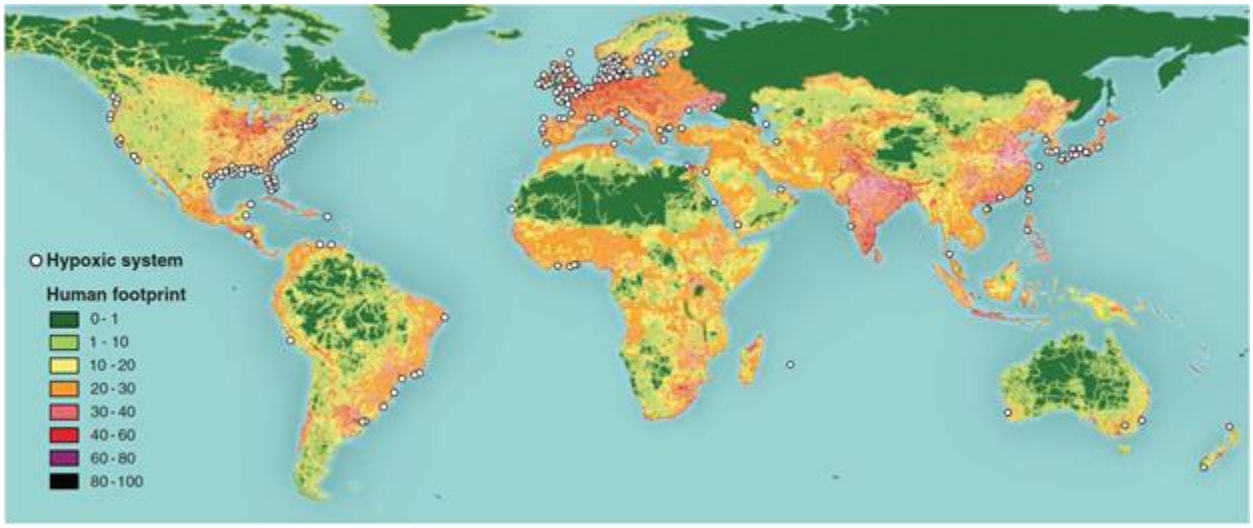
Dead Zones in Coastal Ecosystems

HOW TO USE THIS RESOURCE

Show the figure below to your students along with the caption and background information. The "Interpreting the Graph" and "Discussion Questions" sections provide additional information and suggested questions that you can use to guide a class discussion about the characteristics of the graph and what it shows.



Caption: The map illustrates the severity of our global "human footprint" rated on a scale from 0 to 100. Green areas are the least influenced by humans and black areas are the most heavily influenced. The human footprint index includes measures of population density; land use; light pollution; and the region's accessibility by roads, railroads, rivers, and coasts. The white dots on the map are hypoxic systems, or dead zones, caused by eutrophication.

BACKGROUND INFORMATION

The number of dead zones in the ocean has approximately doubled every decade since the 1960s. Dead zones, also called hypoxic systems, are areas of coastal systems with low oxygen levels caused by human activity. Dead zones are often caused by eutrophication, a process in which excess nutrients enter a body of water, causing an overgrowth of algae and other plants. As these plants die and decompose, microbes consume dissolved oxygen in the water. The resulting hypoxic conditions, where dissolved oxygen levels fall below 2 ml of O_2/L of water, cause fish and other marine life to abandon their habitats or die. Eutrophication can occur naturally, but it has increasingly been linked to human activities, such as when excess agricultural fertilizers run off the land into waterways that ultimately empty into the ocean. Dead zones upset the ecological balance in coastal oceans and have resulted in losses to the fishing industry in numerous locations around the world. Researchers compiled information on more than 400 hypoxic systems linked to eutrophication that they identified from published reports. Dead zones have only recently begun being reported for the southern hemisphere and Asia, so these may be underrepresented. The researchers overlaid the locations of hypoxic systems on a map of the global "human footprint," which is an index that was developed based on measures of population density; land use; light pollution; and the region's accessibility by roads, railroads, rivers, and coasts.

INTERPRETING THE GRAPH

The dead zones appear to cluster near areas that are heavily impacted by humans. The most likely causes of the dead zones are untreated sewage and large inputs of agricultural runoff containing excess fertilizer that

accumulates along coastlines. The fertilizers raise the nutrient levels of coastal waters (eutrophication) and spur the growth of plants and microbes that consume much of the water's oxygen when they die and decompose. The resulting abnormally low oxygen levels (hypoxia) fail to support communities of marine life, which either die or are forced to relocate. This correlation between dead zones and areas with a high human footprint provides evidence that the dead zones result from human activity.

Teacher Tip: Prompt your students to explain the parts of the graph as applicable:

- Graph Type: Global Map
- Data Represented: Location of dead zones (white dots) resulting from eutrophication. The human footprint, or degree of human influence, is represented by a range of colors that lie on a scale of 0 to 100, with 100 (black) representing the greatest severity of human influence.

DISCUSSION QUESTIONS

- What patterns do you see in the distribution of dead zones around the world?
- Is there an association between the locations of dead zones and the human footprint? If so, describe the association (i.e., are dead zones associated with low or high human footprint?).
- If more data on dead zones in the southern hemisphere is collected, how do you think the distribution of dead zones in this area will change?
- The scientists that constructed this map write, "The key to reducing dead zones will be to keep fertilizers on land and out of the sea." How do you think this could be achieved?
- If global climate change increases freshwater runoff flowing into major rivers, would you expect the dead zone areas of the continental coastlines to increase or decrease? Explain.
- How would you expect marine fisheries to be impacted by the increase in the number and distribution of dead zones?
- This paper is a review, which gathered information on 400 dead zones from 42 scientific journals spanning 50 years. What role do you think review papers play in science? Why do you think they are important? Has this map been updated since 2008?

SOURCE

Figure 1 from:
Diaz, R.J. and Rosenberg, R. Spreading Dead Zones and Consequences for Marine Ecosystems. 2008. *Science*. 321: 926-929.
View article: http://science.sciencemag.org/content/321/5891/926.full

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