

BULLETS, BOMBS & *Butterflies*

Biologists are working on a rescue plan for the St. Francis' satyr, an endangered butterfly that lives only in artillery impact zones at Fort Bragg.

When N.C. State University biology professor Nick Haddad first began working to restore the imperiled St. Francis' satyr butterfly on Fort Bragg seven years ago, he started entirely from scratch.

"Nobody even knew what its larval host plant was," Haddad said. Which, in butterfly lingo, means no one knew squat about the cocoa-colored, quarter-sized insect.

Knowing the host plant would tell scientists what kind of habitat the butterfly uses to reproduce, because most butterflies lay their eggs on the same plant that their larval caterpillars eat. So Haddad began the painstaking process of decoding the imperiled insect's life history: figuring out where the adults laid their eggs in the wild, when the larvae hatched, what the caterpillars ate and where they might be on Fort Bragg, which happens to be the only place in the world this rarest of Eastern butterflies lives.

"A lot of our work has been sleuthing to reconstruct its historic habitat use and how that habitat was maintained," Haddad said. "It turns out that the St. Francis' satyr has this love-hate relationship with beavers, water and fire."

Only a few hundred years ago, when longleaf pines covered 90 million acres from Virginia south to Florida and west to eastern Texas, the St. Francis' satyr likely lived in sedge meadows that overtake deep, mucky sediments left behind when a beaver dam fails. Sedges of the genus *Carex* fan out over saturated mud and grow into thick, long-bladed meadows. Small fires that historically maintained the longleaf pine system also preserved the

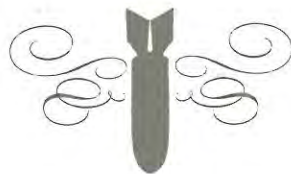
meadows within the pine systems by preventing new hardwoods from growing, which kept sunlight flooding through large gaps in the forest canopy.

"The early explorers describe walking along creeks in this area, and they would literally see evidence of beavers everywhere," Haddad said. "They'd see an active dam in one spot, an abandoned dam in another and further up, signs that beavers had cut down trees—there was this constant disturbance of beavers flooding, abandoning and reclaiming areas along creeks."

But now that our longleaf pine ecosystems are whittled down to 3.4 million acres, less than 4 percent of their former range; beavers have been pushed out of many areas; and the natural fire regime has gone up in smoke, the St. Francis' satyr has adapted by developing a curious dependency upon the artillery impact zones of Fort Bragg. Where soldiers lob bombs into the forest and train on small- and large-weapon systems, incendiary devices spark small fires that mimic the natural regime of old and maintain remnant pockets of humid sedge meadows.

"The artillery impact zones are actually some of the best areas in all of Fort Bragg for this species," Haddad said, as long as there is water to maintain the muck and grow the sedges they need.

A forest riddled with bullets and bombs might seem an imperfect spot for a butterfly with paper-thin wings and legs slimmer than silk thread, but the St. Francis' satyr's story is full of quirky contradictions.



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PHOTOGRAPHED BY MELISSA MCGAW



DISCOVERING A NEW SUBSPECIES

The butterfly was first discovered on Fort Bragg by an off-duty soldier who happened to be an amateur insect collector. Thomas Kral whisked his butterfly net in a muddy meadow and caught the first St. Francis' satyrs on the evening of June 2, 1983. He knew a lot about butterflies, but he didn't know this particular one. It was cocoa brown, and its wings were rimmed in a rusty orange double stripe. The wing scales seemed to give way to tiny hairs projecting off the wing's lip. Its lower wing had five or six silvery eyespots edged in yellow and daubed with metallic blue in the middle. The upper wing held three or four similar eyespots. Two widely spaced rusty orange stripes raked top to bottom from forewing to hindwing. To someone who prefers flashy colors and patterns, the brown butterfly might have appeared plain. But the more you study its colors and rusty orange stripes, the more it beckons like an unassuming, rough-hewn jewel.

Kral netted five that night, which he added to his collection of 25,000 butterfly specimens. Six years later, Kral co-authored an article in the *Journal of the Lepidopterists' Society* naming and describing the new species as *Neonympha mitchellii Francisci*.

