Are Harvard's Dying Hemlocks a Warning for Trees Everywhere?

Snowshoeing through Harvard Forest is a chance to ponder the fate of forests on a rapidly warming planet.

By **Hillary Rosner**, National Geographic

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(-7°C) and no wind—felt almost balmy. Sunshine snuck through the canopy, making the ice crystals glimmer. It was a perfect day in the woods—if you ignored the fact that all around, the trees were basically ghosts.

The hemlock woolly adelgid, an insect the size of a sesame seed, is killing giant hemlocks from Georgia to Maine—including, probably, this tree in Virginia's Shenandoah National Park.

PHOTOGRAPH BY SCOTT SROKA, NATIONAL GEOGRAPHIC CREATIVE

The hemlocks here teem with a pest that's slowly killing them; their demise is all but inevitable. "I'm hoping some will survive," said Orwig, the forest's senior ecologist, "but we're on borrowed time."

Harvard's forest, 70 miles (113 kilometers) west of the university's campus in Cambridge, Massachusetts, is not alone. These are troubling and confusing times for forests all over the world.

On the one hand, according to a study published this week, the total mass of trees on Earth isn't decreasing: Tropical rain forest is still being lost in the Southern Hemisphere, but forests are regrowing in northern temperate zones—in Russia above all. Those forests are being fertilized by and are helping to soak up our emissions of carbon dioxide, at least for now.

"I'M HOPING SOME WILL SURVIVE, BUT WE'RE ON BORROWED TIME."

| DAVID ORWIG | SENIOR ECOLOGIST, HARVARD FOREST |

pollution, and from insect pests both native and invasive. In many forests, swaths of dead, dying, or doomed trees are an increasingly common sight.

Another study published this week, for instance, found that a recent die-off of aspen in the San Juan Mountains of Colorado was due primarily to water stress—and that it was harbinger of things to come throughout the Southwest, where global warming is expected to make drought a regular visitor.

And as I report in *National Geographic* magazine this month, drought and rising temperatures already bear part of the blame for the mountain pine beetle infestation that has killed trees across more than 60 million acres of the western U.S. and Canada. The beetles are a native species, but they've been able to swell their ranks exponentially because pine trees in the region are already stressed.

When trees are stressed from heat and drought, they succumb more readily to the onslaught of insects. At Harvard Forest and across the eastern U.S., warming temperatures have let populations of hemlock woolly adelgid—an invasive insect—quickly expand. The question for many of these forests is whether they will pass a tipping point, leaving them unable to bounce back.

WATCHING THE WOODS ALL OVER

The Harvard site is part of a network of some 60 forests around the world called the Center for Tropical Forest Science–Forest Global Earth Observatories (CTFS-ForestGEO), where scientists are studying how forests are responding to the turmoil humans are stirring up. Kristina J. Anderson-Teixeira, an ecologist with the network, says its forests are "being impacted by a number of different global change factors. We do expect more of this, be it pests or pathogens or droughts or heat waves or thawing permafrost."

A recent paper that looked at data from all these sites found that change was the constant, with unique geographical stamps. At Scotty Creek, in Canada's Northwest Territories, thawing permafrost is shrinking the forest as trees at the edges die. As permafrost melts and the water table drops, the trees' relatively shallow roots can no longer easily reach it: Despite living in a very wet environment, they're struggling with drought. (Drought has hit many of the network's other forests too—including some in Panama, China, and the United States.)

The woolly adelgid, which is native to Japan, surrounds itself and its eggs with a wool-like sack made of white, waxy filaments. The insect produces two generations a year.

PHOTOGRAPH BY DINA RUDICK, THE BOSTON GLOBE/GETTY

At a site in Malaysia, severe overhunting of birds and large mammals is changing the whole forest: Trees that require animals to disperse their seeds are sprouting less often and more clustered together. The diversity of the site's trees has declined.

And then there are Harvard Forest's hemlocks. More than 50 species of trees and shrubs live in these woods, covering 3,000 acres (1,215 hectares) in Petersham. But eastern hemlock prevails. Dark green, bushy conifers with gracefully drooping branches, the hemlocks, some more than 200 years old, make up roughly a quarter of the forest. Their canopy controls the rate and timing of snowmelt, influencing patterns of spring flooding throughout the area. That canopy also creates a cool, dark microenvironment that nurtures food webs from bacteria and fungi on up.

ornamental Japanese hemlock shipped to Virginia. From there it slowly ventured into nearby forests, where wind and birds helped out—the bug sticks to birds' feathers and feet.

