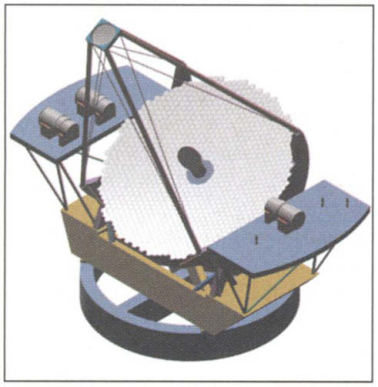
face. CELT's 1.0-meter mirrors would be easier to make, polish, and handle than Keck's 1.8-meter units, and they would also be less prone to sagging and other distortions.

Nelson feels confident that building such a fly's eye is within reach. However, giving it a clear view of the heavens will take optical wizardry. A 30-meter telescope will gaze through such a wide cylinder of atmosphere that astronomers must compensate for turbulence in many places at once. Caltech astronomer Richard Dekany and Nelson's team at the National Science Foundation–funded Center for Adaptive Optics in Santa Cruz envision a system of seven lasers arrayed in a ring to spark artificial stars in a layer of sodium atoms 90 kilometers high. Ultrafast computer processors would analyze the stars' wiggles and adjust the flexible surfaces of additional mirrors near the observing instruments, erasing the blurs.



Next generation. CELT could go from model to reality in a decade.

"Correcting distortion in the volume of our entire field of view is a huge complication," Nelson says. "At Keck we sort of knew about it, but we didn't think about it during the design." In contrast, nearly one-third of CELT's projected budget would pay for adaptive optics alone. That investment is worth the risk, Ellis notes: "We'll resolve areas of the sky equivalent to what Hubble sees in each imaging pixel and get detailed spectra of those regions. That's a phenomenal advance."

Another key issue is where to build the observatory. The long-range development plan for Mauna Kea allots a site for a giant telescope on the volcano's northern shield, but the viewing conditions there might not be as good as at the now-crowded summit. Moreover, notes Caltech astronomer S. George Djorgovski, native groups in Hawaii might fight such a prominent addition. "Mauna Kea may not be politically viable," he says.

Under consideration are sites in dry northern Chile, both near the coast and in the high Atacama Desert. Djorgovski heads a group working with the U.S. National Optical Astronomy Observatory (NOAO) to conduct "vigorous site testing" at unnamed locations in Chile. Astronomers also are studying clear-weather spots in northern Mexico and the southwestern United States.

None of this will matter unless Caltech and UC raise the money, starting with about $70 million for a detailed design study. Caltech's description of CELT in its $1.4 billion campaign announcement focused only on its own role, ruffling some feathers at UC. However, UC administrators won't make a public statement about CELT until the institutions sign a long-delayed legal agreement.

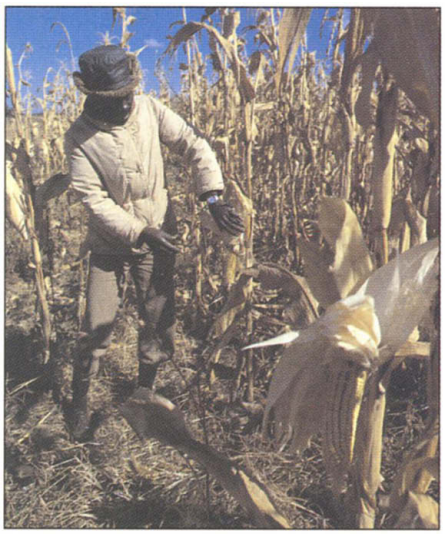
UC's chancellors endorse CELT, but, according to astronomers, they fret about its cost when the vicissitudes of the California state budget put pressure on donations for other needs. With federal funds for astronomy in similar straits, the solution might involve some hybrid of CELT and a U.S.-funded Giant Segmented Mirror Telescope through NOAO, says Mountain. "People are hopelessly optimistic about how many of these things they're going to have," he says. "We may struggle to operate more than one."

–ROBERT IRION

FOOD AID

Zambia Rejects GM Corn On Scientists' Advice

CAMBRIDGE, U.K.—In a stunning decision, the government of Zambia last week rejected thousands of tons of corn donated by the United States because it is likely to contain genetically modified (GM) kernels. The refusal leaves an estimated 2.9 million people at risk of starvation, according to the United Nations Food and Agriculture Organization. But it turns out that the government was only following the advice of its own experts: *Science* has learned that a delegation of Zambian scientists and economists, after completing a fact-finding tour of labs and GM regulatory offices in South Africa, Eu-



Drought. Zambian farmer inspects dried corn.

