Mduma hope to identify healthy stands of forest with abundant animals and compare them to more fragmented, disturbed forests. "That may give us some idea of how much forest is necessary to maintain the species, and an inkling about why this fragmentation is occurring," says Sinclair.

Once they have detailed data on certain habitats, they can spot-check other examples of the same habitat to see if the diversity patterns hold true. Then they can get a sense of how the whole park works by putting it all together.

The transect results, coupled with Sinclair's notebooks, are already turning up new long-term biodiversity patterns. For example, certain shrikes and thrushes have moved into the park, says Sinclair—ones "that I know for certain weren't here 30 years ago, because they are so visible. We don't yet know why this has happened." Similarly, the visit to the forest along the Grumeti River turned up a small population of black-and-white colobus monkeys, the farthest west these monkeys have ever been seen. Again, at the moment, no one knows why.

But species are disappearing, too, particularly in the riverine forests. One site had seemingly healthy populations of trogons and large-casqued hornbills in 1965. Now it has lost much of its tree cover, as well as many species of birds, including these two. "It's quite clear that some [bird] species will exist only in intact forests, ones with a complete canopy cover," says Sinclair. "We want to measure how much canopy cover is necessary for maintaining species like those." So far it seems that the canopy needn't be wide—perhaps only 50 to 100 meters—but it must extend for some distance along the river.

Eventually, the duo plans to extend the faunal inventory to the park's insects, reptiles, and fish with the aid of specialists in those fields. But because of limited funds, Sinclair imagines that only a handful of people will be involved, so many organisms would still be left out.

Tropical ecologist Daniel Janzen of the University of Pennsylvania in Philadelphia, who pioneered the idea of all-taxa inventories, cautions that to achieve his goals, Sinclair may need to identify more species. That means more people and much more money. "If you're going to invade Normandy, you're going to have to pile on the resources," says Janzen. "It's OK to start out small like they're doing, but to do the full inventory requires a massive attack. And it's going to be expensive." Without that full inventory, including, for example, the "gut flora of the buffalo," Sinclair won't have the "full Yellow Pages" of the Serengeti, adds Janzen.

Other experts, including James L. Patton, an evolutionary biologist at the University of California, Berkeley, who has begun the first small-mammal survey of the Amazon Basin, think Sinclair's more scattershot approach is feasible. "To get down to the soil microorganisms isn't always necessary," says Patton. Besides, he adds, Sinclair's focus on the Serengeti's dynamism "as the key to its biodiversity is what makes this project so neat." Raven, who is investigating the possibility of having his institution team up with Sinclair, adds that "Sinclair is gathering baseline data that will help people manage that park; you don't need every microbial organism for that."

The debate doesn't trouble Sinclair, who thinks that their count will take a minimum of 10 years and "in some ways, given the park's cycles, it will never be complete." Nor does this open-ended aspect of his research worry him: "It's a record of what we see here today in the Serengeti. It's what I wish the first European explorers in East Africa had recorded. If they'd done this, we'd have a much better understanding of how the Serengeti changes over time—and a far better idea of how to preserve it."

–Virginia Morell

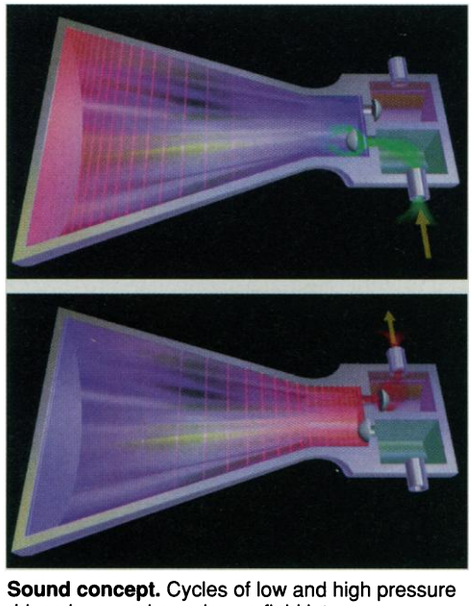
PHYSICS

Cool Sounds at 200 Decibels

The loudest controlled sounds ever made by humans were produced earlier this month—not by a rock band, but by a physicist. At the Acoustical Society of America meeting in San Diego, Timothy Lucas of MacroSonix Corp. in Richmond, Virginia, demonstrated a new "acoustic compressor" that uses ultra-intense sound waves to do the work of a mechanical pump. The technology may soon be used in everyday appliances such as refrigerators and air conditioners.

The idea of the compressor is simple: You shake a can back and forth to create vibrations in the air inside. Just as a child can produce huge waves in a bathtub by sloshing back and forth at just the right rate (a phenomenon called resonance), the air vibrations become especially intense if the can is agitated at a certain frequency. But the water in the child's bathtub will splash out if the waves start to crest. For acoustical engineers, the analogous problem is shock waves, which dissipate the sound energy as heat. By making his compressor just the right shape—essentially that of a bowling pin—Lucas was able to keep the shock waves from forming, even as the can vibrated at about 600 times a second.

How loud are the resulting sounds? The pain threshold is about 120 decibels, and a jet engine produces 150 decibels. If you stand next to a sound of 165 decibels, it will ignite your hair. The sound waves inside Lucas's compressor are about 3000 times more powerful, or about 200 decibels. But because the can's own vibrations are much smaller than the vibrations of the air, on the outside it sounds just like an ordinary compressor.



TIMOTHY LUCAS *et al.*/MACROSONIX CORP.

Sound concept. Cycles of low and high pressure driven by sound can draw a fluid into a compressor *(top)* and expel it at high pressure.

The intense sound waves oscillate between low and high pressure in certain regions; with the help of valves that open and close at the right moments, these pressure differences can suck gas into the compressor and shoot it out at high pressure. Lucas's compressor could be especially useful for refrigerators and air conditioners, which work by compressing a refrigerant—traditionally a chlorofluorocarbon. Steve Garrett, a physicist at Pennsylvania State University in University Park, explains that some of the ozone-sparing refrigerants now being used break down in the oil that lubricates a conventional compressor. But Lucas's compressor has no moving parts inside and therefore requires no lubrication. MacroSonix has already signed a licensing agreement with an appliance manufacturer.

Other specialists in acoustics call Lucas's compressor a breakthrough. "What Timothy Lucas has done is shift the debate from whether acoustic compression can be done to who can do it better," says Garrett. Lucas himself thinks his sound waves will ultimately find many other roles. "Electromagnetic waves have been commercialized for over 100 years," he says, "but the commercial application of sound waves has only scratched the surface."

–Dana Mackenzie

Dana Mackenzie is a science and mathematics writer in Santa Cruz, California.