A High-Tech Mosquito Barrier

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Collier County Mosquito Control District technician Adrian Salinas (left), ARS entomologist Dan Kline (center), and Gene Lemire, assistant director of research and public education for the district, inspect a line of traps forming a barrier between a residential area and nearby mosquito breeding grounds. (K7097-2)

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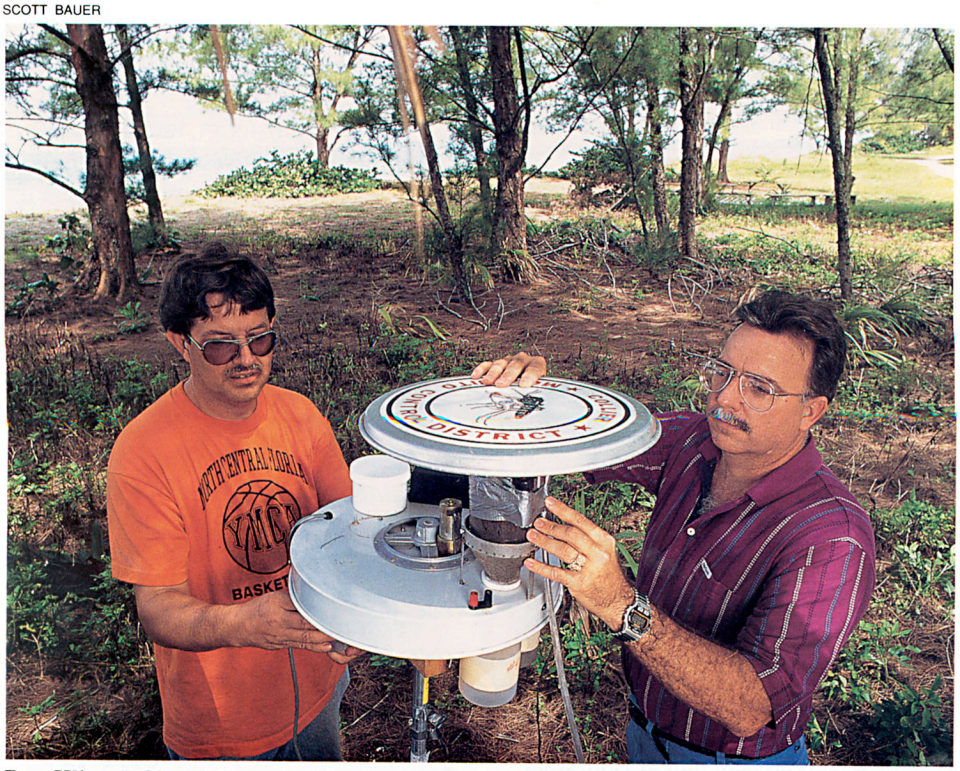

Dan Kline (left) and Gene Lemire inspect a rotator surveillance trap used to monitor daily changes in mosquito levels. (K7100-10)

The mosquito meter at the Everglades was bad news for tourists but good news for Dan Kline on that June 1987 day when he arrived at the south Florida park. The meter showed a picture of a female mosquito's proboscis, which she uses to suck blood, pointing toward "unbearable." Not a fun spot for a summer vacation.

But Kline, a U.S. Department of Agriculture scientist, didn't seem too upset by the meter's reading. He had arrived to rent a cabin, knowing that billions of salt marsh mosquitoes would be swarming around the lodge, campsites, marina, and trails around Flamingo, a town along the south shore of the Everglades.

When Kline called to make the cabin reservation, he was warned about the mosquitoes. But his attitude was: "the more, the better!" When he says that, the entomologist with USDA's Agricultural Research Service gets all kinds of reactions—ranging from "what, are you crazy?" to "so you study mosquitoes, do you?" But he's used to it.

Kline and his research team journeyed to the Everglades to conduct preliminary studies on octenol and carbon dioxide, two environmentally friendly chemicals that showed promise as attractants for the salt marsh mosquito species *Aedes taeniorhynchus*. He knew if the attractants worked in a place as bad as the Everglades, they would probably work anywhere.

Carbon dioxide had long been known as a universal attractant for biting insects, while octenol had been identified in Africa as a lure for the tsetse fly. Kline had decided to test octenol—an ingredient in cows' breath—on salt marsh mosquitoes. Octenol is given off by ruminant animals when they digest grasses in their rumen, the first compartment of their stomach. Female mosquitoes

use these gases and other cues to find a blood meal.

"They don't really see you like we see things, but they sense where you are by detecting these aromas," Kline says, adding that scientists have not yet unraveled exactly how mosquitoes detect these scents.

He also wanted to try combinations of the two attractants. Everglades work in the late 1980's showed that the attractants were effective against salt marsh mosquitoes and had potential for mosquito control, especially in environmentally sensitive areas.

Over the next several years, Kline tested the attractants against a wide range of mosquito species and other insects, and by 1993 he was ready for a large-scale field test. While looking for a test site, he found the perfect place at Key Island.

If there is a "mosquito hell" on Earth, this may be it.

