

Dear Editor,

We are thankful for the thoughtful reviews. Below we respond to Reviewer 1 in detail. Additionally, because of the suggestions of Reviewer 2, we have added one figure to the main manuscript and 2 figures to the supplemental material. In case Reviewer 1 would like to see these new figures, we are including them at the end of this reply.

In the response below,

Reviewer 1 text is in blue

Our response is in black.

Direct quotes from the revised manuscript are in black italics.

Sincerely,

Rachel Stanley (on behalf of all the authors)

Reviewer 1: I think this is an excellent paper, and the comments I have are so minor that I do not need to review it again.

The work is very well executed, and the authors make a strong case for the occurrence of a relatively large *Hemiaulus* bloom on the NES in 2019. The text itself is well written. I especially liked how the authors clearly presented their definitions of GOP, NPP, NCP and export efficiency in the introduction. Use of data from other years, to put the 2019 'anomaly' in context, was a great strength, as were the backward particle trajectory simulations

We gratefully acknowledge the praise of the reviewer.

Minor edits that I recommend for clarity:

- In the Introduction, line 86, large phytoplankton (LP) cells are defined as those > 10 μm , but then a 20 μm filter is used to define LP in the actual study. I suggest changing the intro to read something like "LP, defined as > 20 μm in this study".

Thank you for pointing that out. We used the 20 μm data because we have it for every time and space point whereas we only have 10 μm for some of the samples. The conclusions did not change whether we used the more limited 10 μm or the extensive 20 μm data but of course it is important for the text of the paper to represent what we did. Since this part (lines 83-89) of the introduction is about the general ecosystem rather than this particular study, we omitted the size definitions from the sentence the reviewer mentioned and instead just say large and small since different studies define those terms differently. In section 2.6 where we talk about size fractionation, we have added a sentence as follows:

"Note that in this study large phytoplankton are defined as > 20 μm ."

-line 117 - why is the underway system giving only km-scale resolution? Do you mean that the samples were collected AT km-scale resolution..or every km?

The underway NCP data is limited by the time interval of the mass spectrometer measurement, which is every 30 seconds. Additionally, there is gas equilibration inside the liquid cartridge that practically means each datapoint represents about 2 to 5 minutes. The ship traveled at 5 to 10 knots typically (the slower speeds were when we were towing a video plankton recorder) so this translates to 0.3 to 1.5 km spacing. The phytoplankton data were only collected every 20 minutes so the spacing for that data is 3 to 6 km depending on the speed. Our use of km scale resolution was being intentionally general to encompass the different types of measurements described in that sentence. But we have rephrased the sentence to be more clear. The salinity and temperature data that we used were one minute averages so represent data at 0.14 km spacing.

“Some data during that event, such as surface seawater temperature (SST), salinity (SSS), NCP rates, and phytoplankton composition were collected continuously from the underway system (every 0.1 to 6 km depending on the measurement type and ship speed), while other parameters (e.g., NPP, grazing rates, Chl-a, nutrients) were measured discretely at the NES- LTER stations”

-line 138 - Have previous studies proven that diaphragm pumps are less damaging? (If so, I suggest adding a citation). When making any physiological measurement I usually avoid pumps completely and use water collected by Niskin or other bottle.

The images from the IFCB (available at https://ifcb-data.whoi.edu/timeline?dataset=NESLTER_transect) show that many phytoplankton are easily identified and thus not very much damaged when they go through the diaphragm pump. In response to the reviewer's suggestion, we have added a citation:

Cetinić et al. 2016. Characterizing the phytoplankton soup: pump and plumbing effects on the particle assemblage in underway optical seawater systems. *Optics Express*. DOI: 10.1364/OE.24.020703

-Some justification should be given for the choices of C:Chl and PQ values. C:Chl, especially, can be highly variable.

We agree that C:Chl ratios are highly variable, especially in coastal waters and have added in a reference to that effect. However, in this study, the C:Chl ratio is only used indirectly when calculating rates of NPP for 2018 since direct NPP measurements were not available during this summer. In particular, we first used the C:Chl ratio to convert phytoplankton growth rates from all years into an estimate of primary production. We then compared the PP calculated this way to the actual NPP measured for 2019-2022 and then determined the linear regression. We next adjusted our calculated rates for 2018 based on this linear relationship. Thus as long as we use the same C:Chl ratio for the entire analysis, the results are insensitive to C:Chl – the relationship between PP and NPP would change to compensate for a different C:Chl ratio. We have described this in more depth in the paper.

