NAVIGATION

GPS's 'Dress Rehearsal' For Year 2000 Problem

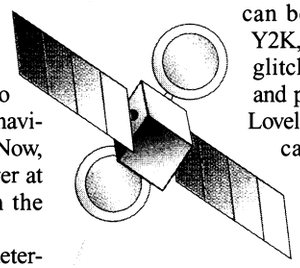
It's a glaring Sunday in August, somewhere in the trackless wastes of Nevada beyond Death Valley, and you've had enough geological mapping for one day. Ready to head home, you check your GPS (Global Positioning System) receiver for the shortest route back to the truck. Surprise! You're not in Nevada anymore, the readout informs you, but close to downtown Los Angeles. Welcome to the Week Zero Problem, a design glitch that will befuddle thousands of GPS receivers come the 21st of this month. "It's serious enough to be called a 'dress rehearsal' for Y2K," says John Lovell, director of quality at Trimble Navigation Ltd. in Sunnyvale, California. "Users who depend on GPS for geographic locations on land, at sea, or in the air could face serious safety hazards." The receivers depend on knowing the time to function properly, and on the 21st, timepieces on the fleet of GPS satellites will roll over to zero like car odometers hitting 100,000 miles. Manufacturers believe they've got the problem well in hand with software fixes for the receivers, but they expect some older receivers to act up—and advise caution during that last week of August.

Like the Y2K problem, the Week Zero Problem has its origins in an early programming decision. Just as the first computer software designers economized on computer memory by recording only the last two digits of the year, designers of the U.S. military's GPS opted to track time on the satellites by counting weeks—using only 10 bits in a binary code of 1's and 0's. That meant the GPS week counter could tally up to 2^{10}, or 1024, weeks before rolling over to week zero. The clock started on 6 January 1980, and since then GPS has penetrated all sorts of civilian markets, from monitoring earthquake faults to surveying roads, tracking freight, and navigating cars, ships, planes, and hikers. Now, the satellites' week counters will roll over at midnight, Greenwich Mean Time, on the night of 21 to 22 August.

When operating properly, GPS can determine geographic positions anywhere in the world to within 100 meters by triangulating on at least three satellites. Each satellite beams a radio signal to a receiver, specifying the satellite's orbit and the precise time the signal set out. By checking three satellites and calculating how long each signal took to arrive, a receiver can triangulate its position. But when the rollover happens, the satellites will send out 19-year-old dates.

Exactly how a receiver reacts will depend on the model. Receiver manufacturers began building in fixes in the early 1990s that prevent confusion over what week it is, so most receivers will do fine. But some units will try to track satellites with the schedule of the original Week Zero and so may take from a few seconds to as much as 20 minutes longer than usual to locate satellites, warned the U.S. Department of Transportation (DOT) in early June. Spokesperson Sara Beane of Garmin Corp. in Olathe, Kansas, a leading GPS manufacturer, says that less than 20% of their GPS receivers—those more than 3 or 4 years old—have this problem, and Garmin offers a free software patch to fix it.

Other GPS receivers will fare worse. They may never locate satellites and fail to work at all, says the DOT, or they may appear to work but display the wrong position. No one knows for sure just how many of the world's 10 million to 15 million GPS receivers will turn into pumpkins. The DOT maintains a Web site of contact information for more than 60 manufacturers worldwide,* but it's up to each manufacturer to test its products and provide upgrades. Magellan Corp. spokesperson James White in San Dimas, California, says that 99% of their GPS products should perform normally and that word is getting out to users about the problem. White sees the response to the rollover as an example of what can be done when, as in Y2K, people know about a glitch and can test for it and provide a fix. Still, as Lovell points out, "No one can predict precisely how GPS satellites and GPS technology will function in each and every application." So when you go out that Sunday, you might want to bring the old map and compass. **–RICHARD A. KERR**



*www.navcen.uscg.mil/gps/geninfo/y2k/gpsmanufacturers/manufacturers.html

ENVIRONMENTAL SCIENCE

Science Board Floats $1 Billion Trial Balloon

After years of complaints from scientists and activists that it pays environmental research short shrift, the National Science Foundation (NSF) heard a similar message last week from its own governors. The National Science Board (NSB) issued a report recommending that NSF ramp up spending on environmental science from $600 million in 1999 to $1.6 billion in 5 years.