WHAT HAPPENS TO A FOREST WHEN THE DOMINANT TREE SPECIES VANISHES?

Within half a century, it had colonized forests in 17 states, from Georgia to Maine. The bugs feed on a tree's starch reserves, which causes it to shed leaves, which reduces its capacity to photosynthesize. In the southern U.S., the hemlocks die quickly—sometimes in a single year. Farther north, they die more slowly, over a decade or more.

Petersham's adelgid crisis, while seriously unfortunate for the hemlocks, at least offers an important research opportunity: What happens to a forest when the dominant tree species vanishes? It's a question Orwig hopes to answer, difficult as it may be to watch.

THEY'VE BEEN THERE FOR MILLENNIA

For more than a hundred years, researchers have studied these woods. Today, experiments dot the landscape. Towers climb to the canopy, tracking carbon dioxide going in and out; underground pipes heat patches of soil to show what happens to stored-up carbon when temperatures rise. Tags and blazes mark thousands of trees. Orwig recently oversaw a team of students who mapped the size and location of all 116,000 trees in an 86-acre (35-hectare) study area.

Along a road in the Great Smoky Mountains National Park, a forestry technician sprays hemlocks with a mix of water and horticultural oil—a short-term method of controlling the woolly adelgid that cannot be applied to whole forests.

PHOTOGRAPH BY CLAY OWEN, KNOXVILLE NEWS SENTINEL/AP

Orwig has watched the hemlock woolly adelgid spread through the woods here since its arrival around 15 years ago. “The trees in Massachusetts have lasted a lot longer than I’d have predicted,” he said, pausing in a shady glade. All around us, the snow was sprinkled with silvery hemlock leaves, a canvas of decline. Ultimately, most of the hemlocks here will die.

It was a disturbing fact to contemplate as we traipsed past trees that are unaware of their destiny. Sediment core studies show that hemlocks have grown in this same spot for at least 8,000 years.

But their disappearance won’t be the end of the forest. When the hemlocks die, black birch will move in—along with maple, red oak, and white pine. You can already see the birch rising in openings where large hemlocks have fallen. Decades on, winter sunlight won’t be filtered through a canopy; it will pour down through a hardwood forest devoid of leaves.

“It’ll be forest again, but it’ll be completely different,” said Orwig. “You won’t get the same sense that you have, standing in it right now.”

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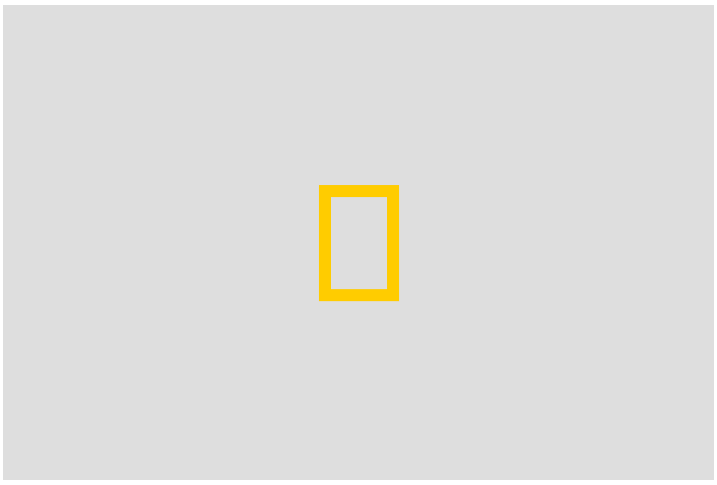

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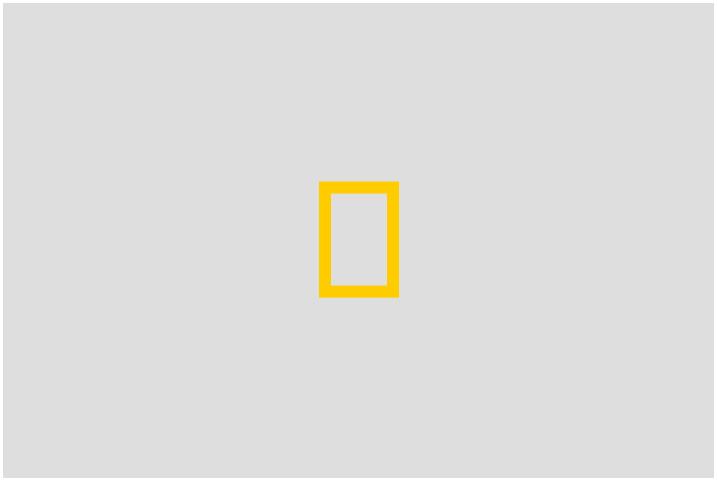

