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rising from \$431 million next year to \$659 million by 2005. The future of station research, meanwhile, depends on new European and Japanese contributions to the overall program. But Goldin pledged to have at least 10 experiment racks operating by 2004.

• **DOE:** The Office of Science's \$3.16 billion budget would remain flat, although one of its four major programs—Biological and Environmental Science—would drop by 8%, to \$443 million, largely by eliminating 24 congressionally ordered projects. DOE's microbial genome research would grow by \$10 million to \$19.5 million. In high-energy and nuclear physics, U.S. funding or Europe's Large Hadron Collider and the Spallation Neutron Source being built in Tennessee would stay on track, but some user facilities would operate on a reduced schedule. The Relativistic Heavy Ion Collider in New York, for example, would operate for only 20 weeks, down from 27 this year. In addition, notes Lubell, the money to universities "declines slightly across many programs."

Outside the Office of Science, renewable energy research takes a 36% hit, to \$237 million, while the Nuclear Cities Program, designed to keep Russian nuclear scientists working on peaceful projects, would be cut 80% to \$6.6 million.

• **Environmental Protection Agency:** The Office of Research and Development (ORD) would drop 7%, to \$535 million, but EPA officials say that's a \$3 million increase after \$42 million in earmarks added by Congress last year is removed. The STAR extramural grants program would remain unchanged at \$97 million. There are "no wild swings" in most research programs, says budget analyst Amy Battaglia. But agency scientists are bracing for the loss of 36 of ORD's 1971 full-time positions, mainly through attrition.

• **USGS:** The 8% cut will strike hardest at the agency's Toxic Substances Hydrology and National Water-Quality Assessment (NAWQA) programs. The toxics effort drops by 71%, to \$4 million, while NAWQA falls over a waterfall, dropping by 30% to \$45 million. "This means people out of work," says USGS director Chip Groat. Up to 300 positions are in danger if USGS can't find partners to foot the bill for 18 long-term studies of river basins and watersheds. Funding for biological research would decline 7%, to \$149 million, including a 52% cut in programs that distribute biological information.

• **National Institute of Standards and**

**Technology:** NIST's standards measurement laboratories will jump 12%, to \$337 million. But the White House wants to suspend new research projects with industry in the \$145 million Advanced Technology Program, requesting just \$13 million to finish existing projects and conduct yet another study of the controversial initiative.

• **National Oceanic and Atmospheric Administration:** The budget catch for key science programs was off 4% to \$1.3 billion, with most of the cuts coming from the National Marine Fisheries Service, which helps enforce the embattled Endangered Species Act.

The president's budget must now work its way through Congress. Decisions about the ultimate size of a proposed tax cut and defense spending will largely determine how much money is left for domestic discretionary programs like research, whose projected \$95 billion budget represents less than 5% of a \$1.96 trillion pie.

—DAVID MALAKOFF

With reporting by the news staff.

## SMITHSONIAN INSTITUTION

### Plan to Close Zoo Lab Draws Fire

The Smithsonian Institution plans to close two research centers as part of a move to consolidate and reshuffle its scientific activities. The plan, released last week, has raised an outcry among many researchers, who worry that other valuable programs may be cut as well. An influential member of Congress has already asked officials to rescind the plan, which is part of the agency's newly unveiled 2002 budget request (see previous story).

Considered by many the U.S. equivalent of a ministry of culture and science, the Smithsonian consists of 16 museums, the National Zoo, and a half-dozen research centers. Slated for the ax are the Center for Materials Research and Education, which seeks to improve preservation and curation techniques for museum artifacts, and the

Conservation and Research Center (CRC), a 1290-hectare rural breeding and study facility for threatened or endangered species, operated by the zoo. The proposed closures are "a redirection of spending," as the Smithsonian focuses on a few key disciplines, says Lawrence Small, a former investment banker who last year took over as secretary of the 150-year-old institution.

The proposed cuts must still pass muster with Congress, which provides about 60% of the institution's \$750 million budget, and with the Smithsonian's governing board, which is expected to review them next month. Representative Frank Wolf (R-VA), a member of the House appropriations panel whose district includes the center, immediately chastised the Smithsonian for the plan and called for a reversal of the decision. "I have let Smithsonian officials know of my extreme displeasure," Wolf said on 6 April, 1 day after word of the cuts was leaked to the media.

Smithsonian researchers say that they are shocked by the news, which was announced by the zoo's director, Lucy Spelman, during a surprise 4 April visit to the conservation center some 100 kilometers west of Washington, D.C. "It's kind of amazing," says Devra Kleiman, a former zoo researcher and now a conservation biologist at Conservation International in Washington, D.C. "At a time when most zoos are making major efforts to hire people to do research and conservation that link the work they do in zoos with the work they do in the field, the Smithsonian National Zoo, which was a model for that 25 years ago, [is] eliminating those functions."

In a staff memo, Spelman explained that "the resources are simply not available to maintain the CRC as a world class facility," even though Small insists that conservation research remains important to the Smithsonian. The CRC gets about \$5 million per year in federal funds. The materials center, which was set up in 1963 to service all the museums, has a federal budget of about \$3.3 million per year, but Small says it is "not an area of high priority" because most individual museums now have their own preservation pro-



**To the rescue.** The black-footed ferret is one of several species helped by Smithsonian center.

grams. Small's plan would also create discipline-based institutes in astrophysics, geology and earth sciences, and the life sciences. A fourth, perhaps in conservation biology, would encompass the Smithsonian's remote field sites in Panama, Florida, and Maryland. Currently, each administrative unit, be it the CRC or a museum department, operates its own research program.

