

<b>Institution:</b> University of Hull
<b>Unit of Assessment:</b> C17: Geography, Environmental Studies and Archaeology
<b>Title of case study:</b> Research for the Environment Agency to counter EU infraction proceedings against the UK Government relating to the alleged eutrophication of estuaries including the Humber
<p><b>1. Summary of the impact</b> (indicative maximum 100 words)</p> <p>In 2008-2009 the UK was subject to legal infraction proceedings at the European Court of Justice (ECJ) for allegedly failing to implement the European Union's Urban Waste-water Treatment Directive (UWWTD). Research by the Institute of Estuarine and Coastal Studies, Hull (IECS) for the Environment Agency (EA)/Defra provided evidence to the UK Government for its defence against these allegations. The research consisted of:</p> <ul style="list-style-type: none"> <li>- literature/data reviews and collection and analysis of critical evidence from the Humber.</li> <li>- co-ordinating workshops and convening an expert panel of sufficient authoritative academic opinion to counteract the European Court of Justice allegations.</li> </ul> <p>In December 2009 the European Court of Justice ruled in favour of the UK. Our research therefore helped to save very significant, unnecessary capital investment in nutrient removal technology for sewage treatment nationally and in the Yorkshire and Humber region especially. The UK government thus avoided the possibility of major European Commission fines of up to €703,000 per day, or €256m per annum, for infraction of the Urban Water-water Treatment Directive [1].</p>
<p><b>2. Underpinning research</b> (indicative maximum 500 words)</p> <p>The Humber estuary is hypereutrophic by domestic and agricultural nutrients (Boyes &amp; Elliott, 2006). In the 1990s the European Commission (EC) was concerned about nutrient levels in estuaries and their associated environmental problems (after Directive 91/271). After commissioning a report from a consultancy on the possibility, the European Commission suggested that the Humber might be (or may become) eutrophic. The Commission therefore raised a legal infraction case on 4 November 1999 relating to the Humber and other UK estuaries [2: 14]. The infraction process requires the national government to address the allegation or eventually face very substantial fines.</p> <p>The UK Government required the Environment Agency (EA) to respond to the allegation with full, robust and appropriate evidence, that would be legally defensible. In turn, the Environment Agency asked IECS to test the conceptual and empirical validity of the allegation and to provide the regional evidence for the Humber estuary –which drains 20% of England- to prepare a response: this was the 'Humber Infraction Project' (HIP).</p> <p>One element of the underpinning research for this impact originates with work by Mike Elliott (Chair in Estuarine and Coastal Sciences and IECS Director, 1996 to present) into the Humber's nutrient status. He undertook research funded by Yorkshire Water on this topic in 2002 and wrote a key paper as an output (Boyes and Elliott 2006). Therefore, IECS was approached by the Environment Agency due, in part, to Elliott's prior research, but also due to the international reputation of IECS in estuarine ecology, management and eutrophication [3].</p> <p>The second element of the underpinning research for this impact is the work undertaken by IECS for the 'Humber Infraction Project' in response to the infraction proceedings. This research was undertaken by Elliott; Krysia Mazik (Senior Benthic Ecologist, IECS, 2000 to present); Shona Thompson (GIS specialist and Coastal Geographer, IECS, 2003 to present); and IECS staff Sue Travers, Anna Phelps, Katya Solyanko and Lauren Tewson (Research Assistants, IECS, 2008-09).</p> <p>Between 1 June 2008 and 31 March 2009, IECS led the following research:</p> <p>a) IECS assembled six international experts for a workshop to determine the validity of existing scientific evidence, that might be used to respond to the European Commission's case. This expert panel was chaired by Elliott and included Mazik, de Jonge (Honorary Professor, IECS), an independent consultant and two other academics from UK Universities.</p> <p>The expert panel concluded that eutrophication would not occur in the Humber due to the hydrodynamic conditions in this estuary, especially the shallow photic zone, that restrict</p>

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excessive growth of phytoplankton and macroalgae in hypereutrophic water bodies, which otherwise have the potential to become eutrophic (Elliott et al. 2008).

This research, drawing upon the extensive international expertise of the panel and their targeted literature reviews, contributed significantly to the evidence-base for the overall Environment Agency response to the European Commission.

- b) IECS also identified, designed and led further field-research into the Humber estuary (Mazik et al., 2008), which helped to establish a more robust scientific base for the Humber Infraction Project. This additional research included ground-truthing surveys for the whole estuary to validate Environment Agency Compact Airborne Spectrographic Imager (CASI) aerial surveys. The research programme also involved extensive analyses of:
- sediment chlorophyll-a content (via field sampling);
  - macroalgal, macrophyte and diatom cover (via field sampling and airborne spectral survey);
  - ecological quality data (via diatom survey and species identification);
  - phytoplankton data provided by the Environment Agency (to determine the source of (re)suspended microalgae).

