Partnership for Interdisciplinary Studies of
Coastal Oceans (PISCO)
www.piscoweb.org

Updated October 30, 2006

Frequently Asked Questions about Hypoxia and the Central Oregon Coast 'Dead Zone'

1) What is hypoxia?

If the amount of oxygen is less than 1.43 milliliters of oxygen per liter (ml/l) of seawater, it is defined as 'hypoxic" which simply means 'low oxygen'.

2) Is hypoxia typical off the coast of Oregon?

It is normal for low-oxygen water to appear occasionally on the sea floor along the outer and middle portions of the continental shelf, many miles from the coast. These areas are sometimes naturally hypoxic, with levels of dissolved oxygen generally in the range of 1-3ml/l. Many of the animals that live there are tolerant of occasional low oxygen conditions. The ocean bottom on the outer shelf is invaded by low-oxygen water from the deep sea during summertime upwelling (typically from late spring to early fall) . As surface waters are pushed offshore by the combined action of winds and the earth's rotation, deep, nutrient-rich yet oxygen-poor waters are pulled up onto the continental shelf (refer to Question 8 for more details) These conditions have been known by scientists and fishermen for a long time and are not usually termed a 'dead zone.' The low-oxygen water may kill some species, but its occurrence is not unusual and not new.

3) What is new or unusual about hypoxia on the Oregon coast?

The occurrence of low-oxygen water close to shore (the inner shelf, less than 50 m (165') of water) is highly unusual and not reported prior to 2002.

In addition to the location of hypoxia in waters inside the 50m (165') depth contour, the levels of oxygen in this inner-shelf water in 2006 and other years since 2002 are lower than the levels of oxygen in the low-oxygen water at the margin of the continental shelf.

And, significant numbers of dead organisms due to this low oxygen water have been documented off of Cape Perpetua in 2002, 2004 and 2006, hence the popular term 'dead zone.

4) What is a dead zone?

A dead zone is an area of the ocean that doesn't have enough oxygen to support most marine life. Hypoxic waters can kill organisms if the oxygen levels are low enough in

combination with how long the low oxygen conditions last. While the media and many people use the term 'dead zone' to describe low-oxygen, or hypoxic, areas, scientists prefer to link the term dead zone to areas where organisms have been shown to have died due to lack of oxygen. The term 'dead zone' has been applied to all near-shore waters where very low oxygen levels have been measured, even though we have documented dead organisms only in the portion of those waters off of Cape Perpetua in 2002 and 2006

5) Does everything die in a dead zone?

No. It depends on the behavior and physiology of the animals and the rate of movement, oxygen content, and persistence of the mass of low oxygen water. Some animals such as fish or crabs may be able to swim or scuttle away from a mass of low-oxygen water and thus escape suffocation. Most animals that do not escape will die if the low-oxygen water persists or if the levels of oxygen drop even lower. Some species are more tolerant of low-oxygen conditions than others.

6) Why is the dead zone occurring off the Oregon coast?

Scientists are not sure why this dead zone has appeared in recent years. They suspect that there have been fundamental changes in ocean conditions off the Oregon coast. These changes may include either oceanic or atmospheric changes or both. This is an active area of investigation.

7) Is the dead zone caused by climate change?

Scientists cannot say whether or not the dead zone is caused by climate change[1]. We can say that changes in oceanic and atmospheric conditions are expected under a changing climate. The changes in oceanic and atmospheric conditions that are causing the dead zone are thus consistent with predictions of climate change. That is not the same thing, however, as saying that climate change is definitely causing the dead zone.

8) How is the Oregon dead zone formed?

Every summer off Oregon, northerly winds – winds blowing from the north to the south, which are sometimes referred to as southward winds – drive surface waters offshore. This causes deeper, colder, nutrient-rich waters to rise to the surface near the coast. When the nutrient-rich, upwelled water reaches the lighted zone near the ocean surface, the microscopic plants called 'phytoplankton' bloom and contribute to Oregon's productive ocean ecosystem. These phytoplankton sink to the sea floor where microbes decompose them, consuming oxygen in the process. This leads to lower levels of oxygen near the sea floor than near the sea surface. Oxygen also stays high right near the shore, where breaking waves efficiently mix oxygen into the water.