Such a boost would jibe with the direction in which NSF director Rita Colwell, an ecologist, is steering the agency. Last year, she proposed a network of "biodiversity observatories" to study interactions among organisms (*Science*, 25 September 1998, p. 1935), a project that could get under way in 2000. But although NSF takes advice from the science board seriously, the prescribed boost is far from a fait accompli: Congress must approve any increase, and early indications are that NSF's overall budget request could face a tough time this year (see p. 813).

The NSF panel that produced the report,* chaired by marine ecologist Jane Lubchenco of Oregon State University in Corvallis, reviewed scores of reports on environmental policy as well as hundreds of comments from organizations and individuals. It says NSF devotes about $600 million, or 20% of its budget, to worthwhile environmental research projects ranging from microbes that thrive in hot springs to field sites that collect data on long-term trends, such as acid rain's effects on forest growth. But that's not near-

* Environmental Science and Engineering for the 21st Century: The Role of the NSF, www.nsf.gov/nsb/tfe/nsb99133/start.htm

CREDIT: TERRY E. SMITH

ly enough, concludes the report, which argues that environmental research "should be one of the highest priorities of the [NSF]," with additional funding for everything from more interdisciplinary research to objective reviews of data for policy-makers.

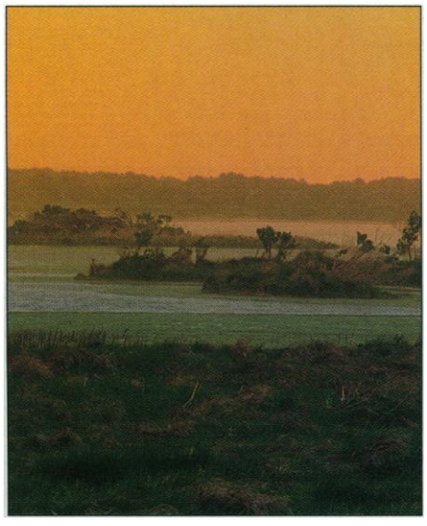
According to the panel, one area ripe for more funding is ecosystem services, a field that blends social sciences and environmental science to get a handle on the economic benefits of, say, preserving watersheds, which filter contaminants from drinking water. Also high on the agenda is research on environmental technologies, such as remote sensing of landscapes and DNA chips that can identify which genes a microbe needs to thrive in a particular environment. "There are really exciting opportunities for progress," Lubchenco says.

As the NSB did last year, the task force rejected the notion that NSF establish an institute or new directorate. Overseeing environmental research, it says, can be done by a "high-visibility, NSF-wide organizational focal point" that would "[identify] gaps, opportunities, and priorities" and have "budgetary authority." One possible model, says Lubchenco, is the agency's Office of Polar Programs.

Some environmental researchers believe that approach doesn't go far enough. Ecologist H. Ronald Pulliam of the University of Georgia, Athens, says the vaguely defined entity NSF envisions may not accomplish the "change in culture" that's needed, among other things, to prevent interdisciplinary studies from falling into the cracks between the agency's single-discipline review panels. "If it's just more money, I think that's the wrong approach," says Pulliam, who sits on the board of the Committee for the National Institute for the Environment, a Washington, D.C., nonprofit that advocates the establishment of an environmental institute within NSF.

The overarching concern, however, is whether Congress will go along with a $1 billion boost earmarked for environmental science. Howard Silver, who heads a lobby group called the Coalition for National Science Funding, says he is skeptical that such funding will materialize anytime soon. But he applauds the agency for "thinking big." As he says, "One can plant a seed."

