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Factors affecting the accumulation of phytoplankton biomass in Irish estuaries and nearshore coastal waters: A conceptual model

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ABSTRACT

A multivariate statistical approach was used to investigate the response of phytoplankton in Irish estuaries and nearshore coastal waters to nutrient enrichment and to examine the factors which modulate this response. The analysis suggests that while many estuaries are nutrient-enriched, relatively few display phytoplankton-related symptoms of eutrophication as the response to nutrients is primarily affected by insufficient retention time, in some by inadequate light availability, and only rarely by both factors acting together. Nearshore coastal waters are nitrogen (N) and silica (Si) limited in summer, but in some nearshore waters along the south coast, where N is elevated, phosphorus (P) is potentially limiting. The reduction in P loadings to estuarine waters is likely to lead to an improvement in the eutrophication status of these mainly P-limited waters. The disproportionate reduction in loadings of P compared to N (52% versus 24%, since the early 1990s), and the potential weakening of the estuarine N filter, as eutrophication symptoms lessen, may result in the downstream movement of nitrogen to N-limited coastal waters. These findings support the view that an integrated dual-nutrient reduction strategy is required to address eutrophication along the freshwater-marine continuum. The outcome of the analysis is a conceptual model which is of direct value and use to water managers in determining the relative susceptibility of these waters to nutrient enrichment. This understanding can in turn be used to develop informed programmes of measures which are targeted and ultimately cost effective.

1. Introduction

Estuaries and nearshore coastal waters form the interface between the land and the open sea. The presence of human populations near the coast means these waters are exposed to a wide range of pressures associated with human activity. In Europe, 41% of the population, around 205 million people, live in coastal regions (Eurostat, 2011). Pressures can include discharges of nutrients and other substances from industrial and municipal waste water treatment plants, nutrient inputs from diffuse agricultural sources, morphological alterations associated with harbour and port activities and accidental discharges from marine vessels. It is not surprising then, that in terms of ecological status, as defined by the European (EU) Water Framework Directive, estuaries, referred to as transitional waters, are the worst performing water category (EEA, 2012). In Ireland, nearly two-thirds of transitional waters were found to be at moderate or worse ecological status (EEA, 2012).

The picture in Ireland and across Europe dictates that considerable effort will be required to improve the status of these waters (EEA, 2012). The most likely vehicle for achieving this will be the WFD, which is implemented by the development of river basin management plans. The purpose of these plans are to set environmental objectives for individual water bodies while at the same time identifying appropriate measures required to meet these objectives. The objectives include restoring waters to at least 'good' ecological status or the protection of waters already at 'good' or 'high' status.

The selection of effective measures for estuarine and coastal waters will be predicated on having a well developed understanding of how pressures interact with environmental factors and impact on biological receptors. For example, the response of

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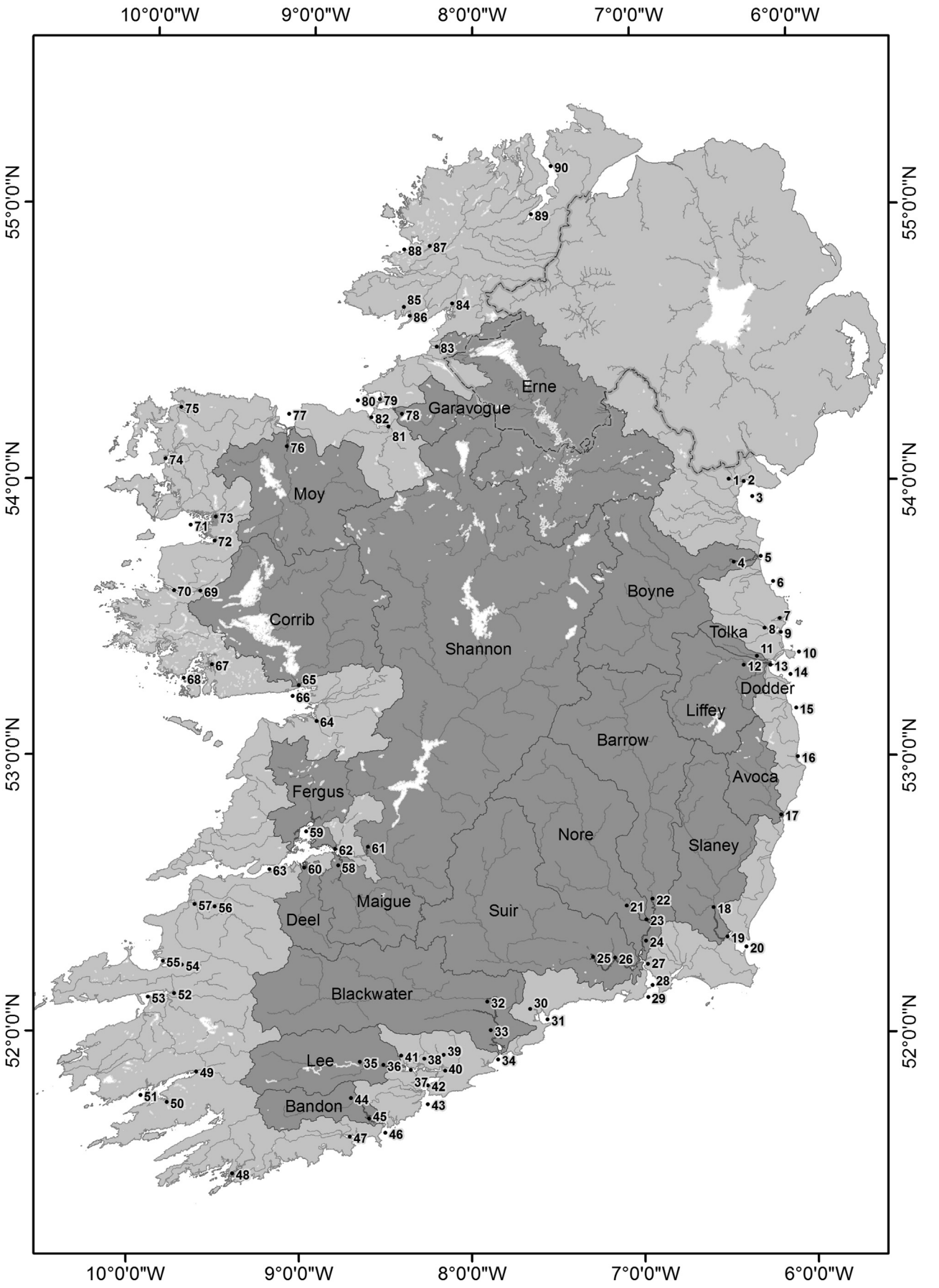

Fig. 1. Location of the water bodies in this study. The major river catchments are also shown, the river catchments shaded dark grey are monitored for riverine inputs. The name of each water body is given in the legend to Fig. 2 below.