can get infected without coming anywhere near a biodefense lab.)

Some scientists and biosafety experts are more worried about risks at BSL-3 labs, because the standards at these labs are not as stringent. But even most of these pathogens—with the exception of SARS, avian influenza, and 1918 flu—are not very communicable, and in any case vaccines and other treatments are available. At most, says infectious disease modeler Ira Longini of the University of Washington, Seattle, "the result could be a handful of cases and maybe deaths." Another exception is foot-and-mouth disease, which doesn't infect humans but is extremely contagious among animals; the escape in the United Kingdom, which has been tied to an outdated effluent treatment system, would be unlikely to occur at more modern facilities in the United States, Richmond says.

Peters worries that the "hysteria and witch hunting" by people like Hammond of the Sunshine Project is compromising safety by making lab workers worry that reporting potential exposures will get them fired. "People can't be terrified to report," agrees Jean Patterson of the Southwest Foundation for Biomedical Research in San Antonio, Texas, which runs a BSL-4 lab.

Safety check

So how can biosafety be improved? One proposal is an anonymous, mandatory reporting system for all laboratory accidents. Such a system would enable labs to learn from one another's mistakes, as do the data compiled on aviation accidents by the National Transportation Safety Board, says Gigi Kwik Gronvall of the Center for Biosecurity of the University of Pittsburgh Medical Center in Baltimore, Maryland, who co-authored a paper describing this proposal earlier this year in *Biosecurity and Bioterrorism*. "Other industries have gone through this," says Gronvall. The system would also capture lab exposures to pathogens not on the select-agent list, such as HIV and tuberculosis. Reporting these to NIH or CDC is not mandatory, Rutgers's Ebright notes.

But some microbiologists caution that reportable incidents should be well-defined, lest the system become glutted with minor mishaps. (Peters cites UTMB's recent decision to release, at a community group's request, a list of its 17 near-misses in the past 5 years.) Also important, says biosafety consultant W. Emmett Barkley of Bethesda, Maryland, reports should include not just bare facts but analysis, as CDC now provides for selected lab accidents in its *Morbidity and Mortality Weekly Report*.

A more radical idea is to require that BSL-3 and BSL-4 labs be licensed by the federal government. This would mean that all these labs, not just those working on select agents, would be inspected and they would be required to follow the same operating procedures. One supporter of this proposal, biosecurity expert Anthony Della-Porta of Geelong, Australia, says the problem now is that *BMBL* offers only general guidance. Others, such as Barkley, say institutions need flexibility, especially the many BSL-3 labs that don't do biodefense work.

There's one fact that nobody disputes: The risk of accidents in biosafety labs goes up with the number of workers. For that reason, watchdog groups and even some biodefense researchers lament the lack of analysis on whether all of the six planned BSL-4 and two dozen new BSL-3 biodefense labs are actually necessary to protect the nation from bioterrorism (see map). Says Gronvall: "Is there too much [biodefense research]? Without seeing the plan of action, it's hard to say."

–JOCELYN KAISER

ECOLOGY

Setting the Forest Alight

To validate satellite data for carbon-emissions modeling, researchers this summer torched a jack-pine forest in Canada and tried to ignite a stand of larch in Siberia

KODINSK, RUSSIA—In July, as temperatures soared during a heat wave in eastern Siberia, scores of large fires flared through the region's dense pine forests. For 500 kilometers along the Amur River northwest of Lake Baikal, thick smoke blanketed the wilderness. Officials with Russia's famous airborne forest fire fighting service, Avialesookhrana, were tracking the wildfires at an airbase here in Kodinsk, a small city on the Amur. They were tense. To them it seemed bizarre that a team of international scientists had received permission to burn a patch of nearby forest. Even with every local helicopter and plane conscripted to serve their firefighting crews, millions of dollars' worth of timber was going up in smoke in wildfires. "It's not as though we don't have enough to worry about already," mused Oleg Mityagin, the overtaxed local Avialesookhrana boss. "We're in no position to help them if they lose control."

Sixty kilometers to the west at the experimental site, a group of Russian, American, and Canadian researchers hoped to set a test fire that would thoroughly burn a hectare-sized patch of larch forest, Siberia's dominant conifer. Their aim was to quantify carbon emissions from fires in larch forests across Siberia, now inadequately documented, according to Douglas McRae, a forest-fire researcher with the Canadian Forest Service. McRae has been conducting experimental burns in Canada and Russia since 1999 as part of project FIRE BEAR (Fire Effects in the Boreal Eurasia Region), a research program aimed at studying forest-fire behavior, ecological effects, emissions, carbon cycling, and remote sensing.

Safe distance. Douglas McRae checks out a gap in a pine forest during an experimental burn in Ontario, Canada.

Conceived in 1997, FIRE BEAR brings researchers from the U.S. Department of Agriculture (USDA) Forest Service and the Canadian Forest Service together with colleagues at the Siberian branch of the Russian Academy of Sciences' (RAS's) V. N. Sukachev Institute in Krasnoyarsk. As the group's previous studies have shown, extreme forest fires are growing more frequent in Siberia. And some models predict that climate change will bring dramatic warming—and more forest destruction—in eastern Siberia and other northern regions. The experimental burn, the FIRE BEAR team hoped, would yield direct observations to buttress satellite data and fill gaps in the models.