Research assistant Samantha Walker nets a St. Francis' satyr. Cloth-covered pots contain the sedge that hosts satyrs in various life stages from caterpillar to chrysalis.

Taxonomically, it was a subspecies of the Mitchell's satyr, which is known from Michigan with several newly found relic populations in Virginia, Alabama and Mississippi.

But Kral and his co-author, David Parshall, chose to name it *Francisci* as a nod to St. Francis, whom most people know as the patron saint of animals and the environment. But St. Francis of Assisi, who died in 1226, is also the patron saint of merchants. So perhaps it only makes the butterfly's story even more compelling that Kral was busted in 1992 by the U.S. Fish and Wildlife Service in one of the biggest butterfly collecting stings to date for illegally poaching and selling protected species. The 1,600 specimens agents seized from his home in Tucson, Ariz., were reported to equal about 2 percent of his 80,000-strong personal collection. Though he is rumored to have had many St. Francis' satyrs in his collection at that time, it was not yet illegal to possess them.

In 1995, Kral was convicted under the Lacey Act, fined \$3,000 and given 300 hours of community service doing educational outreach about wildlife protection laws.

Also in 1995, the St. Francis' satyr was formally listed under the Endangered Species Act (ESA). It had been rumored to be extinct in the wild, or teetering close to it, mainly due to over-collecting compounding its dwindling-habitat threats. But more of the cocoa brown critters had turned up alive and well, in the nets of Stephen Hall, an invertebrate zoologist

with the N.C. Natural Heritage Program, when he was doing surveys in 1992 in Fort Bragg's productive wetlands.

"All I had was a rough sketch map that Parshall had given us showing where the butterfly had been found on the base," Hall said. "When I finally re-located the original population site, they were still there, although I only saw three or four individuals on that first trip."

Erich Hoffman, of Fort Bragg's Endangered Species Branch, and Hall found two new populations that summer and documented several more in 1993. Hall checked up and down the Coastal Plain, and in the Sandhills too, but never netted any off the base. He worked with Hoffman on early studies of the butterfly's habitat, and the pair did the legwork to get the insect emergency-listed under the ESA in 1994.

In 2000, they passed the butterfly's fate to Haddad. "We were really glad when he showed up and seemed to have a strong interest in its conservation," Hall recalled.

A BLUEPRINT FOR RECOVERY Once Hall, Hoffman and Haddad pieced together the historic habitat of St. Francis' satyrs, Haddad and Brian Ball, a civilian biologist with Fort Bragg's Endangered Species Branch, began mapping out a three-pronged recovery program for the species. One line of work involved figuring out husbandry techniques to captive-rear caterpillars in an effort to gear



up for full-scale captive breeding. A second line of work entailed investigating how to restore habitat on Fort Bragg, and a third involved mapping and monitoring known colonies on the base.

The last turned out to be the trickiest because people aren't allowed in the artillery impact zones the butterfly favors. Haddad and Ball suspect that the butterfly's habitat lies about 50 percent inside and 50 percent outside the zones. "But numerically, it's probably like 95 percent of the butterflies are inside and 5 percent are outside," Ball said. The pair received permission twice to enter the zones — once in summer 2009 and once in summer 2010, and only for a few hours — to survey. "We had so many sites we were trying to get to, we were literally running all day. Well, as best as you can run in mud," Ball joked.

The biggest differences they noticed in the habitat inside the impact zones compared to outside were the lack of roads, unbroken stretches of creeks and huge expanses of giant canebrakes. The base's four impact zones total about 33,039 acres ringed by 83 firing ranges. Inside the impact zones, canebrakes several hundred yards long often harbored hundreds to perhaps a thousand St. Francis' satyrs. And when Haddad parted the canes and peered at the ground beneath, the soil was carpeted in a green sea of *Carex*. None of the canebrakes outside the impact zones have *Carex* sedges growing below them, and Haddad and Ball have never found the satyrs in them.