“This calculated productivity from chlorophyll was then converted into NPP based on a linear relationship determined between Chl-calculated productivity and measured NPP during the summers when NPP rates were measured directly. While C:Chl ratios in coastal systems are

highly variable seasonally (Jakobsen and Markager, 2016), we used the same C:Chl ratio when calculating the linear relationship and when scaling up NPP, and thus the estimated NPP rates are insensitive to the choice of C:Chl ratio. C:Chl ratios were not used for NPP rate calculation for any other year. “

-What is the average cell size for *Hemiaulus*? I know they are big, but how big? Please add scale bars to Figure 2.

Scale bars have now been added to Figure 2. Individual *Hemiaulus* are typically slightly smaller than 50 μm and the chains collected were up to a few hundred μm - the new scale bars allow readers to judge this for themselves.

-Line 588 - growth rates for *Hemiaulus* from the dilution experiments are very similar to values for large (non-symbiont containing) *Rhizosolenia* species...suggest citing some of T. Villareal or T. Richardson's work.

We thank the reviewer for suggesting those references. Indeed, the growth rates we find are nearly the same as those reported in Villareal 1990 in which cultures were grown at the same temperature as was observed during our cruise. Note the rates reported in Villareal 1990 have to be multiplied by the natural log of 2 to convert division/day units (Villareal 1990) to per day units (our study). We thus added in a sentence to the paper as follows:

“Notably, these low phytoplankton growth rates are in the same range as other diatoms with Richelia symbionts, namely 0.3 d⁻¹ for Rhizosolenia-Richelia cultured at a similar temperature (Villareal, 1990).”

-Line 649 - This section (4.2) was a bit confusing, and I think the point could be made in much fewer words. Suggest revising for clarity and brevity.

We have shortened section 4.2 while still keeping the main point. We do think it is important to define compositional and aggregative variability since many readers may not be familiar with those terms so we left the beginning of the section unchanged. But near the end before we went into more details about the differences among years, we have now omitted some sentences and kept discussion to a minimum.

Additional Figures Below we show the figures we have added to the paper in case they are of interest to the reviewer.

