GENSET

Optimist. Genset's Daniel Cohen says SNP problems can be solved.

lead geneticists to elusive disease genes. "Risch and Merikangas have been taken out of context" by overly enthusiastic promoters of SNPs' potential, he argues.

Terwilliger notes that although Risch and Merikangas found association studies practical for identifying disease genes in which one mutation accounts for most of the increased risk, that situation may be uncommon. In a survey of all the new disease genes reported in the *American Journal of Human Genetics* during the past 1.5 years, Terwilliger found that about 90% of those genes had more than 10 pertinent mutations that predispose an individual to disease. With so many different mutations involved, none is likely to stand out in a SNP analysis. And that's the easy case, involving diseases caused by mutations in a single gene. The situation will be worse for cancer and the many other diseases in which multiple genes contribute to increased risk. "It's not just the underestimated complexity of the genome as much as it is the underestimated complexity of the etiology of a complex disease," he adds.

Researchers at Skokloster agreed that it will be difficult to gauge the usefulness of SNPs until they know more about how genomes vary between and within the world's ethnic groups. Because the most universal SNPs will be among the oldest, they are likely to exist in people both with and without disease. This means that there may be no distinctive pattern of SNPs specifically associated with a key variant of a gene. It could be easy to miss an important association or to make an association with the wrong gene variant. "If we don't think carefully before we do these experiments, we'll wind up with a lot of false signals," Uppsala's Brookes says.

Others at the meeting pointed out that association studies require that researchers look at much larger numbers of people than typical family studies, to sift out the false signals. "It's not enough to have 70 controls and 50 patients," says Gert-Jan Van Ommen, head of the Human Genome Organization and a geneticist at Sylvius Laboratories in Lieden, the Netherlands. "You're talking about requiring populations of several thousand." SNP analysis won't begin to be useful without new, high-speed technology for analyzing the thousands of DNA samples required, says Spurr.

Even with these caveats, however, the researchers expect to see SNPs research proceed. "We know they will be successful in certain situations," comments Case Western's Chakravarti. "We just don't know how successful they will be."

Already, association studies have linked a few gene variants to diseases. The tying of the *ApoE4* gene to an increased risk for Alzheimer's disease in Caucasians is one often-cited example. And geneticist Daniel Cohen, head of Genset in Evry, France, says that his company has worked out many of the issues raised by the conference participants, in part by developing new methods—which he would not describe in detail—for analyzing the data and discerning real associations. In October, for example, he plans to announce the SNP-based discovery of two genes involved in prostate cancer. "I am absolutely confident of this strategy," says Cohen. "It works."

Although others may not share Cohen's confidence, they want SNPs to be put to work. "Provided they are not being regarded as the panacea for complex disease findings, there is value in producing SNPs," says Van Ommen. "[SNPs] are going to make a big difference." **–ELIZABETH PENNISI**

ECOLOGY

Software Helps Australia Manage Forest Debate

A computer program to promote biodiversity gives loggers and conservationists a chance to end their fierce fighting over forest reserves

MELBOURNE, AUSTRALIA—The forests of New South Wales (NSW) have seen many bitter battles in the last 20 years between logging interests eager to feed an insatiable Japanese appetite for wood pulp and conservationists trying to preserve the country's dwindling arboreal heritage. Those battles have taken a heavy toll on the participants. Just ask Col Dorber, the executive director of NSW Forest Products Association. In 1995, Dorber suffered a stress-induced heart attack after being roundly condemned by government and industry officials and vilified in the media for publicly defending a logger caught punching a "greenie."

Now back on the job, Dorber sees his remarks as an unfortunate reflection of the historic enmity between the two camps. That's why he's so encouraged by an experiment drawing attention from ecologists and resource managers around the world that attempts to inject science into forest management and that respects the interests of all parties. "Since 1995, we've been through a culture change," he says. "Prior to that, we [industry and conservationists] wouldn't speak to each other. But now we've learnt to respect each other. It's a fantastic process."