"This is purely speculative, but I think fire plays a big role inside the artillery impact zones," Haddad said. "I think that the giant canes carry fire over their tops, which would prevent the sedges from burning below, but it would also limit the cane's growth and keep light pouring down to the grasses below."

Fort Bragg maintains a three-year burning regime to maintain its 120,000 acres of forest, but Haddad suspects that the smaller incendiary-sparked fires inside the impact zones affect the habitat structure in a different way, a way more favorable to St. Francis' satyr survival. The habitat differences are "like night and day," he said. "There is this unknown black box of the artillery impact areas. And from what I've seen after visiting out there last summer, they are some of the best areas for the butterfly to be. What we saw in there was impressive."

Haddad and Ball found a single robust colony that might have numbered 1,000

individuals inside the impact area, whereas the three known sites outside the impact area number between 100 and 400 individuals each.

Fort Bragg's 650 miles of creeks also play a role in the butterfly's genetic diversity. Haddad suspects that dispersing adults fly along the creeks and use them as corridors to get to new habitat or existing colonies. The boundaries to the butterfly's dispersal so far seem to coincide neatly with the edges of wetlands. The insect rarely flits into developed habitat or crosses open fields.

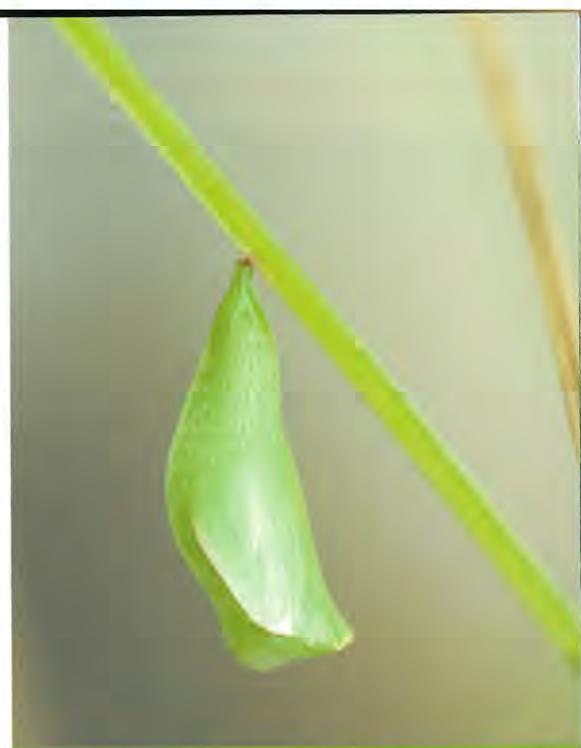
"It seems to really like this mosaic habitat of some open canopy and sedges, and some nearby shaded shrubs," Haddad said. "It darts between the two." In other words, the St. Francis' satyr is a denizen of intermediate disturbance. It likes things mucked up just so — an abandoned beaver dam will do for a home, as the community succeeds to meadow — but a new beaver pond is its bane because, well, caterpillars can't swim. And the species likes a little bit of fire to keep the canopy open, but not so much that the sedges fry completely.

This satyr is the Goldilocks of butterflies, needing habitat that's just right.

Johnny Wilson, a student working in Haddad's lab, used remote sensing such as LIDAR (Light Detection and Ranging) and aerial imagery to analyze Fort Bragg and other public lands in North Carolina for suitable St. Francis' satyr habitat. The technique helped rustle up two good sites inside the impact zones. His analyses suggest that there might be a little less than 250 acres of land on Fort Bragg that could be potential habitat for the St. Francis' satyr. By contrast, the species' known habitat takes up about 10 acres outside the impact areas, and 25 acres inside the artillery impact zones — on a base that spans more than 160,789 acres.

If the researchers can get the powers-that-be at Fort Bragg on board, Haddad hopes to fill the potential habitat with captive-bred butterflies. In fact, he and Ball are already working out the husbandry formula in a secret lab in the woods.

BREEDING NEW LIFE By practicing first with Georgia satyrs, Haddad, Ball and several students have perfected collecting the eggs from females and growing them out into caterpillars and adults. The St. Francis' satyr has two "flight periods" each year. The first is from mid-May to mid-June, and the second is from late July to August. Both last for about



N.C. State University professor Nick Haddad checks a butterfly pot for adult satyrs that might have emerged. Above, a St. Francis' satyr chrysalis. Bottom, an adult newly emerged from its chrysalis.