CREDIT: PAUL WEBSTER

Flaming wilderness

The searing summer heat in Kodinsk presented a dilemma for the scientific team. "We want the larch to burn well in order to obtain good data," McRae explained, "but we risk losing control if it burns a little too well." In the days leading up to the experimental burn, bulldozers hacked firebreak lanes around the test patch, and researchers wired the forest floor with probes to gauge heat release, carbon emissions, and effects on vegetation and microbes. McRae had good reason to be anxious. In May, in similar weather, he and his FIRE BEAR colleagues conducted an experimental burn near Sault Ste. Marie, Canada, in which a hectare-sized patch of bone-dry jack-pine forest fanned out of control. That experiment was meant to show how infrared technology can be used to estimate fuel consumption and carbon emissions during fires. McRae and his colleagues hoped it would help them gauge how Russian wildfires contribute to greenhouse gas emissions. (Russian security laws prevent infrared filming from the air.)

Only minutes before the scientists ignited the fire in Ontario, wind gusts unexpectedly blew through the treetops. After ignition, the entire test plot flared in an explosive burst that melted computerized monitoring equipment. The equipment technicians got out unharmed with much of the damaged, although still-functioning, gear belonging to Martin Wooster, a geographer at King's College London.

Wooster believes that the amount of carbon emitted from wildfires every year is possibly half that released by fossil-fuel consumption. He has been traveling the world collecting data to confirm his theory. In the Canadian test, he had an opportunity to gather data at ground level and at 300 meters above the fire in a helicopter. Researchers will use the observations to test the accuracy of satellite data.

While making an infrared film, Wooster watched the test fire jump across the firebreaks around the experimental site. Within a few hours, more than 1400 hectares of magnificent pine forests were ablaze. Water bombers, surveillance planes, and Wooster's rented helicopter scrambled to get the situation under control. Wooster came away with an impressive data haul that will help to validate the usefulness of infrared measurement, he said later. But Ontario forest officials were not pleased. "I strongly doubt they'll be quick to give permission for more such experimental fires in future," Wooster said.

Foresters aren't the only ones to express doubts; Russian security officials have been wary, too. Thanks to an infusion of funding from the International Science and Technology Center in Moscow, which supports nonmilitary collaboration between Western scientists and those within the Russian weapons complex, FIRE BEAR has attracted former-Soviet military experts in remote sensing. Other scientists have joined, including members of the Siberian RAS's Institute of Chemical Kinetics and Combustion in Novosibirsk, as well as U.S. researchers funded by NASA.

Hot results. A sudden gust of wind sent flames temporarily out of control in a Canadian test area, but the fire produced terrific data.

Some Russians have complained of being arrested and undergoing harrowingly long interviews, says Anatoly Sukhinin, a remote-sensing expert who joined FIRE BEAR after a career in the Soviet military. "I still spend a fair amount of my time explaining our work to the police," complained Sukhinin, sitting in his laboratory in Krasnoyarsk, which NASA helped equip to receive and interpret Siberian fire data beamed from American and Russian satellites. "It doesn't help that we're doing these experiments in a region which was until recently secret and still remains heavily militarized."

Despite the hassles, the partnership seems to be paying off. In recent years, says Amber Soja, a research scientist with the U.S. National Institute of Aerospace, currently resident in the Climate Dynamics branch of NASA's Langley Research Center in Hampton, Virginia, FIRE BEAR papers have widened knowledge of Siberian forest fires and their global atmospheric effects. In 1998, Brian Stocks of the Canadian Forest Service reported a positive correlation between climate-change impacts and an increase in the severity of Siberian fires. A 2004 paper by Soja, along with McRae, Sukhinin, and Susan Conard of the USDA Forest Service, concluded that disparities in the amount of carbon stored in different forest types and the severity of fires within them can affect total direct carbon emissions by as much as 50%. This is why they need specific data on larch fires, which emit less carbon than pine. In extreme fire years, they found, total direct carbon emissions from wildfires can be 37% to 41% greater than in normal ones, because severer fires consume more organic matter in the forest floor.

Last year, Soja, Stocks, and Sukhinin published a review of predictions of climate-induced boreal forest change. Four of seven models predict that warming in Siberia will be 40% greater than the global mean. Soja spent several weeks at the FIRE BEAR camp near Kodinsk last summer, living in a tent and subsisting largely on tinned fish and buckwheat cereal while comparing notes with her Canadian and Russian co-investigators in the run-up the test burn. The predictions she co-reviewed, she says, are already coming true in Alaska, Canada, and Russia. In Siberia, 7 of the last 9 years have resulted in extreme fire seasons, she explains. Speaking from the camp, she said, "If you are looking for climate-change impacts on forests, this is the place to be."

On the day of the big test burn this summer in Kodinsk, however, all predictions went up in smoke. Minutes after local fire crews ignited the perimeter of the experimental larch site with benzene, dark clouds suddenly appeared and rain doused the flames. "You'd be surprised how often this sort of thing happens," McRae said with a shrug. "That's what you get for playing with fire." The researchers, who still need the larch data, are already planning to torch a forest in Siberia next summer.

–PAUL WEBSTER

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