That process is a joint initiative by the federal and state governments to negotiate long-term agreements for forest reserves that allow continued logging while maximizing biodiversity. At the core of the negotiations is a computer program, called C-Plan, that gives adversaries a chance to trade in their swords for software. Like some ecological card game, the software puts a biodiversity value on each parcel of land and presents stakeholders with various packages that meet the conservation target. C-Plan was developed by NSW National Parks and Wildlife Service conservation planners Bob Pressey, Simon Ferrier, and colleagues, and programmer Mathew Watts at the University of New England in Armidale, NSW. So far it has been used in two major sets of negotiations; a third exercise, involving a large swathe of old-growth forest, has just begun.

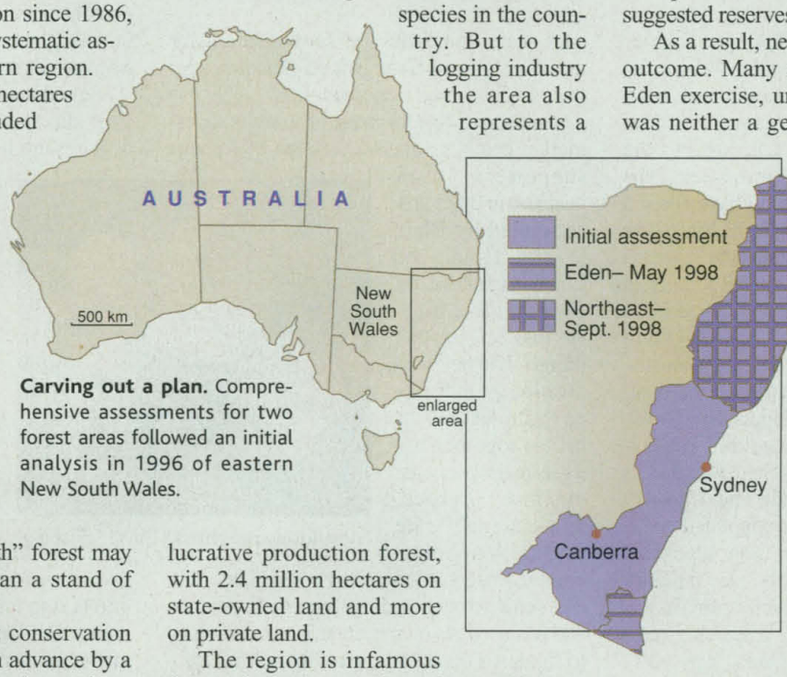
"It's setting the gold standard in the field," says ecologist Reed Noss, co-executive director of the Conservation Biology Institute in Corvallis, Oregon, and president of the international Society for Conservation Biology. Indeed, the World Bank is using C-Plan for an assessment in Guyana, and Pressey is currently in South Africa to help

TOM BARRETT

Green software. Negotiators use C-Plan to help select reserve areas in Eden forest.

plan new reserves in the southwest portion of the country. Officials at the U.S. Fish and Wildlife Service (FWS) are also thinking of applying it to reserve designs now under way in Indiana and Illinois as part of a national assessment of biodiversity. "We think C-Plan might give us a repeatable and scientifically defensible tool," says FWS biologist Forest Clark, who leads the Indiana team.

Pressey has pushed to get science into the process of reserve selection since 1986, when he attempted the first systematic assessment of the state's western region. Although a large number of hectares had been reserved, he concluded that the attempt to preserve biodiversity had failed and that most reserves were in areas left untouched simply because they were too rugged for logging, pasture, or mining. Pressey, Ferrier, and Watts developed C-Plan to improve the process of designating reserves. The program puts an "irreplaceability" value on land based on its contribution to biodiversity. For example, an area of pasture that connects two sullied remnants of rare "swamp heath" forest may be deemed more valuable than a stand of pristine mountain forest.



NSW GOVERNMENT

Carving out a plan. Comprehensive assessments for two forest areas followed an initial analysis in 1996 of eastern New South Wales.