If coastal winds cease or become southerly, surface waters move back toward the shore, driving bottom waters away from the coast -- a process called downwelling. If upwelling periods alternate with downwelling periods, low-oxygen waters do not accumulate at the bottom across the continental shelf. If, however, downwelling-favorable winds do not

blow, then low-0xygen waters can accumulate. When that happens, each successive strong upwelling brings the low-oxygen waters closer to shore. Each strong upwelling also brings more nutrients to the lighted zone, causing more phytoplankton to bloom, sink and decay, resulting in even lower levels of oxygen. Repetitions of these events cause the mass of low-oxygen water to become thicker as well as lower in oxygen.

9) How can we tell if there is a dead zone off the coast of Oregon?

PISCO scientists say that a dead zone is happening if two things are both true: (1) there is low-oxygen water (less than 1.43 ml/l) in waters inshore of the 50-m (165-feet) depth contour and (2) animals are dying. The 2006 dead zone lasted from mid-June through mid-October.

Scientists determine if there is a dead zone by measuring the amount of oxygen in the water. PISCO scientists measure oxygen in the water along lines running from close to the shore out across the continental shelf at five locations: Cascade Head, Lincoln Beach, Newport, Seal Rock and Strawberry Hill (near Yachats). Measurements are taken at the same location every year at depths of 15 meters (= 50 feet), 30m, 40m, 50m, 60m, 70m, 80m, 90, and 100m (=330 feet). The shallowest stations are approximately 6/10 of a mile from the shore; the deepest stations are from 8 to 13 miles from the shore, depending on the site.

Coastal residents may find dead crabs and fishes washed up on the shore in unusually large numbers. (Care must be taken to ensure that crab molts -- found naturally on beaches-- are not mistaken for dead crabs. Molts can be identified by a protruding abdomen, a split at the back of the top shell, and loose legs.) It is difficult to tell from dead animals washed up on beaches how extensive a dead zone is. Many species that suffocate from lack of oxygen may remain on the ocean floor or be transported to deeper waters.

Other indicators of low oxygen may be reports from divers and fishermen of live fish found in unusual places, e.g., bottom fish found high up in the water column, deep-water fish found close to shore. Crabbers might find dead crabs in their pots.

10) Where is the Dead Zone?

In 2006, the Oregon dead zone was documented at its maximum as occurring in a layer along the ocean floor from Cape Perpetua (Florence) in the south to Cascade Head (Lincoln City) in the north and across the shelf as close to shore as 15m (50 feet) depth. As conditions began to improve, the northerly portion of this area became oxygenated while the southerly portion (Florence to Seal Rock) remained hypoxic.

11) Does the dead zone cover the entire area between Florence and Cascade Head or are there places where oxygen levels are sufficient for marine life?

Our measurements indicate that the exact size, edges and thickness of the dead zone can shift with day to day changes in coastal winds. Even in the core dead zone area off Cape Perpetua, pockets of higher oxygen bottom water can be found very close to shore (within ¼ mile). This oxygenated near-shore region can expand when northernly winds ease or winds become southerly. The dead zone typically affects primarily the bottom of the water column. Although this layer of oxygen-poor water can be very thick, the surface layer typically holds enough oxygen for surface and mid-water fishes. It is likely that some fish and crabs and other mobile animals may escape to these refuges – near the ocean surface and very close to shore or in bays -- where oxygen levels are sufficient. However, they may be more vulnerable to their predators in these new locations.

12) When did the 2006 low-oxygen event end?

During mid-October, 2006, a normal shift from summer southward-blowing winds to fall and winter northward-blowing winds resulted in the end of the upwelling season and a rise in dissolved oxygen to levels that can support marine life, scientists said. The oxygen levels are expected to increase throughout the November.

13) Will Oregon experience another hypoxic event next year?

