Nine months after a spill, a stick stirred up oily water in a canal near Cuninico, Peru.

OIL IN THE FOREST A rash of spills in the Amazon has scientists and villagers

scrambling to understand oil's effects on the ecosystem

pring should have been a good time for fishing in the network of dark, tree-lined lakes around this small Kukama Indian village in the northern Peruvian Amazon. Seasonal floodwaters that draw river fish into the lakes to spawn have traditionally meant a bonanza for fishermen here. But this year

"There are no fish in the lakes," says village President Galo Vásquez, a small, soft-

By Barbara Fraser, in Cuninico, Peru

spoken man with a perpetually worried expression. "We have to go farther upriver, sometimes a day or two away."

A late start for the rainy season could be to blame. But Vásquez and his neighbors also suspect lingering effects from a 2014 oil spill along a pipeline that carries crude 845 kilometers from Amazonian oil fields to the Pacific coast. Traces of oil still occasionally float past the village, even after 2 years of cleanup efforts in the area.

Sitting down to breakfast at a wooden

table in an open-sided house typical of the Amazon, as rain pattered on the palm-thatch roof, Vásquez and his neighbors wondered aloud whether the pollution drove the fish away and whether the few fish they did catch were safe to eat. A recent toxicology study found heavy metals in villagers' blood and urine, but did not pinpoint a source, raising more questions than it answered.

The dense green canopy of the rainforest in eastern Peru and Ecuador hides substantial reserves of oil, and over the

May 08, 2025

last 4 decades a web of wells and pipelines has spread through the forest. And where there is oil, there are spills. In the past few years, a spate of oil spills along Peru's main oil pipeline, including three this year alone, has fouled the water and land of dozens of indigenous villages. The spills have sparked a lawsuit by affected communities—and fledgling efforts by scientists to understand how oil affects the Amazon ecosystem. By global standards, the Amazon

By global standards, the spills are small. The 2000 barrels that leaked from the pipeline here are a drop compared with the more than 3 million barrels that spewed out of the sea floor when the Deepwater Horizon drilling rig exploded in the Gulf of Mexico in 2010. But oil may affect the complex Amazon ecosystem in unexpected ways, so that lessons learned in marine spills may not apply. "Where biodiversity is incredibly high," as in the Amazon, each species may react differently, says physical geographer Paúl Arellano of Yachay Tech in Urcuquí, Ecuador. And because local people rely on fishing and on river water for drinking, the human impacts of oil pollution could be especially severe.

A handful of studies are beginning to trace toxic components of oil as they wend their way through the Amazonian ecosystem, into the river fish and possibly into the people who eat them. Still, "of all we know about the fate of crude oil in water in general, only 2% or 3% of the information [comes from] freshwater systems," says biologist Adalberto Val of Brazil's National Institute of Amazonian Research in Manaus. "We are just starting to [learn about] this in the Amazon."

A FISHERMAN FROM CUNINICO

raised the alarm on 30 June 2014 when he saw an oil slick and

dead fish in a stream that flows from a canal containing the submerged pipeline to the Cuninico River. Workers from Petroperú, the state-owned oil company that operates the pipeline, arrived quickly and hired men from the community to search for the rupture. The men worked for days in chest-high, oily water, at first without the protective gear standard in the United States. Later, the company hired a cleanup firm, and by October 2014, most visible oil was gone. In December 2014, however, the rainy season began. The river rose, and booms meant to corral oil in the pipeline canal floated free of their moorings. Oily water overflowed into the forest and the Cuninico River.

Petroperú workers returned last fall. But in March, nearly 2 years after the spill, a villager fishing near the mouth of the Cuninico River caught fish that smelled of gasoline, Vásquez says. Even now, stirring the bot-

Oil across the Amazon

A pipeline ferrying crude oil 845 kilometers from Amazonian fields across the Andes Mountains to the Pacific coast has suffered repeated spills. In January, a spill fouled a stream near the town of Chiriaco in northern Peru (bottom).



tom of the canal with a long pole releases oily bubbles.

The oil has entered a complex ecosystem, where floodwaters rise and fall, water chemistry varies from river to river, and fish have diverse adaptations that can affect how they absorb pollution from the water and sediments. For example, fish in acidic, organic-rich "black water" rivers like the small Cuninico absorb minerals differently than fish in "white water" rivers like the Amazon itself. And fish in both types of rivers have adapted to fluctuations in oxygen levels, which rise during the day and during flood season and fall at night and in the dry season. Some fish actually come to the surface to breathe air, as do river dolphins; others seek oxygen-rich shallow water.

These adaptations can become a liability in an oil spill, as a handful of studies show. Because slicks typically form at the surface, river dolphins and the air-

> breathing fish *Arapaima gigas*, known as pirarucu in Brazil and paiche in Peru, ingest oil when they breathe, Val says. Fish also are exposed to dissolved hydrocarbon compounds that are more toxic near the surface, thanks to chemical reactions catalyzed by ultraviolet light, according to a 2002 study.