With personnel details yet to be announced, the proposed closures have had a devastating effect on staff members. "Morale is just right down in the basement," says one biologist who requested anonymity. Beyond the impact on their job status, some museum researchers worry that creating disciplinary institutes could conflict with the Smithsonian's stated mission of increasing the diffusion of scientific knowledge by putting too much distance between its scientific and educational activities. —ELIZABETH PENNISI

## NEUROSCIENCE

### Location Neurons Do Advanced Math

A mouse's minutes are numbered if it rustles through a field within hearing distance of a barn owl. The owl knows where to aim its talons even in the dark, thanks in part to a precise map of auditory space engraved in its brain's inferior colliculus, located in the brainstem. Now researchers have discovered that space-specific neurons in this map can perform more sophisticated computations than are commonly credited to neurons: Most neurons simply add incoming signals to come up with an answer, but neurons in the owl's auditory map multiply.

If a mouse squeaks to an owl's right-wing side, the owl's right ear registers a slightly louder signal, and slightly sooner, than the left ear. Earlier research by Masakazu Konishi and colleagues showed that a set of auditory neurons calculates this interaural level difference (ILD) and interaural time difference (ITD) and sends the results to neurons in the inferior colliculus that are precisely tuned to particular locations. Humans use ILD and ITD cues as well, but the human auditory map isn't as well understood as the barn owl's.

To discover how the owl's space-specific neurons process the incoming timing and level information, neuroscientists José Luis Peña and Konishi of the California Institute of Technology (Caltech) in Pasadena outfit-

ted 14 barn owls with headphones and monitored the auditory map's responses to pairs of sounds. As they report on page 249, multiplication best describes how the neurons behave; a multiplicative model predicts how the neurons respond to different kinds of stimuli with about 98% accuracy.

"This is the cleanest evidence of multiplication in the brain," says Christof Koch, also of Caltech but not involved in the project. He points out that many neural tricks in humans as well as owls seem to require multiplication, such as keeping neurons in the visual cortex trained on one spot even when the eyes or head move. But most earlier reports of multiplicative neurons relied on "dirty multiplication," he says—some combination of addition and multiplication that wasn't as satisfying as that in this new report.

Two properties illustrate what it means for a neuron to multiply. First, when very faint ITD and ILD signals correspond to the same region of space (giving mutually affirming indications that a mouse is underneath a log off to the right, say), neurons in the inferior colliculus fire robustly. If the two subthreshold signals were added, in contrast, their combined stimulation wouldn't rile up the space-specific neurons enough to fire. Second, the lack of either an ITD or an ILD signal can veto a space-specific neuron's firing. In multiplication,  $2 \times 0 = 0$ ; in a barn owl's inferior colliculus, a strong ITD signal  $\times$  no ILD signal = no response. As

Peña explains, the neuron acts like an "and" gate, requiring both signals, rather than an "or" gate, which could respond to just one.

Archetypal neurons don't compute this way. Normally, a neuron receives a host of excitatory and inhibitory signals of various volumes along its dendrites. When the signals add up to surpass some threshold, the neuron fires. Such a neuron acts like a transistor in an electronic circuit, says Koch. But a neuron with the power to multiply, he

says, "is more like a little processor; computationally it's much more powerful."

Mathematically, the behavior of these space-specific neurons is easy to explain. Neurophysiologically, it's another matter. "We don't know anything about how [multiplication] is computed" in these neurons, says Koch. Peña says his and Konishi's "next step is to figure out the biophysical mechanisms that underlie" the multiplication.

—LAURA HELMUTH



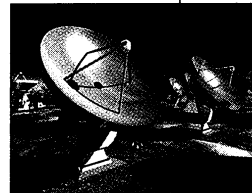
**Where did it go?** Some barn owl neurons multiply location signals.

## ScienceScope

**ALMA Matters** Astronomers' hopes of building a giant 64-dish radio telescope have taken a big international step forward. Japan last week joined North America and Europe in the consortium planning the \$550 million Atacama Large Millimeter/Submillimeter Array (ALMA), planned for Chile's Atacama desert.

In the mid-1980s, astronomers in North America, Europe, and Japan independently started planning such arrays, which will probe the formation of stars and galaxies. North America and Europe officially combined their efforts in 1997. Last week's resolution means scientists from 15 countries on four continents are now working on ALMA, making it "truly a world telescope," says Norio Kaifu of Japan's National Astronomical Observatory.

The next challenge is building it. The Bush Administration has not included any construction funds in its 2002 budget request (see p. 182), although Japan's education ministry has given ALMA a green light, and Europe hopes to keep pace. If the money begins flowing by the end of 2002, scientists say ALMA could be operating by 2010.



**Depressing Difference** Eighth-grade students from Naperville, Illinois, a wealthy suburban district nestled between Fermilab and Argonne National Lab, learned last week that they lead their peers around the world in understanding science. Their urban counterparts 30 minutes away in Chicago city schools, however, rank with the likes of Iran and Tunisia near the bottom of the list. The results were part of an exercise in which 13 state and 14 local U.S. school districts compared themselves to 38 countries that took the Third International Mathematics and Science Study in 1999.

National educators hailed the "courage" of big-city school superintendents like Chicago's Paul Vallas to spend \$75,000 on what was a predictable academic drubbing, given the socioeconomic advantages of districts like Naperville. "These results make the gap visible and therefore attackable," thundered Education Secretary Rodney Paige. Sitting next to National Science Foundation director Rita Colwell, whose agency has spent hundreds of millions of dollars in the past decade trying to improve science and math in big-city schools, Paige declared that the reforms have produced "islands of excellence, but that isn't good enough."

The next version of the global test will be administered in 2003.