Scientists cannot predict whether or not oceanic and atmospheric conditions will create another low-oxygen event in 2007. It would not be surprising if hypoxic conditions developed next year, simply because there has been a low-oxygen event each of the last five years. The causes of the changes in wind patterns that appear to be driving the hypoxia are unknown. These uncertainties point to the need for more research and monitoring to enable better understanding of the causes and consequences of hypoxia. Both a coast-wide ocean observing system to track changes at multiple scales and research to understand impacts of changes on coastal ecosystems and humans are needed.

14) What are the next steps for understanding the impacts of hypoxia and the recovery of the system?

The next order of business is to monitor the recovery from hypoxic conditions. OSU scientists will work closely with the Oregon Department of Fish and Wildlife, and consult with local fishermen to verify their findings. The event is complex – low oxygen waters are not static, they move up and down the coast and also towards shore, resulting in patchiness and variable effects in some areas.

This winter, the ocean off Newport will be continuously monitored for the first time by a submersible “glider” that will provide information on ocean conditions, and a sophisticated new buoy will be moored off Newport along the central Oregon coast to measure biological productivity, dissolved oxygen, temperature, salinity, current velocity and other data.

15) Have there been dead zones off the Oregon coast before?

Prior to 2002, dead zone events had not been reported in the very near-shore waters off the Oregon coast. It is important to note that low-oxygen water occasionally appears at depth over the outer continental shelf. Fishermen and scientists both know that this low-oxygen water sometimes appears in the summertime along the continental margin and on the outer portions of the shelf. What is different in the last five years is the presence of low-oxygen water in the inner shelf (less than 50 m (165') of water).

16) Is 2006 different than past years?

This year's dead zone is significantly different from the ones in 2002-2005 in four major ways. It is (a) larger, (b) thicker, (c) lower in oxygen, and (d) longer lasting.

(a) The 2006 dead zone is at least 4 times larger in area than in years past, stretching from Florence to Cascade Head. (In the four previous years, the northern extent was around Newport) In 2006 there have also been reports of a dead zone of undetermined size off the central coast of Washington: dead fish and crabs washed up on beaches and reports from scientists indicated low-oxygen waters close to shore.

(b) The mass of low-oxygen water that is close to shore in 2006 is thicker than in previous years. At our 50 m (165') station off Newport, the bottom 4/5ths of the water column was hypoxic in early August. Only the top layer had enough oxygen to support life.

(c) In 2006, PISCO scientists measured the lowest level of oxygen ever recorded in shallow waters off the coast of Oregon. Levels of dissolved oxygen as low as 0.05 ml/l persisted at the 50 m (165') station off Cape Perpetua for many weeks. These levels of dissolved oxygen are much lower than the low oxygen that is typical off the edge of the continental shelf.

(d) The 2006 dead zone persisted for 4 months – from mid-June to mid-October. This duration more than doubles the previous record of 6 weeks set in 2004.

17) Why is the dead zone worse this year?

Scientists are not sure why the low-oxygen water varies from year to year. The formation and duration of the dead zone varies with the wind and ocean patterns along the coast. The winds are connected to larger, atmospheric changes over the Pacific Ocean. Ocean conditions off Oregon reflect larger-scale oceanic changes in the Pacific. The dead zone is a local expression of the larger changes happening in the atmosphere and the ocean. The evidence suggests that the area off Cape Perpetua is particularly susceptible to hypoxia, but that the changes causing the hypoxia are happening over a much broader area.

18) Why do some folks say that a dead zone in Oregon is not unusual or that dead zones have happened in Oregon prior to 2002?

There appears to be confusion about the location of low-oxygen water under discussion. It is normal for low-oxygen water to appear occasionally on the sea floor along the outer and middle portions of the continental shelf, many miles from the coast. Those conditions have been known by scientists and fishermen for a long time and are not

usually termed a 'dead zone.' The low-oxygen water there may kill some species, but its occurrence is not unusual and not new.

The occurrence of low-oxygen water close to shore (the inner shelf, less than 50 m (165') of water) is highly unusual and not reported prior to 2002. This appearance of hypoxia close to shore is what we call a 'dead zone.'

In addition to the location of hypoxia in waters inside the 50m (165') depth contour, the levels of oxygen in this inner-shelf water in 2006 and previous dead zone years are lower than the levels of oxygen in the low-oxygen water at the margin of the continental shelf.

