term benefit for long-term damage. And that's a trade that we're willing to make genetically, because we were never designed to live the long haul."

If the inflammation does indeed lead to heart disease and not the other way around, that still leaves open the question of whether CRP is simply a marker of inflammation or has its own pathological actions. In other words, is it an innocent bystander or a perpetrator of disease?

Over the past few years, biologists have accumulated considerable data suggesting that CRP is indeed a major player in the disease process. They have shown that CRP is present in arteriosclerotic lesions and that it functions as a chemoattractant to lure monocytes to the site. It has also been implicated directly in increasing the expression of adhesion molecules. It also apparently can activate immune system components known as "complement" proteins, which are important mediators of inflammation. What's more, as Pepys and his collaborators demonstrated in the early 1980s, CRP binds specifically to LDL cholesterol, the foamy stuff of arteriosclerotic plaques. There's also strong evidence that CRP can increase the uptake of LDL by macrophages to form foam cells and that CRP can enhance blood clotting, although that is still controversial. Finally, Pepys and his collaborators have shown that if you put human CRP into rats and then induce a heart attack, the attack is considerably more damaging than an attack induced without CRP, and the amount of heart muscle killed in the attack is greater by 40%. "CRP is clearly enhancing the size of the infarction in the rat model," says Pepys.

CRP is beginning to find its way into clinical medicine. Physicians have started to measure it in patients to assess heart disease risk: President Bush reportedly had his CRP level measured, for instance, and he was told it was fine, says Ridker. Research labs in academia, biotechnology, and the pharmaceutical industry are looking into the possibility of using molecules that inhibit CRP binding to reduce the risk of stroke and heart attack or perhaps to reduce the degree of damage afterward. They are also considering attacking other inflammatory mediators. "We're still left with the challenge of trying to sort out what's really important," says Libby.

The clinical payoff could be twofold. On the one hand, if the latest data stand up, says Libby, it means that plenty of asymptomatic individuals with no classical risk factors and low cholesterol levels but high CRP levels—perhaps one in every five Americans—are at high risk of heart attacks and could benefit from treatment, including statin drugs. "Our challenge is to learn how to treat these walking well who can benefit from statin therapy," says Libby. "We might want to use CRP or other markers of inflammation as a way of targeting therapy to these individuals as primary prevention." Indeed, in March the American Heart Association, the American College of Cardiology, and the Centers for Disease Control and Prevention co-hosted a meeting in Atlanta to develop clinical guidelines for when and how to use CRP measurements in treating patients.

The ultimate payoff is likely to come from identifying the ideal targets for inhibiting inflammation. That step, in turn, could eliminate at least some of the damage caused by arteriosclerosis. "We have our work cut out for us for the next dozen years," says Libby.

–GARY TAUBES

MARINE ECOLOGY

Picturing the Perfect Preserve

Computerized tools help marine researchers map reserve networks that can pass ecological and political tests

NEW YORK CITY—Designing modern marine reserves demands a deft touch. Planners must balance the need to protect fragile marine environments against strong economic and political pressures to mine oceanic riches. It sounds like a job for an experienced diplomat, but ironically, a key tool for dealing with such challenges may instead be a computer.

A growing number of scientists are turning to new mapping software to help them design networks of marine reserves that are both politically viable and ecologically effective. The programs enable planners to test thousands of possible arrangements for achieving conservation goals, such as preserving fragile coral reefs or shielding vulnerable spawning fish from nets. Just as important, cybermapping may allow reserve advocates to sidestep potentially disastrous political conflicts by flagging areas where a protected zone might draw opposition from anglers or other economic interests.

Such simulations recently allowed a U.S.-Mexican research team to pinpoint potential trouble spots for a proposed network of reserves in Mexico's Gulf of California. Australian researchers are applying the approach to patches of the Great Barrier Reef. Another group of scholars hopes to build models that will improve the effectiveness of one of the world's first major reserve networks, in the Bahamas.

"Marine reserve modeling is showing some big improvements over where we were just a few years ago," says Sandy Andelman of the National Center for Ecological Synthesis and Analysis (NCEAS) in Santa Barbara, California, who helped develop the tools. Their growing popularity, she says, reflects the fact that "there are more possible ways of conserving marine biodiversity than we can picture in our heads."

Speaking here last month,* marine ecologist Enric Sala of the Scripps Institution of Oceanography in La Jolla, California, described how the new tools can allow a small scientific team to draft a reserve plan for a large area quickly and relatively cheaply. Sala's target was the shallow water habitats of


Coral jewel. Researchers hope that new cybermaps will help preserve coral reefs and other habitats in the Gulf of California.

CREDIT: (RIGHT) E. SALA

* "Sustaining Seascapes: The Science and Policy of Marine Resource Management," American Museum of Natural History, New York City, 7–8 March.

the Gulf of California, a 150,000-square-kilometer slice of water wedged between Mexico's west coast and the Baja Peninsula. When the project began in 1999, Sala says, researchers had little information about the distribution and abundance of the gulf's biological wealth, which is under increasing threat. "We had to start from scratch," he says.

