

What is a Harmful Algal Bloom, and can it be used as an indicator of anthropogenic nutrient enrichment in marine waters?

Marine Theme Objective: Human Pressures and Impacts on the Marine Environment.

What's the problem?

Anthropogenic nutrient enrichment of coastal waters is often cited as a reason for the occurrence of harmful blooms of micro-algae. Evidence of a link between harmful algal blooms (HABs) and enrichment in some coastal waters has led to the view that a link exists in a wide range of coastal regions and that the occurrence of HABs diagnoses the undesirable consequence of anthropogenic nutrient enrichment, that is eutrophication. A number of assumptions are involved in this view, and there is a clear need to examine the associated scientific arguments and evidence if HABs and the occurrence of harmful algae are to be used as indicators of eutrophic conditions.

What are the aims of the project?

Eutrophication has been defined by the EC and OSPAR as 'the enrichment of water by nutrients causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned'.

This aims of this research project were to examine the scientific arguments and evidence relating to HABs and nutrient enrichment to determine if the occurrence of HABs, or of the species causing them, could be used as an indicator of eutrophic conditions.

The objectives of the project were to:

- Review a representative selection of the scientific literature on the putative link between the occurrence and magnitude of HABs and the anthropogenic nutrient enrichment of coastal waters; and
- Investigate the relationship between nutrients and the abundance of species giving rise to HABs by statistical analysis of data sets from coastal waters of the UK and the Republic of Ireland.

The findings are of direct benefit to Defra in promoting scientifically sound and ecologically relevant indicators of marine ecosystem health.

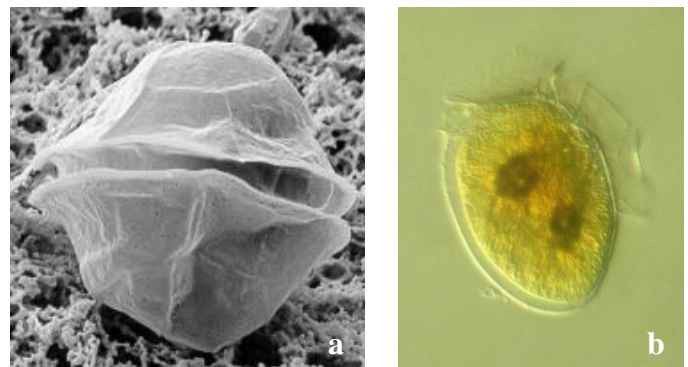


Figure 1: Some species of phytoplankton produce chemical toxins. When filtered by shellfish, the toxins can be transferred through the food chain to humans and cause 'shellfish poisoning'. 1a: *Alexandrium tamarense* a cause of paralytic shellfish poisoning and, 1b: *Dinophysis acuminata* a cause of diarrhetic shellfish poisoning (Source Dr R Gowen: AFBI 2009).

Which policy areas will the research inform?

It will help to determine whether HABs and HAB species should be used to decide the eutrophication status of OSPAR maritime areas as part of the assessment procedure. The current evidence shows no direct link between the presence of HABs and anthropogenic nutrient enrichment, and therefore we may be able to reclassify some of our waters as not being eutrophic under OSPAR and the Water Framework Directive.

This assessment framework also feeds into the Marine Strategy Framework Directive.



What is a Harmful Algal Bloom (HAB), and can it be used as an indicator of anthropogenic nutrient enrichment in the marine environment?

What are the results from the project and how will they be used?

HAB occurrence is not in itself an indicator of eutrophication:

It was concluded that it is important to distinguish two potential causal relationships - (i) between nutrient enrichment and HABs, and (ii) between nutrient enrichment and eutrophication – despite their possible overlap. There is no doubt that excessive addition of anthropogenic nutrients can result in the undesirable disturbances associated with eutrophication, unless light-limitation prevents increased production of algal biomass or unless strong dispersion removes phytoplankton. But HABs are discrete events and as such are distinct from a more general increase in biomass and production. HABs occur naturally, and so the occurrence of a HAB is not, in itself, an indicator of eutrophication. Furthermore, increases in biomass, and changes in the 'balance of organisms' can occur without an increase in HABs.

Trends in HABs were found to be affected by several factors, which makes the use of HABs as a reliable indicator of eutrophication difficult:

The literature review showed that there is no scientific consensus regarding the stimulation of HABs by anthropogenic nutrients. Attempts to verify arguments about global trends in the occurrence of HABs, or to relate these to nutrient enrichment, are confounded by several factors. These include: spatial and temporal variability in naturally occurring HABs; human mediated transport of HAB species between coastal regions; increases in monitoring effort and the reporting of HABs; and, the influence of natural climate change, such as that due to the North Atlantic Oscillation or the El Niño Southern Oscillation. There is no universal explanation for changes in the frequency of HABs.

UK and Republic of Ireland datasets did not support the nutrient enrichment / HABs hypothesis

The compiled data sets from coastal waters of the UK and the Republic of Ireland were used to test the hypothesis that HAB species abundance increases with anthropogenic nutrient enrichment. The results of the statistical analysis were complex, but led to the conclusion that the UK and

Irish data did not support the nutrient enrichment – HAB hypothesis.

HABs and HAB species should not be used as indicators of eutrophication

It was concluded that the occurrence of HABs and the abundance of HAB species **should not be used** to diagnose eutrophication in UK waters unless a link to anthropogenic nutrient enrichment can be demonstrated. Furthermore, evidence of a link in one coastal region should not be taken as evidence of a general linkage in other coastal regions.

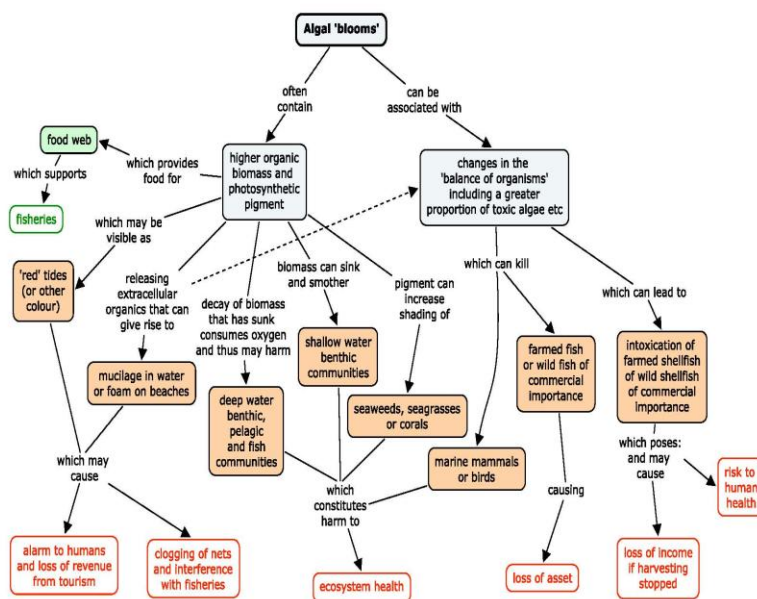


Figure 2: Algal blooms and their effects on ecosystem health and the human use of the marine environment (source: Anthropogenic Nutrient Enrichment and Blooms of Harmful Micro-algae. Gowen R *et al.*, 2009: In-press)

Where can I find further information about this and related research?

The Agri-Food and Biosciences Institute
(www.afbini.gov.uk)

Alternatively,

please contact the Marine and Fisheries Science Unit at Defra, Nobel House, London.

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