This research confirmed that, although the Humber was hypereutrophic, it was not eutrophic (Elliott et al., 2008; Mazik et al., 2008; Mazik et al., 2009). The research also established that there was no extensive proliferation of macroalgal mats (*Ulva* spp.) or nuisance phytoplankton (indicating eutrophication) in the Humber. This was due to:

- the high natural turbidity of the Humber that restricts the light penetration needed for algal growth;
- the softer sediment types of the Humber that are unsuitable for dense green algal growth;
- the high hydrodynamic energy of the Humber, which removes microalgae from the surface, hindering their establishment.

The research also demonstrated that microalgal species in the water column were predominantly re-suspended benthic diatoms (Mazik et al., 2009).

The research produced the following outputs:

- a statement to the Environment Agency by the Expert Panel on the eutrophication status of the Humber (Elliott et al. 2008);
- two scientific reports (Mazik et al. 2008; Mazik et al. 2009);
- a scientific publication in an international journal (Elliott and Whitfield 2011).

This evidence was used to defend the UK's case against the European Commission's infraction proceedings: the IECS research underpinned the EA/Defra response for the Humber - the key estuary in the infraction proceedings against the UK.

**3. References to the research**

- Boyes, S.J and Elliott, M. (2006) Organic Matter and Nutrient Input to the Humber estuary, *Marine Pollution Bulletin*, 53,136-143.
- Elliott, M., Underwood, G., Wilkinson, M., Mazik, K., de Jonge, V.N., Dodge, G. (2008) Statement by the Expert Panel on the Eutrophic status of the Humber Estuary as Requested by the Environment Agency, December 2008.
- Elliott, M. and Whitfield, A. (2011) Challenging paradigms in estuarine ecology and management, *Estuarine, Coastal & Shelf Science*, 94, 306-314.
- Hering, D., Borja, A., Carstensen, J., Carvalho, L., Elliott, M., Feld, C.K., Heiskanen, A.S., Johnson, R.K., Moe, J., Pont, D., Solheim, A., van de Bund, W. (2010) The European Water Framework Directive at the age of 10: A critical review of the achievements with recommendations for the future, *Science of the Total Environment*, 408, 19, 4007-4019.
- Mazik, K., Thomson, S., Elliott, M., Solyanko, K. and Phelps, A. (2008) *CASI ground truth surveys – Humber estuary 2008*, Report to Environment Agency, Institute of Estuarine and Coastal Studies, University of Hull, 8th December 2008.
- Mazik, K., Solyanko, E., Elliott, M. and De Jonge, V.N. (2009) *Summary of microalgal species*

*composition and water quality in the Humber Estuary*, Report to Environment Agency. Institute of Estuarine and Coastal Studies, University of Hull, 26 March 2009.

**Grants**

- Boyes, S. and Elliott, M., *Trophic and organic status of the Humber estuary*, Yorkshire Water, £16,000 (June 2002 – September 2002).
- Elliott, M., *A Scientific Understanding of the Tees Estuary to Determine the Cause of Macroalgal Mats at Seal Sands*, Northumbrian Water £75,425 (February 2006 – March 2010).
- Elliott, M., *Humber Water Quality Status Assessment: Eutrophication and Algal Bloom Issues*, Environment Agency, £11,850 (June 2008 – August 2008).
- Elliott, M., *Site Characterisation of European Marine Sites: Humber Estuary pSAC, pSPA, Ramsar*, English Nature, £19,200 (November 2008 - March 2009).
- Mazik, K., *CASI surveys and ground truthing to assess the eutrophication status of the Humber (specifically looking at the distribution of opportunistic green algae and diatom biofilms) coupled with quality analysis*, Environment Agency, £36,495 (September 2008 – March 2009).

**4. Details of the impact** (indicative maximum 750 words)

The IECS research fed directly into the UK response to the infraction proceedings and it contributed significantly to the UK’s defence against the case [3]. If the infraction proceedings had been upheld, specific estuaries (including the Humber) would be designated as ‘Sensitive Areas (Eutrophic)’ under the European Union’s Urban Waste-water Treatment Directive (UWWTD). In extreme circumstances EC fines can total €256m per annum, so avoiding these costs gives this research impact of national significance [1]. This result also prevented the need for major investment in new tertiary treatment to remove nutrients from estuaries and catchments (a more likely EC measure). Estimates suggest that this would require huge investment (the EA estimate is known, but they wish to keep this confidential) [3]. For the Humber catchment, these costs would be funded by Anglian, Yorkshire and Severn-Trent Water plcs and, ultimately, by consumers. Again, the savings to the UK of avoiding these additional costs renders this impact of national significance.

In addition, the robust nature of the IECS research highlighted the inadequacy of the science and evidence that underpinned the European Commission’s case [2]. By demonstrating the importance of producing excellent, rigorous site-specific research, the Humber Infraction Project also established the importance of thorough, geographically-sensitive approaches in future EC infraction proceedings. This gives this research some international reach.

