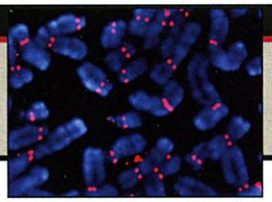

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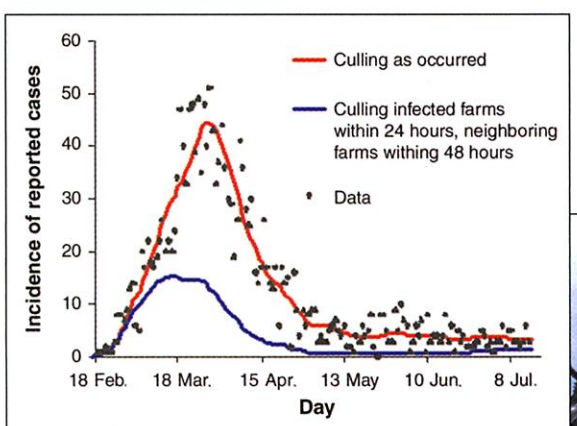
INFECTIOUS DISEASES

Rapid Response Could Have Curbed Foot-and-Mouth Epidemic

To stop a catastrophic outbreak of foot-and-mouth disease (FMD), the British government has so far destroyed almost 4 million pigs, sheep, and cattle—a strategy that has been criticized as overly zealous and draconian by some farmers and animal-welfare activists. But new studies from two teams of British veterinary epidemiologists show that, if anything, the measures haven't been strict enough. If the government had implemented a more rigorous culling policy in the first phase of the epidemic, the total burden would have been much smaller, the researchers say—and millions of animals would have been saved.

Neither of the studies, however, examines whether implementing strict control policies would have been possible politically and logistically—a question that is now the subject of several investigations. Government officials, while acknowledging that, in hindsight, rapid slaughter would have been preferable, say they did the best they could under the circumstances.



Too little, too late? A more intense culling campaign would have reduced the number of cases by 66%, according to one study.

The two studies paint a detailed picture of how the British countryside was ravaged this year by the so-called O Pan Asian strain of the FMD virus. Although they used different mathematical and statistical techniques, both models show that the United Kingdom was not prepared for the onslaught; the disease exploded before authorities started clamping down in earnest. One of the papers, by Roy Anderson and his colleagues at Imperial College in London, is published in this week's issue of *Nature*; the other, from Bryan Grenfell and colleagues at the University of Cambridge and the University of Edinburgh, is published online by *Science* this week at www.sciencexpress.org.

FMD is one of the most contagious diseases known; infected animals shed large amounts of the virus before they become sick, and viral particles can survive on clothes, shoes, or vehicle tires. Even the wind can carry the virus to farms dozens of kilometers away. The disease can affect all cloven-hoofed animals, including pigs, cattle, and sheep. Although it usually doesn't kill adult animals, infected animals become so sickly and weak they lose their economic value.

David King, the U.K.'s chief science adviser, turned to the research teams in March, when the disease was still on the rise. Each group then started cobbling together models. Although crude, both showed that the government needed to get serious about its policy to cull infected farms within 24 hours; in addition, livestock at all adjacent properties needed to be destroyed. That advice helped break "an air of defeatism" at the Department for Environment, Food & Rural Affairs (DEFRA), says Imperial College's Neil Ferguson, and led the government to adopt the massive culling that eventually helped reduce the number of cases (*Science*, 20 April, p. 410).

Now, both teams have produced much more detailed models of the epidemic. They take into account things such as the location of every farm and the estimated number of pigs, cattle, and sheep each farm contained, as well as exhaustive data about the spread of the disease and the culling process, provided by DEFRA scientists on the ground. The groups also calculated a number of what-if scenarios to show how different measures could have diverted the epidemic's course. For instance, if the government had succeeded in culling every infected farm within 24 hours and every adjacent farm within 48 hours, the number of cases would have been cut by 66% and the number of farms culled by 62%, according to the Imperial College model (see graph); the other team puts those numbers at 43% and 46%, respectively.

Other veterinary epidemiologists praise the models' accuracy in describing the epidemic. At the same time, some wish the studies would have offered more clues into how exactly the disease spreads. For instance, the studies don't explain very well why the epidemic has such a long tail, says Mart de Jong of Wageningen University in the Netherlands. De Jong hopes that further analyses of the data will yield such insights.

Still unanswered is whether the government would have been able to contain the outbreak, even if it had all the data now at its disposal. When the disease was first detected in February, it had already spread across the country, and dozens of cases popped up almost simultaneously. The necessary destruction of hundreds of thousands of animals on such short notice was simply impossible, says a DEFRA spokesperson. (Holland and France, by comparison, each had a more localized outbreak around the same time; these were relatively easy to stamp out.)

Indeed, it may be more important to look ahead than back, says the University of Edinburgh's Mark Woolhouse. He says the models underscore the need to increase surveillance and to develop plans for dealing with new veterinary outbreaks. The Roy-

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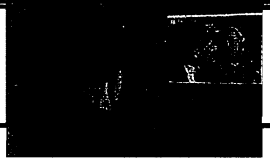


al Society just created a panel to advise on the development of such a plan.