ScienceScope

Break for Beluga There's fresh hope for the world's largest freshwater fish. Last month, the secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora banned the five nations bordering the Caspian Sea from exporting the meat or caviar of the beluga sturgeon for the rest of 2002. Conservationists criticized the body for lifting a similar ban earlier this year (*Science*, 22 March, p. 2191). Its latest decision came after Caspian states failed to present a coherent picture of sturgeon stocks and how the fish can be harvested sustainably. The states are now scrambling to make a case for 2003 quotas.

Moves are afoot to protect the beluga indefinitely. Last July, the U.S. Fish and Wildlife Service (FWS) proposed listing the beluga as an endangered species, which would end the legal import of beluga products into the United States, the biggest consumer. More than 50 scientists backed the move in a 28 October letter to U.S. Interior Secretary Gale Norton. FWS has up to a year to decide but is under pressure to make an emergency ruling before the spring harvest.

Nod for Nonlethal "Nonlethal weapons" might seem a misnomer after Russian security forces killed 118 people with an incapacitating gas in a besieged Moscow theater last month (see p. 1150). Still, similar weapons, aimed at knocking people or equipment out without killing, are a potentially valuable tool for the U.S. military, according to a National Academy of Sciences report released this week. Research in the area should be stepped up, according to the study, which was commissioned by the Marine Corps and the Navy.

Nonlethal weapons include a broad array of compounds and technologies, from foul-smelling gases and slippery foams to microwaves that knock out ships. The panel, chaired by Miriam John, vice president of Sandia National Laboratories' California Division, says such weapons are needed by a modern military increasingly focused on preventing terrorist attacks, enforcing embargoes, and peacekeeping—all while trying to minimize casualties.

But critics say the report comes close to encouraging violations of the Chemical Weapons Convention, which bans the stockpiling and use of chemical weapons. The panel does acknowledge that some nonlethal weapons skirt the treaty. But Jonathan Tucker, a senior fellow at the U.S. Institute of Peace in Washington, D.C., says the report's discussion of the pact is "confusing at best and sophistry at worst."

CREDITS: (TOP TO BOTTOM) CELT; CHRISTINE OSBORNE/CORBIS

rope, and the United States, urged the government to reject the corn. The delegation's final report, which was expected to be released earlier this week, concludes that the U.S. corn should be refused on the "precautionary principle" because studies of the health risks of GM foods "are inconclusive."

It was a message that the Zambian government apparently wanted to hear. After a national GM debate on 10 August, President Levy Mwanawasa declared his intention not to allow GM food to be distributed in Zambia. Last week's decision means that of the six southern African nations reeling from drought-induced famine since 2001, only Zambia has categorically rejected U.S. food donations, the bulk of which is corn. The largest donor to the stricken region by far, the United States has promised to provide half of the 1 million tons of food required to feed people in southern Africa until the March 2003 harvest. But because GM and non-GM corn are stored together in the United States, donations cannot be certified as non-GM. Swaziland has accepted unprocessed U.S. corn, whereas Zimbabwe, Lesotho, Mozambique, and Malawi have accepted it on the condition that the kernels are first milled into flour to prevent farmers from growing GM crops.

The corn donated by the United States, which Mwanawasa has labeled "poison," is likely to include kernels from strains engineered to produce a protein from *Bacillus thuringiensis* (Bt) that's toxic to insects. In the 6 years that Bt corn has been consumed worldwide, no adverse health effects have been reported, according to the U.S. Food and Drug Administration. Seeking to get that message across, the U.S. Agency for International Development sponsored the GM fact-finding mission by seven Zambian experts.

But the Zambian delegation, led by Mwananyanda Lewanika, science adviser to Mwanawasa, took a dim view of Bt corn. Its report notes that the long-term effects of the modified corn have not been studied. The report also warns that antibiotic-resistance genes present in the altered strains could in principle be incorporated into the genomes of gut flora and promote drug resistance. "There is no scientific consensus on GM," Lewanika claims. "The first concern is that Zambia does not have a biosafety framework that would regulate the introduction of GM organisms."

Many observers have expressed chagrin at this stance. "The Zambian government has disregarded the scientific evidence," Richard Boucher, chief spokesperson for the U.S. Department of State, said in a statement on 30 October. The Zambian rejection of GM food is based on "pseudoscience," says Channapatna Prakash, a plant geneticist at Tuskegee University in Alabama. Prakash speculates that economic rather than health risks motivated the Zambian decision, referring to the possible loss of Europe—which is friendlier to non-GM products—as a food export market if GM crops are planted in Zambia.