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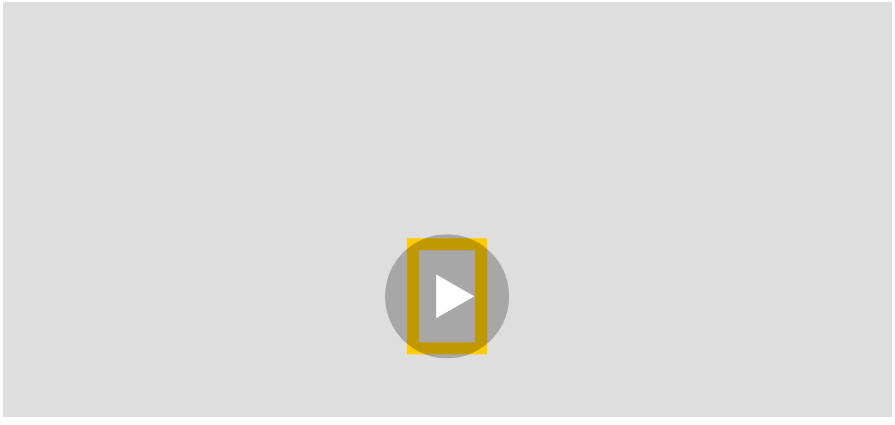

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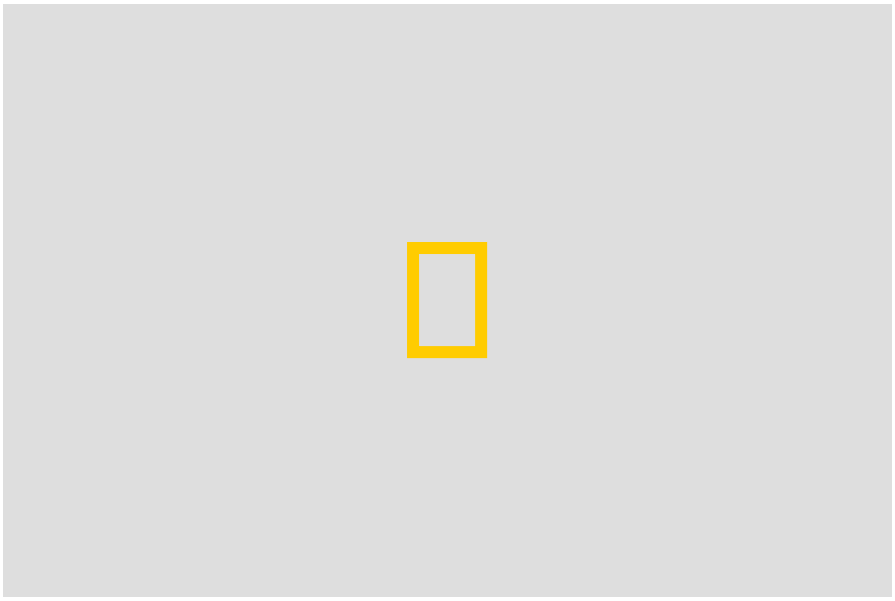

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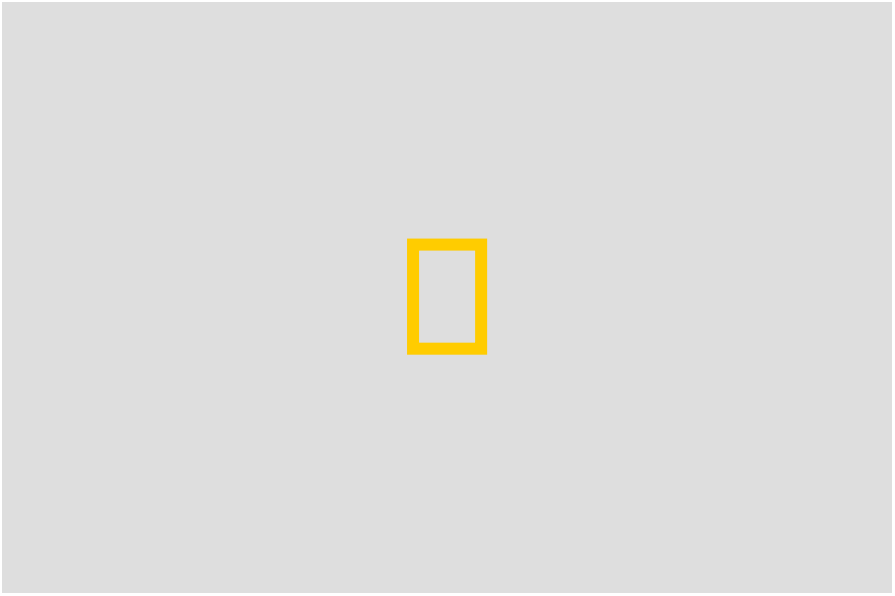

