

Dead zones

from the Esri GeoInquiries™ collection for Environmental Science

Audience – Advanced environmental science

Time required – 15 minutes

Activity	Explore water pollution and its impact on ocean life in aquatic dead zones.
Science Standards	APES: VI. Pollution (Pollution Types; Water Pollution) APES: VII. Global Change (Loss of Biodiversity; habitat loss, pollution) NGSS: HS-LS2-1 and HS-LS2-4
Learning Outcomes	<ul style="list-style-type: none">Students will identify and describe the locations most affected by hypoxic conditions and dead zones.

Map URL: <http://esriurl.com/enviroGeoInquiry7>

Engage

How are current land covers distributed across the United States?

- Click the URL link above to open the map.
- ? What patterns of land cover do you notice? [*Crops in the plains of the Midwest, and forests in the mountains and near coasts*]
- With the Details pane visible, click the button, Show Contents Of Map.
- Click the checkbox to the left of the layer name, World Hydro Reference Overlay.
- Zoom in and then out.
- ? What are the names of at least three major rivers throughout the United States? [*Answers may include the Colorado, Mississippi, and Missouri.*]
- ? Which of these rivers (watersheds) seems to have the largest area of coverage? Hint: Zoom in. Dotted brown lines outline major watersheds in the U.S. [*The Mississippi River*]

Explore

Where are the dead zones?

- ? Where does the Mississippi River eventually drain? [*The Gulf of Mexico*]
- ? What are some potential impacts of river runoff into a larger body of water? [*Sediment flows, chemical runoff, and water pollution*]
- ? Using the previously identified rivers, what type of land cover do these rivers seem to flow through? [*Primarily agricultural*]

Explain

What causes a dead zone?

- Fertilizer application is a common practice in yards, golf courses, and large-scale agricultural farms. Excess nutrients can runoff into the local watershed.
- Turn on the layer, GLDAS Runoff.
- ? What do the darker blue colors represent? [*Higher amounts of runoff.*]
- ? What patterns are visible related to runoff? [*Higher amounts of runoff near larger urban areas*]
- ? What generalizations can be made about the relationship between urban areas and runoff? [*Impervious land cover increases the amount of surface runoff generated.*]
- Turn on the layer, Chlorophyll-a Concentration.
- ? Where do you notice increased concentrations of chlorophyll? [*Near the coasts*]
- ? What are possible causes of elevated chlorophyll levels? [*Warmer water temperatures, and increased nutrient and light levels*]

Elaborate

What are the effects?

- Increased chlorophyll concentrations have the potential to supply large amounts of decomposition organic matter.
- ? What is a likely result of excess decomposition? [*Decreased dissolved oxygen levels*]
- Turn on the layer, Gulf of Mexico DO.
- ? What is the approximate surface area of the dead zone (near coast of Louisiana)? Measure the light areas indicated in the layer, Gulf of Mexico DO. [*Approximately 7,000 square miles*]
- ? What relationship(s) do you notice between chlorophyll concentrations and dissolved oxygen? [*Higher amounts of chlorophyll correspond with lower dissolved oxygen levels*]
- ? What are the implications of low dissolved oxygen levels on local marine life? [*Fewer animals are able to live in areas of reduced dissolved oxygen.*]

Evaluate

What are some potential solutions to marine dead zones?

- Turn on the layer, Seafloor Dissolved Oxygen.
- ? What patterns do you notice around the country for locations of increased chlorophyll or increased dissolved oxygen levels? [*Near river deltas, estuaries, or tidal streams*]
- ? Define hypoxia. What are some potential solutions to lower hypoxic conditions in marine systems? [*Low oxygen; reduce fertilizer/pesticide use and reduce runoff.*]

CHANGE THE LAYER TRANSPARENCY

- With the Details pane visible, click the button, Show Contents Of Map.
- Click the three dots, and select Transparency.
- Modify the layer transparency to see layers below the top layer.

USE THE MEASURE TOOL

- Click the button, Measure.
- Click the button, Distance. Set the unit of measurement.
- On the map, click once to start the measurement, click again to change direction, and double-click to stop measuring.
- Hint: Position the area of interest on the map so that it is not obscured by the Measure window.

Next Steps

DID YOU KNOW? ArcGIS Online is a mapping platform freely available to public, private, and home schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at <http://www.esri.com/schools>.

THEN TRY THIS...

- Explore the story map, *An Ocean of Data*, to learn more about various scientific data and the world's oceans at <http://esriurl.com/Geo4221>.
- Using an ArcGIS Online organizational subscription for schools, identify other potential marine dead zones based on the environmental criteria used in this activity.

TEXT REFERENCES

This GIS map has been cross-referenced to material in sections of chapters from these texts.

- *Environmental Science: A Global Concern (12th)* by McGraw-Hill — Chapter 18
- *Living in the Environment (15th)* by Thomson — Chapter 21
- *Environment: The Science Behind the Stories (3rd)* by Pearson — Chapter 7