On 17 August 2007, the European Commission brought its case against the UK Government for failing to adhere to European Council Directive 91/271/EEC of 21 May 1991 concerning urban waste water treatment and the risk of eutrophication in vulnerable estuaries [2: 1, 59]. Between 1992 and 1997 the UK Government made three responses to the EC Directive [2: 12]. In turn, the European Commission appointed ‘Environmental Resources Management (UK)’ (ERM) consultancy to report on these vulnerable areas (they reported in March 1999) [2: 13].

Based on this ERM report, the Commission notified the UK (on 4 November 1999) that some estuaries showed signs of eutrophication and should have been designated ‘Sensitive Areas’ under the EC Directive; they included the Humber, the Wash, the Outer Thames Estuary, Southampton Water and the North East Irish Sea [2: 14].

The UK defence involved the EA asking IECS to obtain rigorous and scientifically and legally defensible evidence for the Humber estuary that could address the European Commission’s assertions [3]. The allegation of possible eutrophication in the Humber was based upon evidence collated by the ERM consultancy that assumed the CASI aerial surveys identified dense, green algal growth in the Humber which indicated an adverse, eutrophic impact in the estuary [3].

The Environment Agency had doubts about the quality of their evidence and its capacity to sustain a robust defence against the infraction proceedings. Earlier EA / Natural England studies on possible eutrophication in the Humber (2005-2008) were inconclusive. In 2005 the EA had some evidence that diatoms were the main organisms on the Humber intertidal sediments, but it required better and more defensible evidence – especially with the onus on the UK to demonstrate no signs

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of eutrophication [2]. The EA decided that they needed more quantitative evidence about the algae and nuisance species in the Humber to defend the case. They therefore sought additional evidence through research collaboration with IECS [3].

Thanks to Elliott's earlier research on the Humber's organic and nutrient load (Boyes and Elliott 2006), plus its international reputation, IECS was invited to lead, organise and deliver the Humber Infraction Project for the EA. The research outlined in section 2 was undertaken and the results (including state of the art scientific reviews; ground-truthing data; CASI images and mapping; multivariate statistical analyses; sediment, macroalgae and diatom sampling and mapping) were embedded in the EA/Defra submissions to the European Commission [3].

This new, robust evidence challenged the EU's previous assumptions about the potential eutrophic status of the Humber and other UK estuaries. The research was therefore scrutinised by the EU Joint Research Centre. The JRC concluded that there was now sufficient evidence of significant strength to reject allegations that the Humber estuary was eutrophic (or was likely to become so).

The European Court of Justice therefore ruled in favour of the UK Government on 9<sup>th</sup> December 2009 and removed the infraction proceedings against the Humber [2: 117]. The Court accepted the new evidence and rejected the earlier analysis by the EC and ERM Consultancy as being based on insufficiently rigorous science [2: 88-89]. It also noted that the European Commission failed to demonstrate eutrophication on two criteria from four [2: 117]. The EA submission also resulted in similar outcomes for the proceedings levied against the Thames estuary, Southampton Water, Liverpool Bay and the Wash [2].

**Beneficiaries:**

European Commission fines were not issued against the UK and costly additional sewage monitoring and treatment systems in the catchments feeding these estuaries were not required. The UK was even awarded its legal costs against the European Commission [2: 358]. In addition, the regional sewerage and water companies saved the major costs of nutrient removal throughout the Humber catchment [3]. Due to the scale of this catchment, these costs would have been very sizeable for the region and the country.

By extension, there were other beneficiaries:

- customers and shareholders of the sewerage and water companies, to whom the costs would have been passed [3];
- Environment Agency / Natural England, who avoided additional, costly monitoring and remedial action to combat the effects of eutrophication [3];
- the public, who benefit from the continued amenity values of estuaries (it is argued that the social and economic value of eutrophic estuaries decrease) (Herring et al. 2010);
- wider UK and European local, national and European authorities: because evidence from this case suggests that effective diagnosis of eutrophication can preclude the requirement for costly treatment and court cases.

This applied research also fed into new conceptual paradigms of estuarine functioning which is influencing assessments of estuarine systems worldwide (Borja et al. 2010; Elliott and Whitfield 2011; Hering et al. 2010).

**5. Sources to corroborate the impact**

[1] Infractions of EU legislation:

<http://www.scotland.gov.uk/Topics/International/Europe/Legislation/Infractions>.

[2] European Court of Justice Judgement (10 December 2009):

<http://curia.europa.eu/juris/liste.jsf?language=en&num=c-390/07> [2: 3] denotes this source, point 3.

[3] Corroborating letter from Regional Water Quality Planning Manager, Yorkshire and North-East, Environment Agency. The same person can also be contacted to confirm details on the potential costs of this process.

[4] Borja, Á., Elliott, M., Carstensen, J., Heiskanen, A-S., van de Bund, W. (2010) Marine management – towards an integrated implementation of the European Marine Strategy Framework and the Water Framework Directives, *Marine Pollution Bulletin*, 60, 2175-2186.