education. "It's hard to find a more serious problem," he says. "If NSF can make a significant impact, then I'd have to vote for that." At the same time, NSF's proposed 1995 budget would increase research at three times the rate of education, with Lane making a point of saying that it's time for NSF to evaluate how it's spending its $570 million education budget.

With Lane so hard to pin down, *Science* decided to ask him how he would like to be evaluated after spending a few years as director. But his answer provides few concrete criteria for either critics or supporters to use: "I think the question that I would ask is whether NSF continues to support the best ideas and the best people adequately, so that research discoveries continue to get made," he said. "I would ask if the NSF still provides the facilities or access to facilities someplace else in the world. I would want to know if the NSF is still carrying out its mission of supporting the creation of fundamental knowledge and supporting the Administration's priorities, and not lowering its standards in making decisions on how to invest these funds." He stopped, then added, "How do you measure all that? I don't know."

Considering the political land mines that former NIH Director Bernadine Healy touched off with blunt language about her thoughts and goals, perhaps Lane's determination to avoid being pinned down will better serve NSF in the long run. And considering the Clinton team's emphasis on harnessing science to solve national problems, Lane can hardly ignore the subject. Next month he will begin his first round of appearances before the congressional panels that set his budget. Those presentations may offer scientists the first chance to judge for themselves whether Lane's tendency to walk softly and look in all directions before proceeding is indeed the best strategy for NSF.

–Jeffrey Mervis

ECOLOGY

Phosphorus Fingered as Coral Killer

Ever since Charles Darwin looked over the side of the *HMS Beagle* and noticed the apparent paradox of a thriving coral reef only meters away from clear, lifeless water, scientists have been fascinated by the way reefs flourish in waters virtually free of nutrients —lush oases in blue deserts. But this anomaly also makes reefs vulnerable: Supply more nutrients and the delicate balance of the reef's multitude of constituent organisms can be disrupted. Excess nutrients can create an algal "jungle," blocking sunlight from the coral and depriving it of oxygen, a process known as eutrophication. The reefs are left brittle and stunted.

Reef researchers across the globe are concerned that this may already be happening on a large scale. Sewage from cities and run-off from agricultural land carrying fertilizers can dump large amounts of nitrates and phospates into coastal seas, threatening nearby reefs. Now, in a unique experiment on the world's largest reef system, Australia's Great Barrier Reef (GBR), a team of Australian researchers is trying to quantify the effect by carefully exposing isolated areas of reef to high concentrations of nutrients. The experiment has been running for only 5 months, but preliminary results suggest that excess phosphorus may be the biggest threat—a finding that, if confirmed, would have widespread implications for sewage treatment and agricultural practices.

The GBR is particularly threatened by the rapid population growth on the nearby coast of Queensland. A recent study calculated that 15 million tonnes of sediment, 77,000 tonnes of nitrogen, and 11,000 tonnes of phosphorus are discharged along the Queensland coast every year. Before Europeans settled the area, the amounts are thought to have been one-quarter of this.

Studies in the 1970s that exposed reefs to excess nitrogen and phosporus for 8 months showed that both enhanced growth of a reef community by 25% but inhibited calcification of the reef by more than 50%. Last September, the Great Barrier Reef Marine Park Authority initiated the new $600,000 study, called ENCORE (Effect of Nutrient Enrichment on Coral Reefs) to extend those old findings. According to Sydney University biologist Tony Larkum, who heads the research team: "Apart from anecdotal evidence that 'reefs ain't what they used to be,' there is scant scientific evidence of coral reef degradation on the GBR that can be unambiguously attributed to eutrophication. That's what makes ENCORE unique—it's being undertaken before the effects of eutrophication have been clearly demonstrated on the GBR."

A. STEVEN/GREAT BARRIER REEF MARINE PARK AUTHORITY

Too much of a good thing. ENCORE's robot dispenses excess nutrient to the Great Barrier Reef.

Other countries, most notably the United States, are also studying reefs but on the whole, according to marine scientist Marlin Atkinson of the University of Hawaii, U.S. researchers are focusing on how reef organisms take up nutrients, rather than on the effects of excess nutrients as ENCORE is doing. Atkinson says the size, scope, and unique reef environment of ENCORE set it apart.

The project is based at One Tree Island, 70 kilometers offshore on the southern Great Barrier Reef. The team chose the site because its high-rimmed lagoon contains many micro-atolls, small circular patches of reef like swimming pools about 220 meters across. At low tide, these pools are isolated from the main lagoon for about 5 hours and so become perfect test sites.

The team sited nine floating robots in the water alongside 12 micro-atolls. Shortly before each low tide, a base station on the island sends a radio signal to each robot. An onboard computer then triggers the discharge of a measured quantity of solution—nitrogen (in the form of ammonium chloride), phosphorus (potassium dihydrogen phosphate), a mixture of the two, or a control—into the micro-atolls. Nutrient concentrations are raised to 10 times those currently found on the GBR.

Although the experiment has barely begun, some changes to the coral are already becoming apparent. The team has found that both nitrogen and phosphorus stimulate algal growth but, importantly, phosphorus treatment alone inhibits calcification. Reef expert Amatzia Genin of the Hebrew University at Eilat in Israel says he believes that this differentiation between the nutrients has not been observed before. If these early results hold up, phosphate-rich fertilizers and sewage will be unambiguously exposed as a major threat to the world's coral reefs. Says reef scientist Zvy Dubinsky of Bar Ilan University in Israel: "Unless something is done to prevent runoffs, coral reefs will disappear, or will only survive well away from humans."

–Maria Burke

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