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A Response to "Continental Shelf Hypoxia: Some Compelling Answers" by Donald F. Boesch, This Issue

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COMMENTARY

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A RESPONSE TO "CONTINENTAL SHELF HYPOXIA: SOME COMPELLING ANSWERS" BY DONALD F. BOESCH, THIS ISSUE.—Boesch (2003) takes us to task for our suggestion (Rowe and Chapman, 2002) that physical factors on the Texas–Louisiana shelf are as important as nitrate loading as a cause of hypoxia. It was never our intention to deny that total nitrogen is important, and we firmly believe, as we stated in our article, that better management of nitrogen upstream can only benefit the system. The point of our argument was that the physical controls and especially the timing of the nitrogen delivery are equally important and must be considered when remediation strategies are being considered. Boesch apparently acknowledges this when he states "How humans affect the timing and location of the delivery of freshwater to the Gulf also matters a lot." However, to our knowledge, the effects of subsidiary peaks in flow on local stratification, and hence the extent of the hypoxic region, have not been addressed. It was this idea of physics, chemistry, and biology acting together that led us to propose our three-zone system. This schematic picture was not designed to include smaller-scale features such as the coastal current but to indicate variability that needs to be better defined. Similarly, the position of the boundary between our brown and green zones (where turbidity control gives way to biological control) is not fixed—it will certainly move during the year as river discharge varies. We put it at the western edge of the anticyclonic gyre that is frequently visible in satellite imagery of the region. We do believe, however, that the stratified region (the blue zone in our scheme) is a major control on the extent of hypoxia. This was borne out well in the summer of 2003, when two tropical storms in June and July stirred up the water so much that the annual hypoxia survey carried out by Rabalais and coworkers showed only about 8,000 km^2 affected instead of the more than 20,000 km^2 affected in 2001 and 2002 (for the latest information see http://www.cop.noaa.gov/Fact_Sheets/NGOMEX.html).

We (and several others) have recently been funded by National Oceanic and Atmospheric Administration (NOAA) to address the interaction of physics, chemistry, and biology in controlling the extent of hypoxia on the Louisiana shelf. Our colleague Robert Hetland will be making use of a Regional Ocean Modeling System (ROMS) model of the region, which can resolve the physical domain on a 1-km scale and take account of both the prevailing wind forcing and the freshwater input. We believe that this model will improve predictions of the extent of hypoxia and allow us to predict better the effects of changes in the amount of nitrate delivered to the system—even the authors of the Committee on the Environment and Natural Resources report on the hypoxic region have admitted that the model used in their estimates was inadequate for the job (Brezonik et al., 1999). In truth, both we and Boesch are essentially arguing the same points, that nitrate supply, local biological production, and physical forcing (wind and stratification) are all important in determining the extent of hypoxia in this region. Where we differ is in trying to establish the relative importance of each. This will change from year to year and even from month to month depending on the local conditions. Of course, there is also the question of whether the goal of reducing the extent of the hypoxic region to less than 5,000 km^2 by 2015, as recommended by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (2001), is actually attainable, given the excessive organic loading in the sediments close to the Louisiana coast, but this is another subject entirely. Of course, what is really important is the effect of hypoxia on organisms. Although the benthos will certainly be affected by long periods of hypoxia, the overall effect on the ecosystem is unclear. The Committee on Environment and Natural Resources (2000) was unable to document any obvious effect of hypoxia on commercial catches, for example, and it must be remembered that the most productive fisheries in the world are situated in those regions subjected to coastal upwelling, where hypoxia is an almost constant fact of life (see, e.g., Parrish et al., 1983; Crawford et al., 1987). Regardless of whether we or Boesch is correct, there are still plenty of questions to answer (such as the apparently constant respiration rates across the shelf mentioned in our earlier article) before we can confidently predict the demise of the hypoxic zone in the Gulf of Mexico.

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