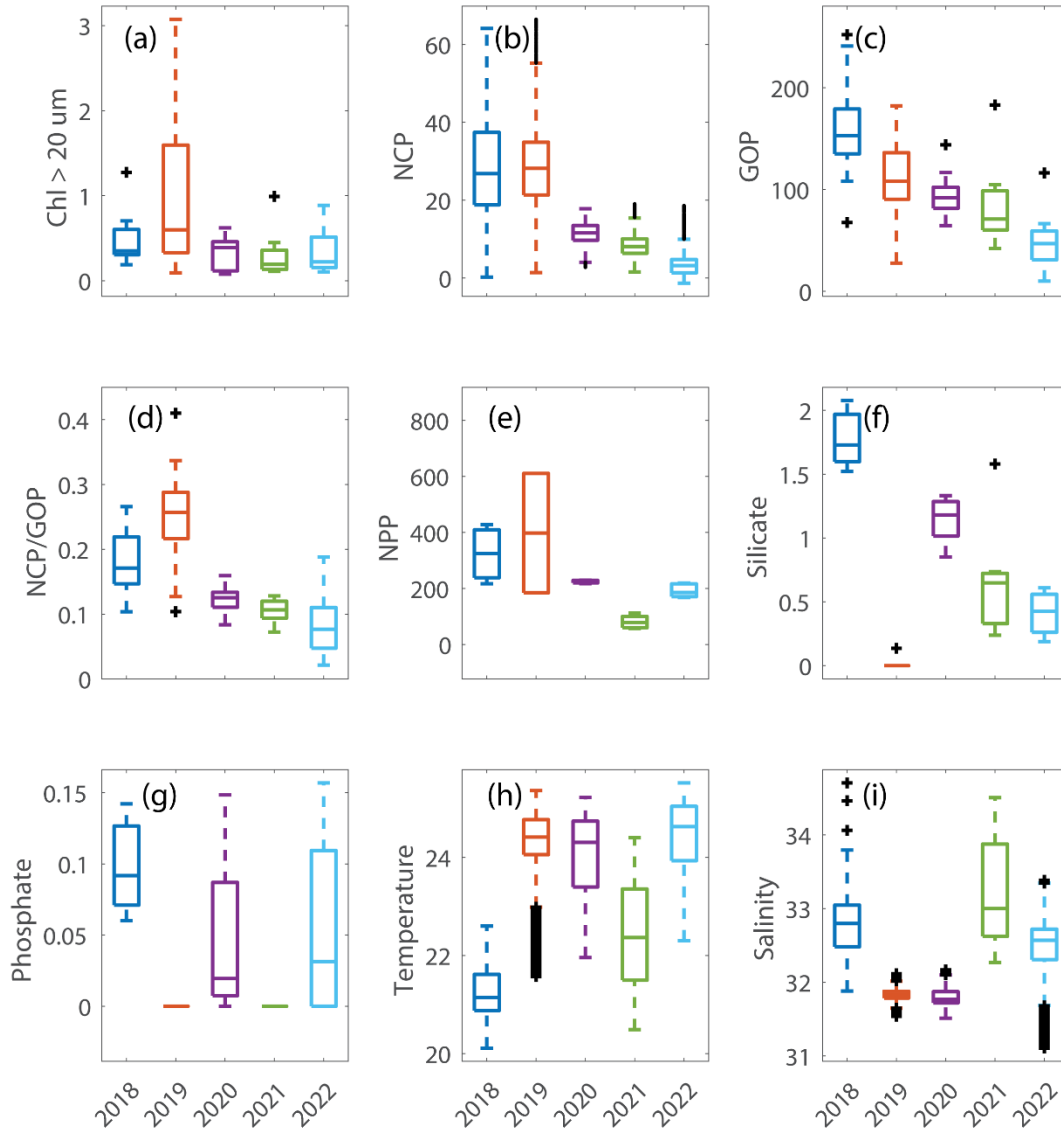


Fig. 5. Box plots of data in the summer, mid-shelf region for a) chlorophyll associated with cells > 20 μm in units of mg m^{-3} , b) net community production (NCP) and c) gross oxygen production (GOP) both in units of $\text{mmol O}_2 \text{m}^{-2} \text{d}^{-1}$, d) NCP/GOP (unitless) which is a measure of export efficiency, e) Net Primary Production (NPP) in units of $\text{mg C m}^{-2} \text{d}^{-1}$, f) silicate and g) phosphate, both in units of $\mu\text{mol L}^{-1}$, h) sea surface temperature in degrees Celsius and i) salinity in psu.. These plots show the differences in the plotted variables that occurred in August 2019 (orange box in each plot), a year when *Hemiaulus* carbon equaled $28.4 \mu\text{g L}^{-1}$, compared to the data from the other summers, all of which had *Hemiaulus* carbon $<0.02 \mu\text{g L}^{-1}$.