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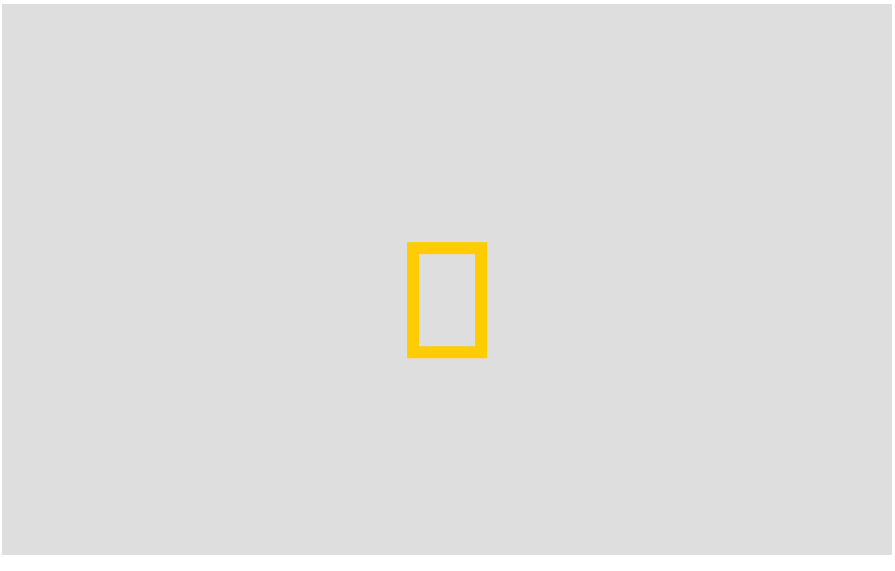

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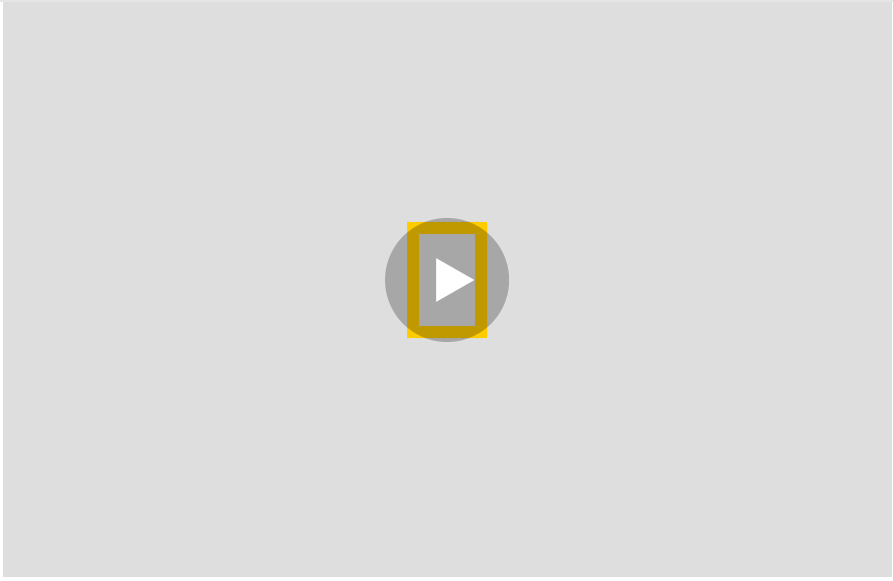

