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Harmful algal blooms in the Eastern North Atlantic Ocean

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Applying a mathematical model to the period 1982-2016, Gobler et al. (1) proposed that ocean warming has expanded the niche for harmful algal blooms (HABs) of the species Dinophysis acuminata and Alexandrium fundyense which can generate shellfish toxicity and pose risks to human health. The model predicted an increase in the growth rate and in the duration of the bloom season for these species, with a “hot spot” being the North Eastern Atlantic (NEA) and North Sea (NS) waters surrounding the UK. Using ships of opportunity, the Continuous Plankton recorder (CPR) has surveyed offshore phytoplankton populations (including Dinophysis, but not Alexandrium) in this region since 1958 (2). We used Dinophysis spp. data to evaluate the model’s predictions, as species data were not available before 2004.

Growth rate is not easily calculated from in situ data, but one might reasonably expect enhanced growth to lead to increased cell abundance. We therefore determined the annual mean CPR surveyed Dinophysis concentration in the NEA and NS. Using the modified Chelton method to remove serial autocorrelation (3), we found that over the modelled period (1982-2015) and the whole CPR time series (1958-2015) there was no statistically significant positive relationship between Dinophysis abundance and sea-surface temperature (4) in the modelled area over either the whole year or the April to September growth season, a result consistent with a previous study (5).

Dinophysis-generated shellfish toxicity is related to short term “bloom” events of elevated abundance. Harm from Dinophysis could therefore increase despite annual abundance decreases, should more frequent or larger blooms occur. Figure 1 shows that while there have been periods of large Dinophysis blooms in the region, these mostly occurred during the early 1970’s and the late 1980’s, and have been followed by a period of briefer
bloom events from the mid 2000’s until 2014. In Figure 2, by calculating the percentage of
days per year that *Dinophysis* abundance was greater than two standard deviations above the
mean of the whole series, we also show that there is no increasing trend in number or annual
duration of blooms.

Understanding the long-term trends of *Dinophysis* concentrations is important in NEA
waters as significant increases in shellfish aquaculture are planned in the region. The work of
Gobler (1) is valuable in demonstrating the potential for increasing water temperature to
increase the associated HAB risk. However, our data indicate that the modelled increases in
*D. acuminata* growth rate are not evident in terms of increases in the annual mean, number of
*Dinophysis* blooms or their duration. Gobler used empirical laboratory evidence of increasing
*D. acuminata* growth rate with increasing temperature to parameterise an individual-based
model. *Dinophysis* populations exist within a complex planktonic food web and are often
comprised of more than one species with different environmental preferences. Our results
suggest that other factors, such as prey availability, predation or ecological interactions are
currently limiting any temperature-driven increase in *Dinophysis* in the region. It will be
necessary to incorporate these factors within models to fully evaluate climate-driven HAB
risk.

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Figure 1 The log(x+1) transformed abundance of *Dinophysis spp.* as recorded by the CPR from an area limited by 49.125°N to 60.125°N; 0.125°E to 10.125°E (area defined by Gobler et al 2017). Abundance is measured per approximately 10 nautical miles of area surveyed by the CPR.
Figure 2 The percentage of days in each year that the abundance of *Dinophysis* spp. as detected by the CPR in the modelled region (1) was greater than two standard deviations above the mean of the abundance from 1958 until 2015.