



THE WOODS HOLE RESEARCH CENTER

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Woods Hole Research Center Plans Controlled Burn in Amazon Rainforest

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Slow-moving fireline on forest floor

Fire is an important agent of transformation in the Amazon landscape. Every year, low intensity fires burn thousands of square miles of Amazon forest. To study the effects of these fires on the forest, and the forests' ability to recover from repeated burning, Woods Hole Research Center scientists will burn two and a half square kilometers of forest in the transition forest of northern Mato Grosso state, at Fazenda Tanguro in Querencia, from late August into early September.

The goal of this research is to better understand what is the impact of fire on the transition forests, which lies between the tall dense rainforests at the core of the Amazon and the "Cerrado" savannas of central Brazil. According to Daniel Nepstad, a senior scientist with the Center, "By studying the characteristics of fires in this transitional forest on the edge of the Amazon rainforest, Center researchers hope to learn how these accidental fires may affect the vigor, health, biodiversity, and animal habitat in these forests, and in the end, to learn whether recurring fire may threaten the very

existence of the forest." Repeated burning of transition forests in the Amazon could cause their eventual replacement by fire-prone scrub vegetation through a process call "savannization."

This is the second phase of this work, the world's largest tropical fire experiment. One square kilometer was already burned in August 2004. This year, from mid-August to early September, one half square kilometer of last year's burned area will be burned for a second time, and two square kilometers of virgin forest will be burned for the first of several times, to simulate the repeated impacts of escaped agricultural fires that burn through the understory of frontier forests every dry season. These areas are already slated for destruction to expand soy fields.

The planned burn provides information that cannot be obtained by studying an accidental or escaped fire. The experiment is being conducted in an area in which researchers have taken many measurements prior to the burning – inventories of thousands of trees to catalogue their species, size, and number, surveys of seedlings, measurements of fuel on the forest floor, censuses of mammals, amphibians, and birds, and monthly measurements of canopy closure at 400 points within each square kilometer of forest. After the burn, a census will be taken of the trees to see how many have survived or how they may be reacting or recovering from the burn; and canopy density will be measured immediately after the fire and at monthly intervals, to monitor the impact of the fire and rate of recovery. Temperature and humidity will be monitored at multiple spots in each forest pre- and post- burn, to detect changes in the microclimate of the forest; and soil moisture will be measured at set points in the parcels at regular intervals, to see how the changes in canopy may



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effect the water available in the soil. According to Nepstad, "This experiment allows us to measure the impacts of recurring fire on the forest by comparing the trees, the animals, the leaf canopy, and the soil before vs. after the fire."

Fires are set in the litter of the forest floor using kerosene drip torches along parallel 1000m-long transects every 50 meters through the square-kilometer parcels, and allowed to spread through the forest naturally. Firebreaks are cleared along perimeter trails and roads in preparation for the event, and swept clear of debris immediately prior to igniting the fires, to contain the fire within the experimental parcel. In the first round of burning last year, the fire was quite low, creeping along the ground burning leaves and small branches that had accumulated on the forest floor. But in spite of the low stature of this first fire, many trees died through 'girdling' of their trunks – the fire lingered close to their thin bark long enough to damage the delicate cambium beneath, permanently cutting off the flow of sap between the roots and the leaves. While most trees in this ecosystem never evolved thick bark to protect themselves from fire, some appear more vulnerable to fire than others, and others that appear to have died soon bounce back by resprouting from their roots. In these repeated fires, scientists will learn just how resilient some of these species are. It is quite clear, however, that the composition of the forest will be altered following a fire, and researchers will monitor the impact on forest composition as well as the effect this change has on animal populations and behavior.

These experimental fires are a crucial part of simulating what is happening in the Amazon today, as fires set by landholders to control weeds in their pastures or to burn recently felled forest in preparation for planting often escape beyond their intended boundaries. Undisturbed forests are resistant to burning because their dense leaf canopy prevents all but a tiny portion of incoming solar radiation from reaching the forest interior, keeping the litter layer too moist to sustain a fire. Now large areas of forest are selectively logged prior to being settled, leaving holes in the canopy; longer, more intense dry seasons provoke leaf thinning; and both of these changes allow the litter to become dry enough to sustain a fire. Once a forest has burned a first time, the combination of a more damaged forest canopy and a stock of larger fuel from trees killed by prior fires make it even more vulnerable to subsequent fires. When humans move into an area and begin clearing forest, they seldom abandon it and move away, so until education can alter their behavior, repeated sources of ignition in the future are all but guaranteed. The expectation is that the second fire will be hotter and more damaging than the first due to the increased volume of fuel available from those trees that perished in the first fire, and the fact that this fuel will be very dry. Center scientists are also curious to see how those trees that have resprouted from their roots will fare in this second fire, as their profusions of dense, green, living branches are very close to the ground and may be damaged if too close to the flames. If their standing dead trunks manage to catch fire, researchers will learn how resilient they really are, and also see new areas of the forest exposed to fire as the standing fuel carries the flames higher into the crowns of trees that have managed to survive the ground fires at their bases. Ultimately, Center scientists will burn some areas yearly for several years in a row to carefully monitor fire behavior, and to see how many fires a forest can withstand and ultimately, how it compares to its former self.

Staffs of the Woods Hole Research Center and its partner research institute in Brazil, the Instituto de Pesquisa Ambiental da Amazonia (IPAM), are carrying out the fires with additional collaboration with faculty and staff of the State University of Mato Grosso (UNEMAT) and Yale University. In addition, local firefighters will be present to aid in controlling the fire and



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also to use the opportunity to train with actual forest fires. Collaborators at Stanford University are collecting satellite data prior to and after the burn for each of the 3 parcels, to compare the appearance of the forest before and after, to perfect methods for identifying burned forest by satellite, and to measure the damage caused by the fires. Wherever possible, our burns are also scheduled during satellite overpasses, to allow collection of remotely sensed thermal data for comparison with our detailed ground measurements of heat and intensity, under the varying but well-measured forest canopy. 'Hot pixel' data from satellites have long been used to detect the presence of fires on the landscape, but it has been difficult to get accurate qualitative information from these sensors, or even to verify how reliable those measurements were for detecting active fires under a forest canopy. According to Nepstad, "One of the discoveries from our first year of burning is that forest understory fires are invisible to the coarse-resolution satellites that are used to monitor active fires around the world. The fire and subsequent fire scar could both be easily seen, however, using the Hyperion EO-1 sensor data. Our hope is that these studies will allow us to better monitor forest fire from space and, eventually, to determine which forests are most susceptible to fire during the dry season."

The "savannization experiment" is a learning laboratory for Brazilian students who live in the Amazon transition forest. School groups frequently visit the research station, and eight college students are conducting their undergraduate theses within the project. The Grupo Maggi, the world's largest private producer of soybeans, owns the study site. By conducting this work on this property, it is hoped that the fire experiment, along with concurrent studies of riparian zone recuperation, soil management, and water quality, will help this and other companies improve the ecological management of their properties. Grupo Maggi provides no funding for this research.

A limited number of journalists will be allowed to accompany this year's burn, which will run from August 15 through September 8.