Addressing the humanitarian crisis in Zambia will now be more difficult, says Richard Lee of the U.N. World Food Programme (WFP), which is trying to arrange for neighboring Zimbabwe to accept at least part of 15,000 tons of U.S. corn in Zambian warehouses in exchange for non-GM corn. WFP had intended to use the U.S. corn to feed 2.5 million Zambians for 3 weeks. According to a conservative scenario from the World Health Organization, at least 35,000 Zambians will die of starvation by March 2003 if more food is not provided. **–JOHN BOHANNON**

FISHERY SCIENCE

Poor to Feel Pinch of Rising Fish Prices

TOKYO—The first major attempt to project global supply and demand for fish has confirmed what many have long suspected: Rising prices are likely to drive fish out of the reach of growing numbers of poor people who rely on the sea for their protein. But, with several fisheries on the verge of collapse, some analysts believe that the study's dire projections—presented last week at the launching of a global research initiative on fisheries science and policy—might in fact be too rosy.

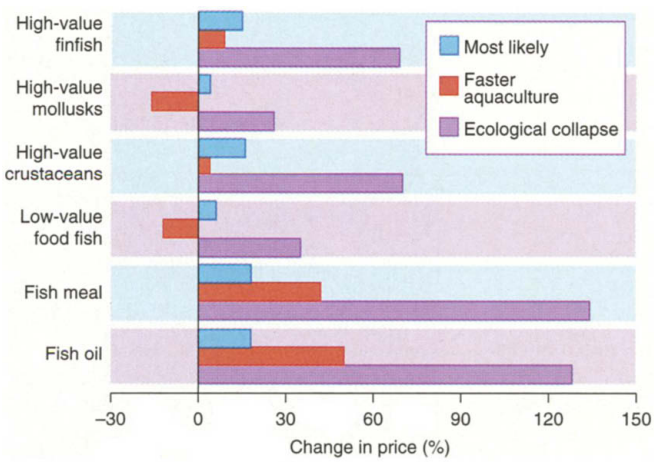
The analysis, by agricultural economists in Penang, Malaysia, and in Washington, D.C., models fish supply and demand to 2020. Under the most likely scenario, it says, prices for salmon and other high-value fish would rise 15%, and prices for low-end fish such as milkfish and carp would increase by 6%. Fish meal prices, it estimates, would jump 18% to satisfy rising demand for feed for cultured, carnivorous high-value fish (below).

"The consequences [of current trends] could be dire, depending on whether supply gains are feasible," says Mahfuzuddin Ahmed, a co-author of the study, which was done by the Penang-based WorldFish Center and the Washington, D.C.–based International Food Policy Research Institute. But a continuation of those gains—which have produced a sixfold rise in total fish catch since the 1950s—is doubtful, says his boss, center director Meryl Williams, because three-quarters of the current catch comes from fish stocks that are already overfished, if not depleted. "Those [who study] the population dynamics of fisheries would probably be pessimistic" about supplies, she says.

Fish now account for about 7% of the total food supply, according to the center, and are the primary source of protein for roughly one-sixth of the world's population. Yet fish consumption is generally overlooked in food supply models, which focus primarily on cereals and legumes. Scientists hope to correct that oversight with Fish for All, an initiative to develop science-based policy alternatives for world fisheries. Scientists, environmentalists, and industry representatives from 40 countries gathered in Penang last week for a meeting to launch the effort, led by the WorldFish Center, formerly known as the International Center for Living Aquatic Resources. Both the fish center and the policy institute are part of the World Bank–funded Consultative Group on International Agricultural Research.

The increased demand will arise primarily in developing countries, Ahmed's model assumes, where rising incomes are leading to a more diversified diet. But the vagaries of international markets might make it harder for those populations to keep fish on the tables. Under the study's most optimistic scenario, in which sustainable aquaculture is focused on the needs of the poor, lower value food fish prices could drop 12%. But prices would rise 35% if both natural and commercial fisheries collapsed.

Williams hopes that Fish for All will generate policies that stave off the worst-case scenario. "It's intended to be a nonpolitical platform for bringing the best minds together" to address fisheries issues, she says. First steps could include better statistics on catches and consumption and studies of how climate change might affect fisheries. **–DENNIS NORMILE**



Sinking feeling. An important source of protein for the poor, fish is likely to be more expensive in 2020 under any of three scenarios.

SOURCE: IFPRI IMPACT MODEL, JULY 2002