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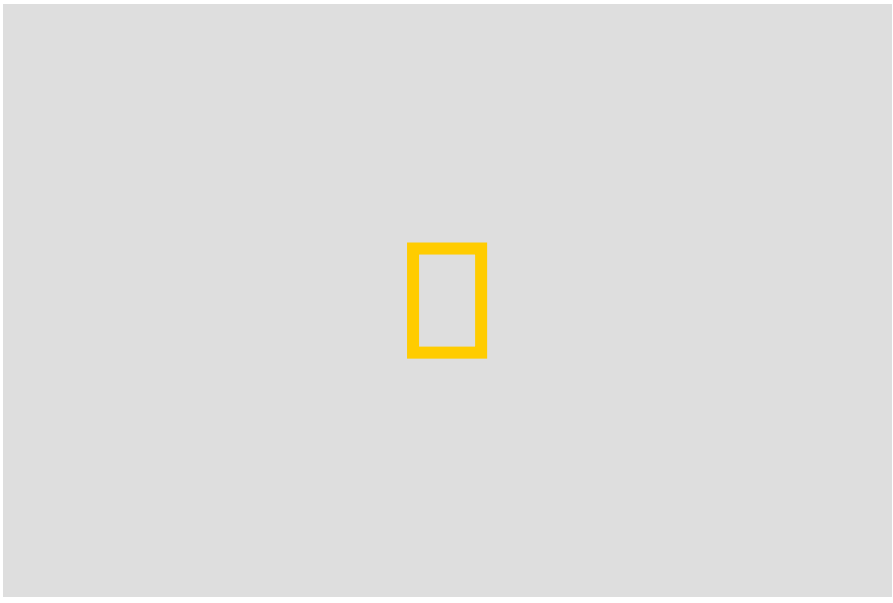

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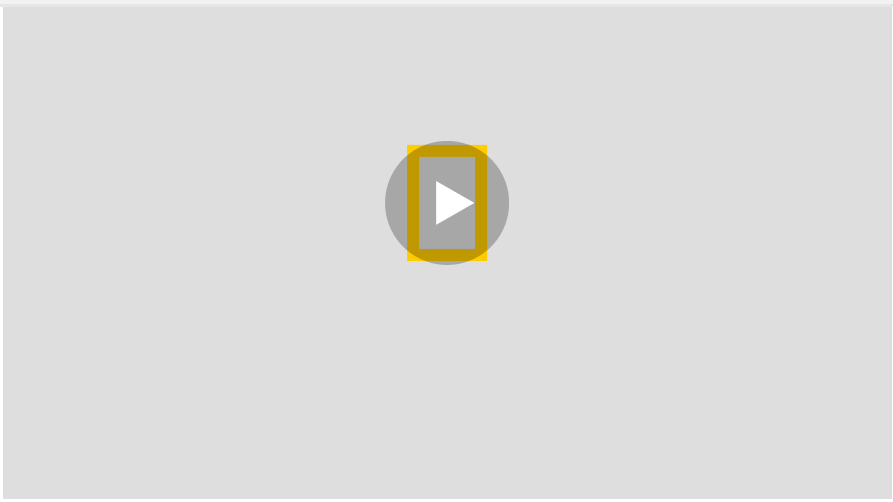

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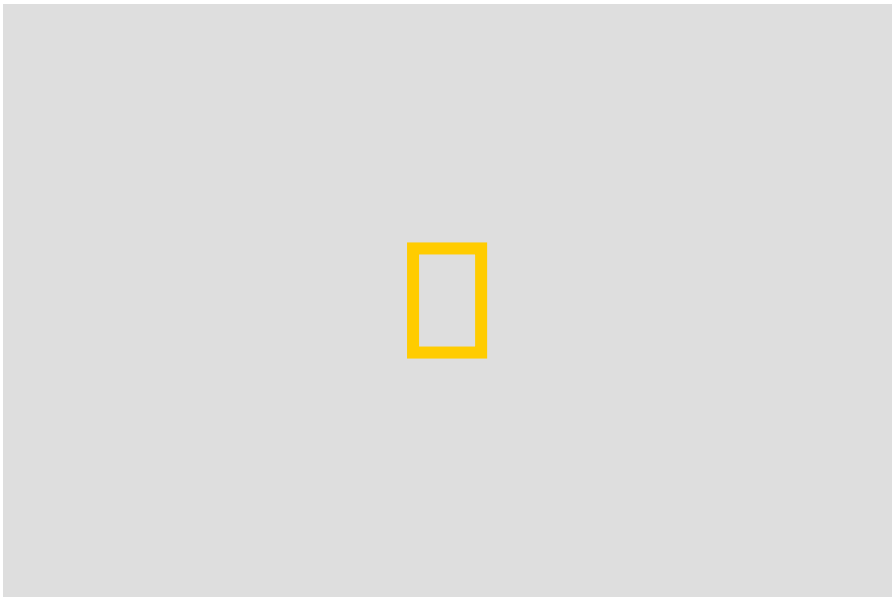