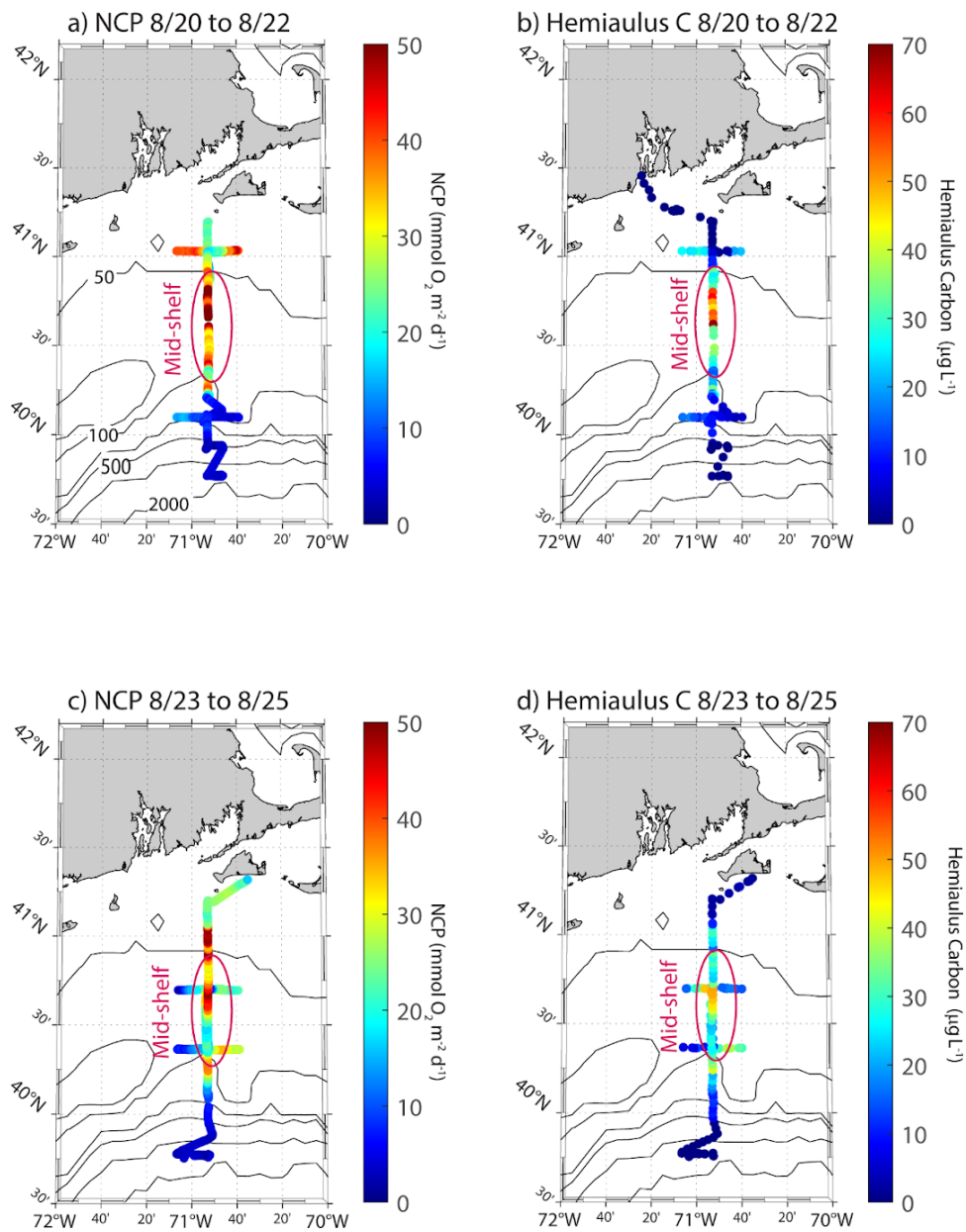


Figure S1. Rates of net community production (NCP) and *Hemiaulus* carbon in the first half of the cruise (panels a and b) and the second half of the cruise (panels c and d). The mid-shelf region is circled for each panel and bathymetry contours are labeled in the first panel. Note that the later time period has smaller NCP and lower amounts of *Hemiaulus* carbon, and this, taken together with the near zero silicate values, suggests the bloom was likely in decline.

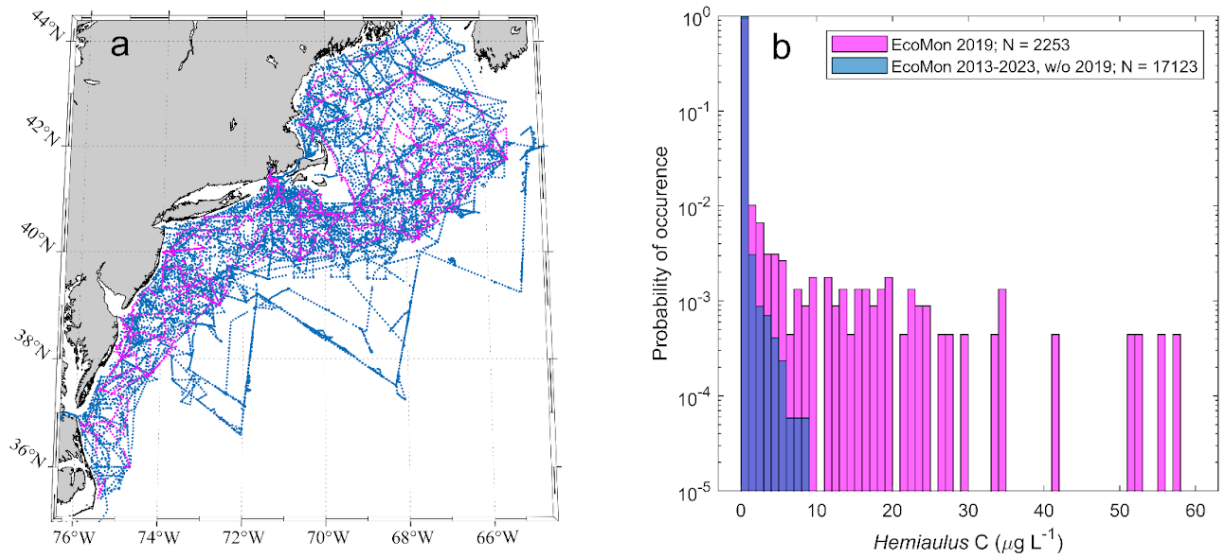


Figure S2. Figure 2. IFCB-based observations of carbon concentration associated with *Hemiaulus* collected across the NES broadscale cruise over the last decade emphasize the extreme nature of the high concentrations observed in 2019. (a) Map of automated IFCB measurement locations on 26 broadscale survey cruises conducted in the period 2013-2023 in partnership with NOAA’s National Marine Fisheries Service, through their EcoMon program plus a couple of other ship-based observational programs (AMAPPS, HAB cyst surveys). IFCB sample locations (N = 19376) extend across the continental shelf from North Carolina to Maine, with the sampling distribution over the three 2019 cruises (N = 2253) highlighted by magenta coloring. (b) Normalized histograms of *Hemiaulus* carbon concentration in 2019 (magenta bars) and for all years except 2019 (blue bars). While most observations had undetectable *Hemiaulus* (0 mgC L^{-1}) in both periods (94.9% in 2019; 99.4% in all other years), the high concentration tail in 2019 is extraordinary compared to the rest of the decade.