The program does not set conservation goals. Those are determined in advance by a panel of experts, chosen by the various stakeholders, in accord with a 1992 national policy that recommends reservation of forest types at 15% of 1750 levels. Instead, C-Plan is applied to decide which bits of forest are most valuable as reserves. Unlike most reserve-selection software, which apply a "pass or fail" test to select the so-called "minimum set" that will achieve the conservation target, C-Plan keeps every land unit—and its irreplaceability value—on the table so negotiators can mix and match options.

C-Plan was designed with conflict resolution in mind. "Negotiators sit around the computer screen together, request modifications, and see the outcomes," explains Tom Barrett of NSW's National Parks and Wildlife Service, who has worked extensively with the program. "The idea is to make the whole process as scientific and transparent as possible." It grew up alongside another software program, called Bio-Rap (rapid assessment of biodiversity) and developed by a team at the Australian National University (ANU) in Canberra, that suggests a pattern of land use that will minimize costs while maximizing biodiversity for a given conservation target.

For years, however, C-Plan was an idea looking for an application. Its big opportunity arrived in 1995 with the election of a Labour government, which had placed forestry reform at the top of its list of election promises. The first region to be targeted for assessment was public land along the state's eastern seaboard. More than half of this region is covered by forests, including the wild remnants of Australia's Gondwana heritage, which contain one of the largest concentrations of species in the country. But to the logging industry the area also represents a lucrative production forest, with 2.4 million hectares on state-owned land and more on private land.

The region is infamous for confrontations such as the one that enveloped Dorber. Although the Labour government had offered funds to help restructure the industry in return for a reduction in logging, the devil lay in the details of deciding which areas should be reserved and which sacrificed. Even industry officials knew that timber production had to be curtailed. "We had a timber demand that was unsustainable," says Dorber.

State officials decided to use the home-grown C-Plan for a 1996 assessment that spanned four intense weeks of negotiations. One of the outcomes was the creation of nine new nature reserves covering 250,000 hectares, nearly 20% of which was on land rated by C-Plan as highly irreplaceable. Pressey says the result is a victory for rational reserve selection given competing interests. "It was driven by explicit conservation targets," he says, "and people decided on areas that would contribute to those targets while trying to maintain timber supply."

The deferred areas were to be revisited in a second round of negotiations. The first of these involved 120,000 hectares in the Eden region—a forested paradise in southeastern NSW and the center of a large woodchipping operation by Harris-Daishowa. Eden supplies more than half the state's pulp logs. Four options were developed, all of which appear to meet 40% to 50% of the conservation targets. Yet within that apparent convergence, conservationists and industry took polarized approaches. For example, conservation groups pushed for the minimum logging quota set by the NSW government, while industry opted for the government's minimum number of reserve hectares. Numbers aside, the options also differed greatly in how the suggested reserves should be structured.

As a result, neither side is happy with the outcome. Many stakeholders said that the Eden exercise, unlike the first assessment, was neither a genuine negotiation nor an open process. The federal and state governments, representing different parties, failed to agree on the conservation targets proposed by outside experts. And many observers feel that state officials rushed the process in hopes of achieving results before the next election in early 1999. There was also the problem of limited data. Uncertainty about the distribution of some animals meant that decisions about land use were made in the dark, says Henry Nix, director of ANU's Center for Resource and Environmental Studies. "[The lack of knowledge] is a disaster," he warns. "We could be giving away the crown jewels."

The next test for C-Plan is the 10 million hectares in the Northeast region, much of it majestic stands of untouched old-growth forests, where the data sets are far more solid. It is also an important center of biodiversity that, together with bordering Queensland, boasts Australia's only representation of wet subtropics ecology. These are the best studied of NSW's forests, with well-established preservation targets for some 200 forest ecosystems, 800 endangered plant species, and 140 animal species.

The negotiations, which began this month, will be a critical test of C-Plan. But scientists are hoping that, with so much at stake and so many stakeholders, science will not again play second fiddle to politics. "A little bit of science is all we can hope for," says Andrew Beattie, director of the Key Center for Biodiversity at MacQuarie University in Sydney. "At least it's better than the days of the old boys in the back room." And it's certainly better than loggers and environmentalists punching each other out. **–ELIZABETH FINKEL**

Elizabeth Finkel writes from Melbourne.