To fill the gap, he and two students from Mexico's Autonomous University of South Baja California in La Paz made hundreds of dives at 84 spots along the gulf's coast, surveying sea life and documenting habitat types. They also interviewed local fishers for information about the spawning sites of seven economically important species of fish and looked carefully for nursery areas. Back at Sala's lab, another trio of researchers fed the information into a computer model designed to achieve preset goals.

In this case, Sala's team proposed a network that would protect all coral reefs, sea-grass beds, and known spawning sites, at least 50% of coastal mangroves, and at least 20% of all other habitat types—in a minimal area. To allow sea life to flow from one site to another, they decreed that no reserve should be more than 100 kilometers from the next one in the chain.

With those rules in place, the software—based on code developed by Ian Ball of Australia's Antarctic Division in Kingston, Tasmania, Hugh Possingham of the University of East Queensland in Brisbane, and NCEAS scientists—then spent hours sorting through thousands of possible combinations. The winning map, Sala reported at the meeting, showed that 18 reserves covering just 12% of the marine habitat could do the trick. As a bonus, it protected even more mangroves and other habitats—from sandy bottoms to submerged cliffs—than Sala's rules called for.

Sala's team wasn't finished, however. Knowing that reserve plans can founder on opposition from commercial anglers and other interests, it incorporated data on fishing boat activity collected by the World Wildlife Fund (WWF), one of the project's partners. The software identified several potential conflict zones, then reconfigured the network to avoid heavily fished areas but still satisfy the conservation goals, Sala said.

"It's a really elegant project" that is sure to influence other reserve planning projects, says marine policy expert Liz Lauck of the Wildlife Conservation Society in New York City. Most impressive, says coral specialist Jeremy Jackson of Scripps, is that the job took less than 3 years and cost only $400,000, provided by funders including the Moore Family and Tinker foundations. "It shows how quickly you can gather useful information," he says.

How Sala's findings will play in Mexico, however, remains to be seen. WWF and other groups are working with government officials to develop a long-term conservation plan for the gulf, and Sala's work is just one piece of the puzzle. Still, says Juan Carlos Barrera of WWF-Mexico in Hermosillo, Sonora, "the ability to consider social and economic factors along with ecological concerns is very helpful."

Data dive. Researcher Gustavo Paredes takes a sea-life survey used to design a marine reserve network for the Gulf of California.

Other researchers are pursuing similar work. Leanne Fernandes of Australia's Great Barrier Reef Marine Park Authority reported that her agency has turned to related software to help identify a network that will protect 70 "representative" bioregions along the reef. "The idea isn't to come up with the [ecologically sound] solution and [send] it in to the minister but to have a plan that already takes into account the concerns of the many stakeholders," she says.

Meanwhile, in the Bahamas, a team led by Dan Brumbaugh of the American Museum of Natural History in New York City hopes to build a dynamic model to finger the shifting social and biological forces that determine a reserve network's fate. Backed by a 5-year, $2.5 million grant from the National Science Foundation's Biocomplexity in the Environment program, Brumbaugh has assembled social and biological scientists from nearly a dozen institutions. A key question they hope to answer is whether networks designed to win community support can work as well over time as those focused on ecological goals.

The project demonstrates how marine reserve advocates, traditionally biologists, have begun to incorporate economic and social concerns into their thinking, says Brumbaugh. Successful efforts to design and evaluate reserves depend on "finding people who are willing to play nice with each other and overcome disciplinary suspicions," he adds. And a little silicon-based helper doesn't hurt, either.

–DAVID MALAKOFF

TECHNOLOGY

Microchips That Never Forget

Magnetic memory promises computers that turn on instantly, smarter gadgets, and a revolution in chip design—if it can elbow its way into the market

It's 2 a.m. and you're at your computer typing up that 20-page report that's due in 6 hours. You're on your eighth cup of coffee and your fourth candy bar, and just maybe you'll finish in time to take a shower before dashing off to work. You haven't saved your document in hours. Then you accidentally kick the electrical cord and unplug your computer.

No problem. Plug the cord back into the wall socket, and the machine instantly blinks back to life. It also remembers every t you've crossed and i you've dotted, so you continue to type as if nothing has happened.

This fanciful scenario could become a reality in the not-too-distant future, thanks to magnetic memory that can store information even when it loses power. The first commercial prototype chips should hit the market within 2 years. But magnetoresistive random access memory (MRAM) may not only allow your computer to turn on and off instantly without forgetting what it was doing; it could also reshape all of electronics.

The emerging MRAM combines the best features of the currently existing electronic memory technologies, says Saied Tehrani, an electrical engineer at Motorola in Tempe, Arizona. It therefore could potentially replace all of them. "MRAM really has the potential to be a universal memory," Tehrani says. MRAM bits can also mix with the transistors in standard silicon chips, so the technology could allow chip designers to put an entire computer on a single chip, making portable devices such as cell phones and personal data assistants far more powerful.

But it isn't certain that MRAM can topple the reigning champion of computer memory, an electronic technology called dynamic random access memory (DRAM), says Bob Buhrman, a physicist at Cornell

CREDIT: E. SALA