Haddad and his crew mark the wings of individual satyrs for easier tracking. A gravid female satyr lays several tiny green eggs.

three weeks. During this time, the butterflies live in their adult form for about four days. They mate, and the females lay eggs.

Unlike other butterflies, the adults do not sip nectar. In fact, Haddad suspects they eat nothing at all. But during the flight periods, Haddad, Ball and the students walk a system of boardwalks through the mucky meadows, swooshing their butterfly nets and bagging critters right where they perch.

"This butterfly is probably the most sedentary butterfly you will ever meet," Haddad said. "It loves to just cling to a blade of grass and sit there, so we swipe our nets over the sedges to get them to fly."

It is also the only butterfly you might ever meet that takes danger-avoidance cues from opossums. When threatened, it keels over, wings tightly clasped, and plays dead. Yes, the St. Francis' satyr plays dead, righting itself again only when safety seems certain.

Haddad and his team collect the females, which are larger and typically have a swollen abdomen, and put them in clay pots topped with window screens. The pots have a succulent sedge blade growing inside. There, the satyrs are held for 24 to 36 hours in the hope they'll lay eggs. If they do, the team gently lifts the eggs, which are like opalescent green orbs, using fine paintbrush bristles and moves them into a Tupperware container where observers can monitor survival. Usually about half the eggs hatch into larval caterpillars. The

team moves the caterpillars onto potted *Carex* sedges draped in cheesecloth stretched over a wire frame. The whole operation takes place outdoors in the butterfly's habitat.

Haddad suspects that *Carex mitchelliana*, which is also largely restricted to Fort Bragg, is probably the insect's larval host plant, so he favors using it for the captive rearing. Enmeshed in gossamer veils of fabric that keep out juice-sucking predators, the caterpillars grow and eventually metamorphose into adults. About half the caterpillars usually emerge as adults. An adult female might lay up to 100 eggs, but only about 25 adults or fewer might be produced from all that genetic material.

"We take two or three adults and place them back into the wild where their mother was captured," Haddad said. "We think of this as demographic replacement since we nabbed the mom to lay eggs in captivity." They release the rest in a site they are trying to colonize.

Haddad's work is funded by the Department of Defense, Fort Bragg and the U.S. Geological Survey, and its budget has increased from \$35,000 in the beginning to about \$100,000 more recently.

It's fair to ask why we should bother with this little butterfly. The St. Francis' satyr could be considered a sentinel species to measure the health and presence of native wetlands, more than 50 percent of which have been ditched and drained in the East. Many rare plants on Fort Bragg are associated with the same habitat that the butterfly uses.

"St. Francis' satyr is currently dwindling on the edge of extinction because people destroyed its habitats by killing beavers, draining wetlands and extinguishing fires," Haddad said. "The butterfly is a North Carolina treasure that we have an obligation to see safely to recovery. And, just as we had the power to destroy its habitat, we have the power to restore it."

TOP SECRET FIELDWORK Over the summer, Haddad recruits students to live near the base and monitor the St. Francis' satyr sites daily. They are sworn to secrecy about the field locations. The students walk transects and count the imperiled butterflies in the wild.

One morning in late May, four of his students trekked with him into a brushy longleaf forest stand. Small turkey oaks popped up through wire grass. The party descended

downhill to where the soil became less firm, squishing into muck and mushy sediment. Small-arms fire popped in the distance, a steady percussion of “rat-a-tat-tat rat-a-tat-tat.” A woodpecker drummed and a green frog called.

Everyone sported boots laced up to their knees, the better to protect against deep muck and snakebites.

“There is an uncanny correlation between St. Francis’ satyr habitat and cottonmouth habitat,” Haddad said as he warned the group to keep an eye out and not to reach down into the tall sedge grasses. Just the day before, someone had extended a hand into the meadow to point at a satyr only to have a cottonmouth shoot out from below, well within striking distance.