The island, about 2 miles long and a mile wide, lies off the coast of Naples, Florida. It has the unfortunate distinction of being on that state's "mosquito flyway," the route that migrating salt marsh mosquitoes take when the prevailing Atlantic Ocean winds carry them from the Everglades up the Gulf Coast. The worst time of year is the rainy season from June through October, when rain floods the salt marsh. The Everglades includes 572,200 acres of saw grass and freshwater marsh, so the breeding potential is enormous.

"They are absolutely vicious biters and come off breeding sites in droves. The nuisance effect is tremendous," says Don Barnard, who heads the Mosquito and Fly Research Unit at the agency's Medical and Veterinary Entomology Research Laboratory in Gainesville.

Once water immerses the mosquito eggs along the dry fringes of the marsh, they hatch and begin to develop into larvae. Within a week, the adults are out and about. In a few more days, the females are ready to search for their blood meal. Only females actually bite and suck blood, which they need to nourish their eggs. Both male and female mosquitoes feed on nectar for energy.

During peak season, billions of mosquitoes start to head north along the Gulf Coast, creating an eerie sound, says Richard Mankin, an acoustics engineer with ARS in Gainesville who is working with Kline on remote detection devices for salt marsh mosquitoes.

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Adrian Salinas, Dan Kline, and Gene Lemire (left to right) determine the proper carbon dioxide flow rate for one of the perimeter barrier traps. (K7099-2)

"It sounds like one mosquito close to your ear, only a lot louder," Mankin says, "like that piercing sound of crickets in the summer, only at a lower pitch."

After salt marsh mosquitoes leave the Everglades, one of the first places the swarms land is Key Island, at the northwest corner of the Everglades. Kline had been to Key Island when the mosquitoes were so thick that if you pulled up your pant leg and waited 15 to 30 seconds, your calf turned black with 500 feasting females. It was also that bad during peak season at the Everglades, where the rangers distribute pamphlets admonishing visitors to close their car windows and doors and to have their keys in hand as they approach their vehicles.

Key Island is part of the 242-square-mile Collier County Mosquito Control District, where mosquitoes pose a particular challenge, says Gene Lemire, a combination researcher and public relations official for the district. "This is probably one of the worst areas in the state for mosquitoes. We have mosquitoes so bad that in 1989, they were killing cows. The cows were inhaling so many mosquitoes they were choking, suffocating."

One of district's worst spots, Key Island is home of what used to be called the Keewaydin Club. That exclusive 63-acre club, at the island's northern end, had been built by a wealthy investor as a winter getaway for the rich, accessible only by boat and including a five-star restaurant and lodge. There were no telephones, no televisions—only the beach, birds, saw grass, salt marsh, and, of course, lots of mosquitoes.

Once the mosquitoes reached the Keewaydin Club, they found plenty of human blood meals lounging around the pool. There were nature trails at the Keewaydin Club, too, but nobody could walk them most of the time—even a winter hike required a strong repellant and thick clothing. The Collier district was restricted from spraying chemicals on Key Island because of a nature preserve on the island's southern end, where mosquitoes are a key source of food for reptiles, birds, fish, and other wildlife. And, because they feed on

nectar, mosquitoes are valuable plant pollinators.

The Collier district sprays an organophosphate insecticide called Baytex from airplanes to kill adult mosquitoes in other areas of the district. Lemire says that had caused trouble in the past because of environmental concerns. But mosquitoes were so bad in the district that something had to be done.

Baytex was one of only a few chemicals approved in Florida for mosquito control, but it wasn't acceptable for Key Island for environmental reasons. Fewer and fewer insecticides are now available for mosquito control; Kline says he hasn't had a new compound to evaluate in 5 years.

So Kline and Lemire got together in the early 1990's to set up a 3-year pilot test on Key Island, beginning in 1993. By then, the Keewaydin Club had been largely deserted, soon to be sold off and planned for 20 homes. The scientists' strategy was to set up a string of traps to create a barrier and block the mosquitoes from invading the club.

At the island's narrowest point, about one-half mile wide, they set up a series of 52 traps about 20 feet apart, between the club and the southern part of the island. Each trap was baited with a combination of carbon dioxide, released from small cylinders, and a liquid octenol solution that gave off the cow-breath aroma. Once the mosquitoes landed, they would be killed by a synthetic pyrethroid insecticide that kills the insects on contact. The traps would be out for 30 days.

Over the last 3 years, the traps have been a great success, Kline says, catching an estimated 90 percent of the salt marsh mosquitoes that would have swarmed over the club. After one test, Kline says, the emptied traps filled three 30-quart coolers—more than 2 billion mosquitoes.

Work is continuing to improve trapping technology, including new, cost-effective "targets" that will replace mechanical traps.

The traps are now fed by carbon dioxide canisters, but the targets can be supplied by carbon dioxide from a pipeline. This would eliminate the need for the canisters, which must be changed by hand.

Kline is also working with University of Florida researchers on new, improved chemical attractants for mosquitoes.

"Using attractants, traps, and targets has a lot of potential for mosquito control, especially in environmentally sensitive areas where spraying can't be done," says Kline.—By **Sean Adams,** ARS.

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Several mosquito breeding areas around Florida's Key Island, at the northwest corner of the Everglades, are potential sites for placement of additional mosquito control traps. (K7097-17)