19) What are the long term consequences of the dead zone?

The long term consequences are unknown at this point. In the last four years, the dead zone has lasted from a week to as long as four months. If the dead zone affects only a small area, lasts a short time, and if many animals can escape to other places while the low-oxygen water is present, it is possible that there may be little long-term impact. The longer the dead zone persists, the lower the amount of oxygen, and the larger the area, the greater is the likelihood of serious impacts.

20) What are the impacts to the fishing industry?

The impacts on the fishing industry are not clear. In conversations with fishermen, it appears that the dead zone has not reduced their catches. This and earlier dead zones occurred at the tail end of the commercial crab season. There have been record catches of crabs in past years despite the presence of a number of dead zones.

It is clear from the surveys done by Oregon Department of Fish and Wildlife (ODFW) and PISCO scientists that there were numerous dead crabs and crab molts on the seafloor off Cape Perpetua in 50 m (165') of water on August 8 and 21, 2006. It is also clear that there were an exceptionally large number of live crabs in Yaquina Bay in August, suggesting that many crabs may have escaped the low-oxygen water and found refuge in the Bay (though at least some of these were caught in recreational crab traps). Nearshore hypoxic conditions also occurred in the summers of 2004 and 2005, yet the commercial Dungeness crab harvests following those events set records.

The impacts on rockfish are also unclear. ROV surveys in Cape Perpetua region indicate no fish at all in places where they usually are abundant. Many observers have reported fish appearing in shallower water or higher in the water column than usual. These observations suggest that at least some fish may have escaped the low-oxygen water and found refuge close to shore or near the surface.

21) Is seafood caught during a dead zone safe to eat?

Yes! Fish or crabs for sale would likely have been caught outside the low-oxygen waters and should be as safe as those caught during any other time of year.

22) Is the dead zone in Oregon the same as the one in the Gulf of Mexico or the Chesapeake Bay?

No, those dead zones are caused by an excess of nutrients running off the land. The Oregon dead zone is not caused by nutrients running off the land, but rather nutrients being upwelled from the deep sea.

23) Does this type of coastal upwelling dead zone happen anywhere else in the world?

Yes, there are a few other places that have the same upwelling and coastal wind patterns that can result in a dead zone: off the coasts of Peru and Chile, and off Namibia and South Africa.

24) What happens when oxygen levels get close to zero?

The scientific term for 'no oxygen' is 'anoxia." The extremely low levels of dissolved oxygen measured off Cape Perpetua in August and September of 2006 (0.05 ml/l) were very close to anoxia (and lower than any of our measurements in 2002-2005). Under anoxic conditions, specialized microbes may colonize and become abundant. The bacterial mats we observed in the 21 August 2006 ROV images may be these anoxia-loving microbes.

However, anoxia-loving microbes do not thrive in oxygenated waters. When normal levels of oxygen return to the area, these microbes will likely be replaced by the microbes and animals usually found at those depths. We anticipate that because oxygen levels were so low for so long in the Cape Perpetua region, it may take longer than usual for the areas to recover.

25) Where can I get further information about the dead zone?

Periodic updates about the dead zone are posted on the PISCO website http://www.piscoweb.org/research/oceanography/hypoxia

Video clips from ODFW ROV surveys from 2001 (prehypoxia), Aug 8 and Aug 21, 2006 (during hypoxia) can be seen at http://oregonstate.edu/media/archives/. These video clips are provided courtesy of the Oregon Department of Fish and Wildlife and Oregon State University.

For more information, contact:

Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)

Liz Riley (liz.riley@science.oregonstate.edu) or
Amy Windrope (amy.windrope@science.oregonstate.edu)
541-737-8645

[1]Scientists prefer the term ‘climate change’ to ‘global warming’ for multiple reasons: (a) there are a broad array of changes underway in addition to temperature (for example, increases in extreme precipitation events, changes in ocean circulation, changes in atmospheric circulation, etc.); (b) although the average global temperature is increasing, some places are warming much faster than others and some are cooling; (c) the changes are not gradual through time, but often abrupt; (d) many changes involve increases in variability not just the average.