Shrubs gave way to bracken ferns, sphagnum moss and open expanses of *Carex mitchelliana* and *Carex atlantica*. “These are all the kinds of plants we suspect the butterfly eats,” Haddad said, balancing on a log only inches above the water and gesturing down to the long-bladed sedges at his feet that were rooted in several feet of spongy sediment. He poked the end of his long-handled butterfly net into the muck. Bubbles of gas leaked from the wound.

The students were standing in the same patch of sedge meadow that Thomas Kral had tromped through 27 years earlier when he bagged the first specimens of St. Francis’ satyr. Ball had worked the site for several months in an effort to restore it.

“The problem here was too much canopy; we needed to get light to the ground,” Ball told the group. “And it was also drying out. All this muck you see saturated now is because of the dammed areas upstream.”

In the years since Kral prowled here, the forest had reclaimed the sedges. So Ball cut down gum and maple hardwoods to make holes in the canopy and let light fall through. He then dammed a creek upstream, diverting water to flood the meadow in a wide swath of inches-deep trickling flow. In a topography where a few inches of elevation make the difference between muck and dry land, his dam did the trick.

“Oh, I see one!” someone called. “Wait, no, it’s an Appalachian brown.”

The “App brown,” as Haddad calls it, is a similar-looking species, though larger, but it flies much faster than the lackadaisical St. Francis’ satyr. Haddad and the students peered through their close-range field binoculars at

another butterfly darting around a shrub. A King’s hairstreak, someone said. They were all itching to spot a St. Francis’ satyr flitting across the grasses. Some swooshed their nets across the sedge tops, hoping to rustle one up.

Even if the St. Francis’ satyr didn’t naturally recolonize the restored site—an existing colony was not too far away—the team would use it to reintroduce captive-bred butterflies. It was enough to know that they had figured out how to mimic beaver habitat and get the sedges to grow.

They piled into pickup trucks and drove to the next site, which harbored the captive-rearing experiments. Haddad and Ball checked a series of potted plants set on a table in the woods while the students scattered across the boardwalks to do their transect walks.

Ball and Haddad squinted into the cheese-cloth-laden contraptions. The potted sedges were lined up in pans of water to mimic the saturated soils they thrived in. The caterpillars were cryptic and hard to see; they were the color and shape of a bowed sedge blade. But most of the caterpillars had curled up into snail-shaped chrysalises, and the biologists were waiting for them to emerge as adults. The potted chambers had to be checked carefully each day. Slowly the students trickled over to the table full of cloth-draped pots.

Haddad pulled a few clay pots out from under the table to check on the wild females he’d caught at dusk the night before. He peered into a pot looking for eggs. “She’s laid seven,” he said. Then he froze.

“Oh, she may be laying right now; watch her abdomen,” Haddad exclaimed. “See how it’s bending up? That is typical egg-laying behavior.”

Everyone crowded around the small table.

“Oh, I can see one! Look at that. Oh my gosh, it’s coming out!” Haddad said. The butterfly was inverted beneath the window screen, hanging upside down in such a way that she was exposing the underside of her abdomen and her ovipositor to the people above. She pushed, and the ovipositor gaped open. Out popped a glistening opalescent egg the color of burnished green sea glass.

“There it is!” Ball said.

The students snapped pictures, and everyone oohed and aahed.

“Wow, that was incredible! That was so awesome!” Haddad said, laughing and smiling. “Oh man, she’s going to lay another one!”



Haddad scans an area for satyrs as research assistant Andeliene Croce takes field notes. Below, a St. Francis’ satyr caterpillar.

She flicked her abdomen back and forth. “There it is! See it? It’s stuck on the window screen. Wait! There’s a third one! She’s on a roll.”

As the students, Ball and Haddad watched over the next few minutes, the butterfly laid nine more apple green eggs that looked like tiny, wet glass beads half the size of a strawberry seed.

Haddad had previously seen four individuals lay eggs in the wild.

“But not from this angle,” he said, shaking his head and smiling in awe at the new cycle of life unfolding in the flooded woods of Fort Bragg. ♦

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