Cleanup crews sometimes apply dispersants-detergentlike chemicals famously used in the Deepwater Horizon spill-to break oil into smaller particles so that microbes can biodegrade it more quickly. In laboratory tests, however, Val and his colleagues found that a combination of oil and a dispersant can be more toxic to Amazonian fish than oil alone, as they reported in 2010. In another paper just a few weeks ago, they reported that oil and a common dispersant appear to be more toxic in "black water" than in groundwater, causing liver and DNA damage in the fish.

The fish that survive a spill potential catch for locals—may be contaminated. After spills early this year, fish farther up the nearby Marañón River contained levels of cadmium and lead above the limits set by Peru's Ministry of Health. No one can say whether some species are safe to eat, however, and it's not clear whether the metals came from oil or other sources such as mining.

WHATEVER THEIR SOURCE, heavy metals may be making their way into people. At village leaders' insistence, officials from Peru's National Institute of Health in January analyzed blood and urine samples from 126 people here and in nearby San Pedro. Cadmium and mercury were above the hazard level in two-thirds of people tested, physician Jonh Astete of the National Institute of Health's occupational and environmental health office told villagers here in June. And about 75% of children had detectable levels of lead in their blood, although only two exceeded Peru's threshold of 10 micrograms/deciliter (mg/dl) for children. (In the United States, the threshold is 5 mg/dl, although experts agree that no level of lead is actually safe for children.)

The findings mirror those of a 2005 study of villagers near legacy oil fields developed decades ago along Peru's Corrientes River. Early on when rules were lax, spilled oil—plus the hot, salty, metals-laden water pumped out with it—flowed into streams and lakes and was not cleaned up. (By law, such fluids are now reinjected underground.) Contaminated sites often went unremediated or were covered over, a practice that has led to lawsuits.

Along the Corrientes, two-thirds of the 75 children tested had blood lead levels of between 10 and 45 mg/dl, a level that experts agree can affect children's cognitive and motor development. About 80% of the 124 adults tested had blood lead levels between 10 and 20 mg/dl, and nearly everyone had blood cadmium levels higher than Peru's reference level.

To work out whether such metals really come from spilled oil, researchers say they need to track oil through sediments and flooded forests. Monitoring polyaromatic hydrocarbons-among the most toxic substances in oil-in fish tissue is also a priority. Astete says a new study of about 2500 people in villages along four rivers in the region, including the Marañón and Corrientes, could help pinpoint the origin of the heavy metals-whether from spills, industrial activities such as oil drilling or mine runoff, burning of trash near homes, or natural sources.

As part of the study, a team from his agency set up a makeshift laboratory here in early June, took blood and urine samples from members of more than 30 families, and filled out detailed questionnaires. They also collected samples of food the families had prepared, including fish, cassava, and bananas. They even bagged a small caiman that a hunter had caught along the Cuninico River, but had decided not to eat because of possible contamination. Samples from both people and food will be tested for arsenic, metals, and hydrocarbons.

Researchers returned in July for sediment, water, soil, and air samples. They hope that comparisons of contamination in people, food, and the environment will reveal the pollution's trail.

While samples are being tested, Astete urged Cuninico residents to avoid fisheating fish, which are more likely to concentrate some pollutants in their bodies, as well as bottom feeders that could absorb pollutants from sediments. But locals say these limits eliminate some of the most commonly eaten fish.

Such public health measures are harder to target when the contamination comes from "legacy oil," dumped years ago and often hidden. Arellano says that during field research he stumbled on places where workers had dumped oil into ponds more than a decade earlier and then covered them up; Arellano is now using satellite data to try to locate similarly stressed trees. His method could be useful for estimating legacy contamination, if he can distinguish the photosynthesis reduction caused by oil pollution from that due to other possible causes, says biologist Gregory Asner of Stanford University in Palo Alto, California, who uses spectrometry to map Amazon biodiversity.

Remote sensing may also help agencies and communities monitor spills from future operations. Low oil prices have lulled Amazonian operations, but new projects are planned, some in or near protected areas, including Ecuador's biodiverse Yasuni National Park and Peru's Pacaya Samiria



Amazonian fishers like these on Monkey's Lake in Brazil rely on the giant pirarucu, called paiche in Peru. But the air-breathing fish rise to the surface often, exposing them to contamination if an oil spill occurs.

shrubs and trees gradually grew back. "You can be walking along and have no idea that you're on top of a pool of oil, but if you dig down a little, you find crude."

Remote sensing may be able to reveal these hidden pools, Arellano says. He compared the leaves of canopy trees in an abandoned spill site with those in uncontaminated ecosystems. Leaves in the spill sites contained less chlorophyll, which subtly changes their color, he reported last year. The leaves also contain more water, suggesting that their pores (or stomata) had closed up, reducing photosynthesis. You can't spot these trees by sight, but satellite imagery can detect the color change starting about 3 weeks after pollution occurs and for decades afterward, Arellano says. National Reserve, a huge expanse of wetlands and seasonally flooded forest.

Back in Cuninico, the rainy season has ended and the river is subsiding. It will be another year before villagers know whether this year's poor fishing was likely due to delayed rains or pollution. Community leaders have filed a lawsuit against government agencies they say failed to protect them. Any compensation will help, but villagers wonder whether their lives will ever be the same.

"People are still worried," says César Mozombite, a member of the village's leadership council. "They're not catching fish." ■

Barbara Fraser is a freelance writer based in Lima.