

Iron in Northwest rivers fuels phytoplankton, fish populations

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A new study suggests that the iron-rich winter runoff from Pacific Northwest streams and rivers, combined with the wide continental shelf, form a potent mechanism for fertilizing the nearshore Pacific Ocean, leading to robust phytoplankton production and fisheries.

The study, by three Oregon State University oceanographers, was just published by the American Geophysical Union in its journal, *Geophysical Research Letters*.

West coast scientists have observed that ocean chlorophyll levels, phytoplankton production and fish populations generally increase in the Pacific Ocean the farther north you go (from southern California to northern Washington). No one has a definitive explanation for the increase, the OSU scientists say, though some researchers have suspected river runoff may play a role. That theory has generally been discounted, they added, because river flows are low in the summer when phytoplankton blooms occur.

In their study, however, the OSU scientists found that Northwest rivers churn out huge amounts of iron in the winter and deposit it on the continental shelf, where it sits until the spring and summer winds begin the ocean upwelling process. The authors studied the relationships between phytoplankton, river runoff and shelf width all along the West Coast.

"If we consider just river flows or shelf width by themselves, they

explain part of the northward increase in productivity," said Zanna Chase, an assistant professor in OSU's College of Oceanic and Atmospheric Sciences and lead author of the study. "But if we analyze both together, they provide a more complete picture. The shelf increases in width as you move north. If the shelf wasn't there, the iron from rivers would be lost to the open ocean.

"Our shelf acts as a 'capacitor,'" she added, "storing the iron for the high-productivity upwelling season."

In their studies, the OSU scientists sampled water from Oregon rivers in the winter and found iron concentrations that were roughly 1,000 times higher than that found in samples of sea water taken from the Pacific Ocean off Oregon. And though previous studies, based on East Coast rivers, have suggested that almost all of the iron in rivers gets trapped in estuaries, this latest study found very different results for Oregon rivers in winter.

The researchers measured iron, ammonium, silicate and salinity levels at the mouth Alsea River during the winter, and tracked how much of it went into the ocean, said Burke Hales, an OSU associate professor of oceanic and atmospheric sciences.

The answer: more than half.

"Iron just doesn't like to be dissolved," Hales said, "especially in sea water. When fresh water meets salt, almost all of the iron sticks to particles that sink to the floor of the continental shelf, waiting for the winds to trigger upwelling. In contrast, Monterey, Calif., has a very narrow shelf and if you step off the beach it almost immediately goes to 6,000 feet deep."

Chase said there doesn't seem to be a direct relationship between the

amount of winter runoff in Northwest streams and the level of phytoplankton production the following summer, indicating the broad Northwest shelf is storing more iron than the phytoplankton need in any given year. As a result, she added, phytoplankton production off the Oregon coast doesn't seem to be limited by a lack of iron, whereas their cousins off central California – where river flow and shelf width are much less than off Oregon – are "iron-starved" in comparison.

The iron from the Northwest's winter runoff is trapped on the continental shelf in the winter by downwelling winds that create an oceanographic circulation barrier that prevents the iron from being transported into the open ocean. The Columbia River also plays a role, spilling out into the Pacific and turning north in the winter, further pinning the iron deposits in Washington's nearshore waters.

Further research is needed to test how much iron is stored in the sediments on Oregon's continental shelf, the scientists say, and how much gets used during a typical season of upwelling.

"We probably have several years of iron stored out there," Hales pointed out, "but we don't know whether 'several' means five, 10 or 50 years."

The importance of iron as a catalyst for ocean productivity invariably raises the question of whether humans can 'fertilize' the oceans to boost phytoplankton growth. All three of the authors have been involved in research in the Southern Ocean off Antarctica that tested that concept.

"It's more complex than simply adding iron to seawater," said Pete Strutton, an OSU assistant professor of oceanic and atmospheric sciences. "Experiments so far have generally shown an increase in productivity that was less than expected – and it didn't last long. Adding iron also changes the type of phytoplankton that grew, which might have important ecological consequences we don't yet understand."

The Northwest's system of iron-rich winter river water, a wide continental shelf, and summer upwelling has the overall effect of making this part of the Pacific Ocean a net "carbon sink" – or sequestering more carbon dioxide than the region produces. The ocean off central California, by contrast, "seems to be poised between a carbon source and a sink, depending on the year," Strutton said.

Source: Oregon State University

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