With three new cases last week, Britain is still awaiting the end of the smoldering epidemic. Both research teams caution against relaxing controls. If the current rules are strictly enforced, the team from Edinburgh and Cambridge predicts, the disease will almost certainly be stamped out by next spring. **–MARTIN ENSERINK**

BIOINFORMATICS

Petition Seeks Public Sharing of Code

Going to the source. Jennifer Weller is planning a summit on open-source software.

When computer scientist Jennifer Weller took a job at the Virginia Bioinformatics Institute in Blacksburg last year, she was eager to start work on new "open source" genome-sifting software that scientists could share. But officials at the parent Virginia Polytechnic Institute and State University delayed her project for a year while they pondered how such collaborative work fit into the school's technology transfer program, which aims to patent and control the distribution of potentially valuable faculty member discoveries. "There was a lot of confusion," she says.

Weller's project recently got the go-ahead, but the experience made her an open-source activist. She's eagerly signed a new petition demanding that the government require scientists to deposit the guts of their taxpayer-funded software into public collections. Although the 3-week-old petition (www.openinformatics.org) has so far garnered just a few dozen signatures, it has sparked widespread debate.

Open-source advocates say that sharing is essential for eliminating duplicative research and perfecting programs that tame biological data. But critics and some government officials warn that mandatory sharing could hinder research by reducing financial incentives—and would probably violate federal law. "I appreciate the spirit that generated this petition, [but] there are some major problems," says Phil Green, a prominent bioinformatics researcher at Washington University in St. Louis.

The petition was drawn up last month by three software developers—Jason Stewart of Open Informatics in Albuquerque, New Mexico; Harry Mangalam of tacg Informatics in Irvine, California; and Jiaye Zhou of Inztro, another Albuquerque firm—who believe that publicly funded research should be made available to all. In addition, they say, public disclosure would allow closer scrutiny of existing software. "You often can't evaluate results without carefully looking at the source code used to obtain them," says Stewart.

The solution, they argue, is for U.S. granting agencies such as the National Institutes of Health (NIH) and the National Science Foundation (NSF) to require grantees to publish their codes under open-source or "free software" licenses. That would give users broad freedom to alter and share programs. Such wide-open collaboration has already sparked the rapid evolution of several popular programs, they note, including common Web-hosting software called Apache. In science, they argue, mandated sharing could free up time and money for research. Scientists would be free to assemble new tools from existing building blocks, Stewart says, while funding agencies "could reject proposals to reinvent the wheel."

NIH and NSF officials appear receptive, noting that both agencies already have policies that encourage grantees to make their discoveries publicly available. But they say that the 1980 Bayh-Dole Act, which allows universities and researchers to patent the results of publicly financed research, probably rules out any mandatory sharing. "I don't think Congress would allow us to overrule a university's privilege to grant exclusive licenses," says one NIH official.

But there are other options. For instance, agencies could require researchers to be more explicit about how they will share the fruits of their research, he says, and create specific financial incentives for sharing. NIH has already launched one initiative to create a "public library" of informatics tools, while NSF review panels are encouraged to favor open-source projects.

Petition critics say that such voluntary commitments are preferable to any system that treats software differently than other scientific tools, such as cell lines or genetically modified mice. Green, who would like to scrap Bayh-Dole, says that mandated sharing "would perpetuate the myth—widespread among scientists who don't actually develop software—that it is inherently of less value than other inventions. This, in turn, tends to inhibit talented scientists from going into computationally oriented academic research."

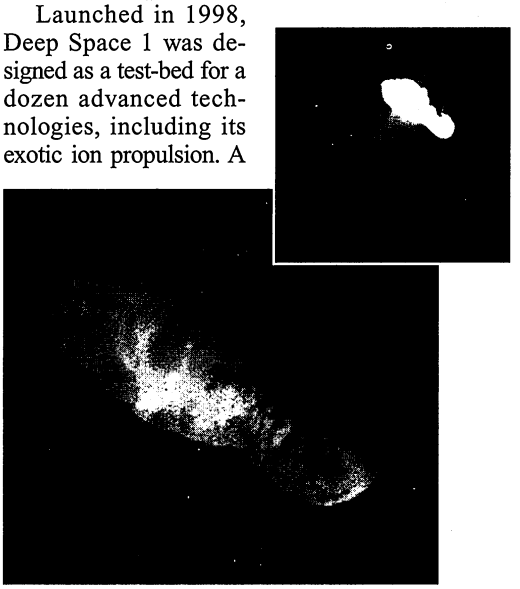
Such views are likely to get a full airing in January at the O'Reilly Bioinformatics Technology Conference in Tucson, Arizona, where Weller will lead a workshop on the licensing issues raised by the petition. "The [least] that can happen" as a result of the debate, says Stewart, "is that a lot of people get educated." **–DAVID MALAKOFF**

PLANETARY SCIENCE

Close Look at the Heart of Borrelly

Flying on a wing and a prayer, NASA's "aged and wounded" Deep Space 1 spacecraft has returned pictures of the dirty snowball buried within comet Borrelly, revealing recognizable geology on a comet nucleus for the first time. At a press conference at the Jet Propulsion Laboratory (JPL) last week in Pasadena, California, scientists described Borelly's rugged terrain and towering jets of dust and vaporized ice that hint at a potentially catastrophic demise for the 8-kilometer-long, bowling-pin-shaped object.

Launched in 1998, Deep Space 1 was designed as a test-bed for a dozen advanced technologies, including its exotic ion propulsion. A



Blowing itself away. Comet Borrelly jets gas and dust (*top*), leaving an eroded nucleus.

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