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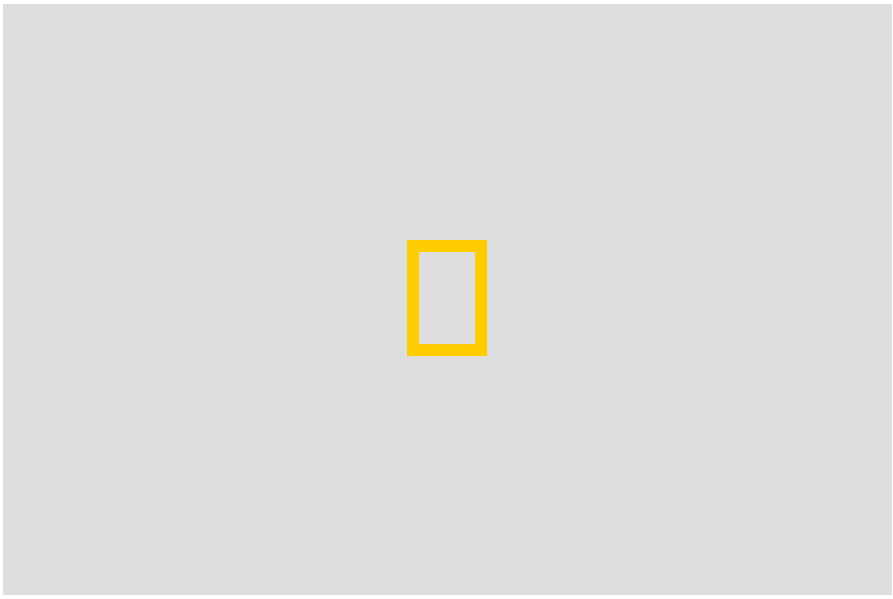

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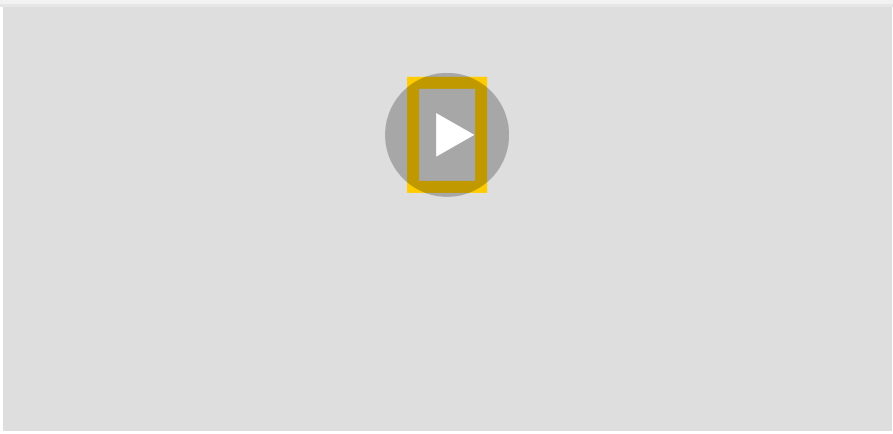

