPS) by removal of certain defences.
		2009	Strengthens European designated site protection.
	Habitats Regulations (HMG, 2010)	2010	Consolidated and replaced the Habitats Regulations (1994) and its amendments. Ensured greater compliance with the Habitats Directive (1992).
	Countryside and Rights of Way Act (HMG, 2000)	2000	Increased protection for Sites of Special Scientific Interest (SSSIs) and certain wildlife.
Natural Environment and Rural Communities Act (HMG, 2006)	2006	Formation of Natural England and strengthening of wildlife and SSSI protection. The Act states that “every public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity”.	
International Policy	Strategic Plan for the Convention on Biological Diversity (CBD Conference of Parties, 2002)	2002	Convention on Biological Diversity agreement to “achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level”.
	Plan of Implementation of the World Summit on Sustainable Development (UN, 2002)	2002	Endorsed the CBD’s 2002 plan to significantly reduce biodiversity loss by 2010.
	Aichi Targets (CBD Conference of Parties, 2010)	2010	Convention on Biological Diversity agreement to reduce biodiversity loss to certain levels by either 2015 or 2020, depending on the individual target
EU Policy	Gothenburg agreement (Commission of the European Communities, 2001)	2001	EU agreement to halt the loss of biodiversity by 2010 and adoption of a Sustainable Development Strategy.
	Sixth Environment Action Programme (European Parliament and Council of the European Union, 2002)	2002	Endorsed the Gothenburg agreement to halt “biodiversity decline with the aim to reach this objective by 2010”. Focused on “conservation” and/or “appropriate restoration” of natural areas, species and habitats.
	Biodiversity communication (Commission of the European Communities, 2006)	2006	Highlighted the importance of biodiversity as part of sustainable development, and set out a detailed EU Biodiversity Action Plan.
	Renewed EU Sustainable Development Strategy (Council of the European Union, 2006)	2006	Reiterated commitment to halt biodiversity loss by 2010 and references the EU’s Biodiversity Strategy as one of the means to achieve this.
	Review of the European Union Strategy for Sustainable Development (Commission of the European Communities, 2009b)	2009	Stated that “the destruction of biodiversity is continuing at a worrying rate” and recommended “intensifying environmental efforts for the protection of biodiversity, water and other natural resources”.
UK Policy	Planning Policy Statement 9 (ODPM, 2005)	2005	Outlined government objectives to promote sustainable development, and conserve, enhance and restore biodiversity in England.
Guidance	Guidelines for Ecological Impact Assessment in the United Kingdom (IEEM, 2006)	2006	The first dedicated EclA guidance available for practitioners, Competent Planning Authorities (CPAs), developers and others involved with EclA.

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