–JOCELYN KAISER



CREDITS: (TOP) MUTSUMI Y. STONE; (BOTTOM) DANY KRIST/UNIPHOTO

New research horizon? An NSF boost for environmental science could benefit salt marshes.

ENDANGERED SPECIES

A Plan to Save Hawaii's Threatened Biodiversity

HONOLULU—Botanist Steve Perlman will gladly risk his life to help endangered species, shimmying to the top of a rare species of palm tree to pluck fruit with viable seeds, or rappelling down a cliff above pounding surf to dab pollen on a lonely dicot clinging to the rocks. But even such heroics aren't enough to stave off the danger looming over Hawaii's unique native habitats, now under siege from alien species and development. "We're fighting a losing battle," says Perlman, who works at the National Tropical Botanical Garden in Kauai. "It's depressing, especially when you witness an extinction that could have been prevented."

Countdown to extinction. New initiative hopes to save endangered Hawaiian species, such as this *Brighamia*.

Now researchers are hoping to turn the tide before the casualties become unbearable. At the Hawaii Conservation Conference here last week, an advisory group of government and university scientists and land managers unveiled a draft plan for a $200 million, 5-year initiative to preserve Hawaiian biodiversity. The plan, called Legacy 2000, gets a warm reception from conservationists. "I think it's dynamite," says William Everett, president of the Endangered Species Recovery Council in La Jolla, California. For the initiative's architects, however, the hard work has only just begun: They must find a way to pay for it. "It will have to be a manna-from-heaven situation," admits Robert Smith, manager of the U.S. Fish and Wildlife Service's (FWS's) Pacific Islands Ecoregion. The challenge, says Michael Buck, administrator of Hawaii's Department of Land and Natural Resources (DLNR), will be to convince people on the U.S. mainland that tackling Hawaii's ecological woes is just as important as, say, fixing the Everglades, a multibillion-dollar job that Florida and the federal government are about to embark on (*Science*, 9 July, p. 180).

Formed over the last 5 million years from volcanic eruptions, the main Hawaiian islands once had a breathtaking variety of species—many found nowhere else on Earth—that evolved from a few hardy pioneers. But in only 1500 years or so of human habitation, Hawaii has lost two-thirds of its native forests and hundreds of species. According to FWS, Hawaii has more species on the federal endangered list—297—than any other state. Major culprits in this decline are habitat loss and alien species, such as weeds and feral pigs, that prey on the natives or flourish in the absence of predators. But although a decade-long slump in tourism revenue has resulted in scant state support for conservation programs, not all the news is bad. Managers are making inroads against a particularly nasty invasive plant called *Miconia*, and conservation programs are beginning to involve Hawaiians of Polynesian descent, boosting popular support for such measures.

Hoping to parlay these successes into an ambitious program to protect more species across larger swaths of land, a panel composed of representatives from several federal and state agencies and the University of Hawaii, Manoa—the major players that manage or study Hawaiian species—drafted Legacy 2000. Highlights of the initiative include calls for $5 million a year for community-based conservation, $3 million a year for academic research on Hawaiian ecosystems, and $4 million a year for a slate of programs to find Hawaii's rarest species, bolster endangered species through captive propagation, and create a plant germ plasm storage network.

Few scientists would quibble with those goals. But some experts point out an additional vital step: Hawaii must do a better job of interdicting species that slip across its borders. "One of the major threats to endangered species is the hemorrhaging of alien species into the state," says DLNR's Fred Kraus. Legacy 2000 does have some provisions that target alien species, particularly stepped-up inspections of flights from Guam and elsewhere that may be carrying the brown tree snake. A particular problem, Kraus says, is that Hawaii now bars importation of only a few kinds of noxious plants. Regulations to close this loophole, Kraus says, are "sorely needed."

Smith and other managers plan to incor-