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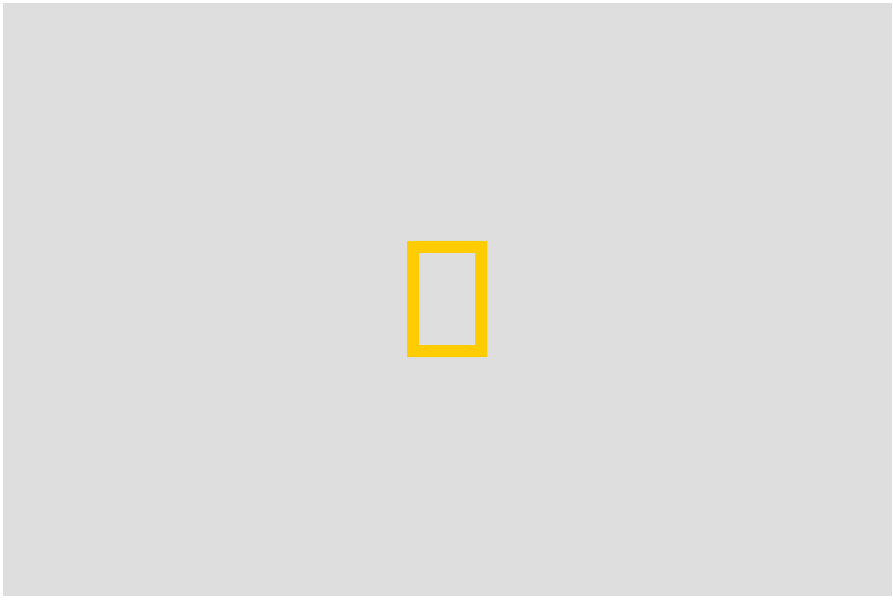

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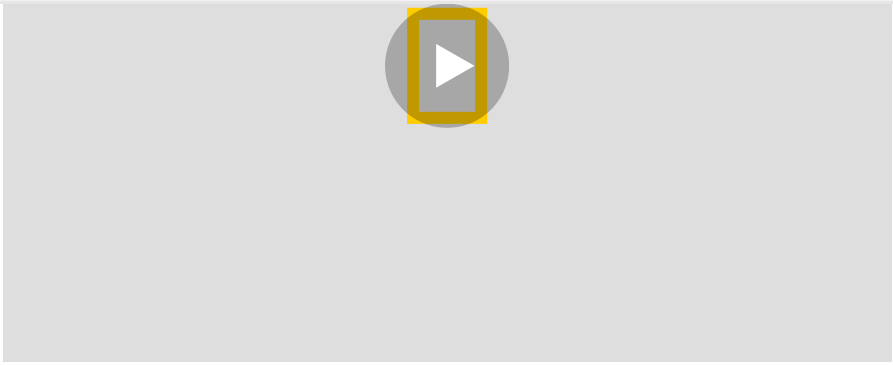

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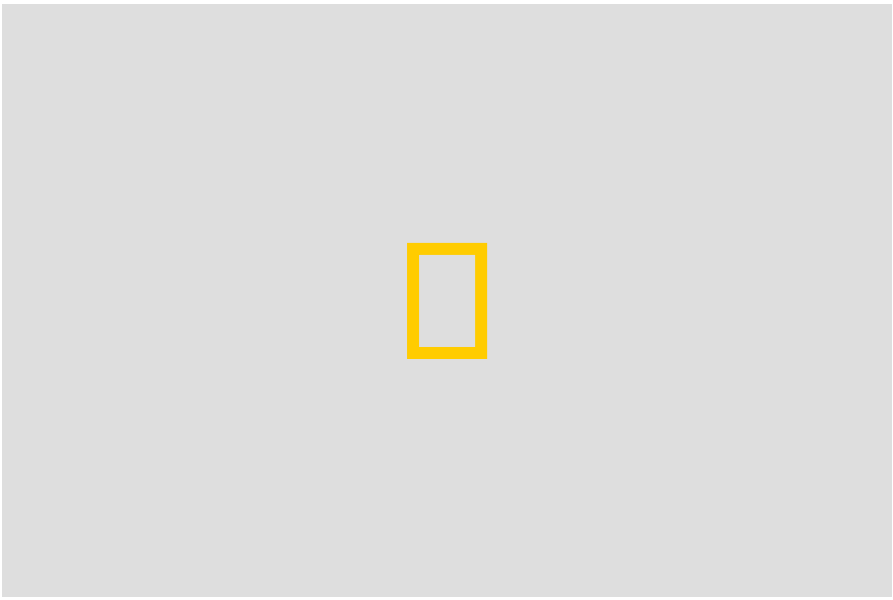

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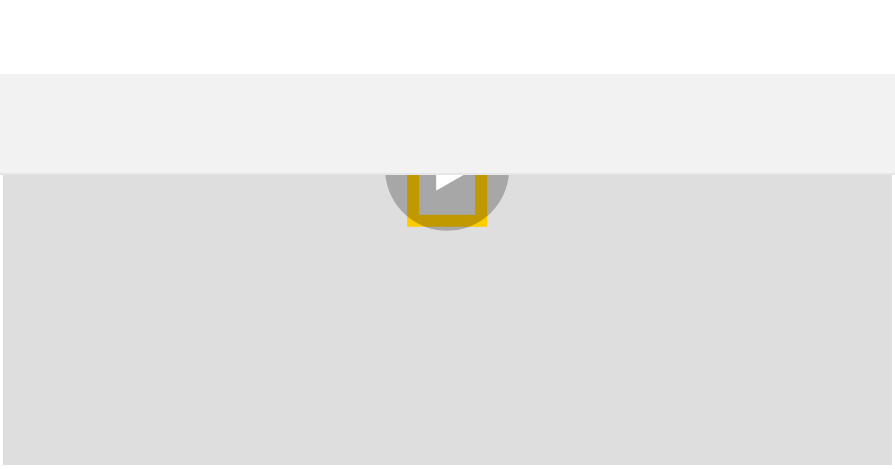

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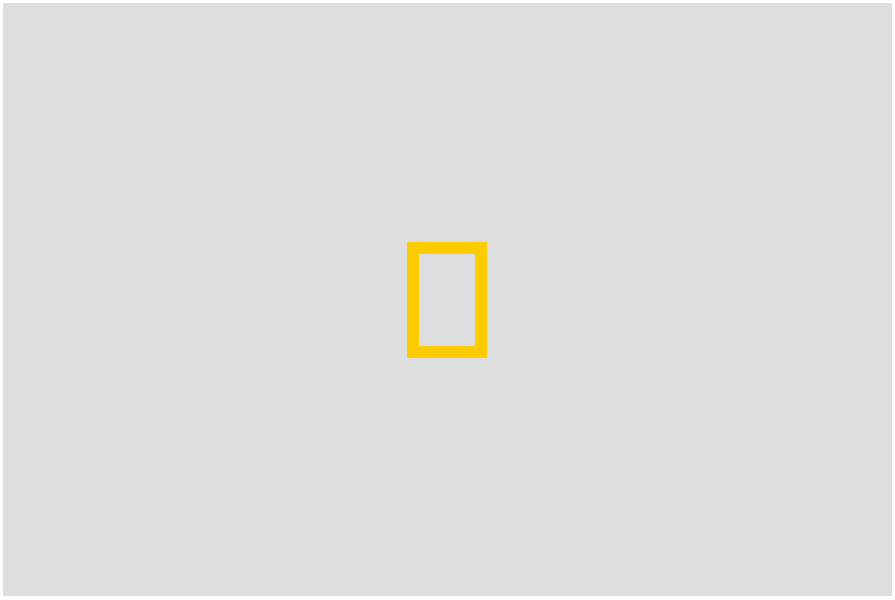

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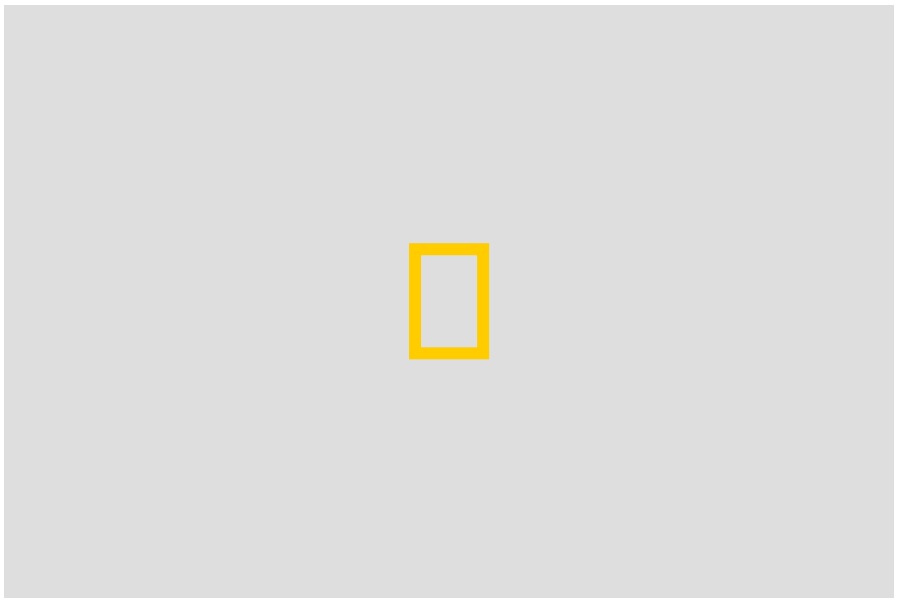

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