



Gag pack into reef cubes when disturbed.

UF RESEARCHERS ARE
CREATING **ARTIFICIAL REEFS**
THAT GIVE **YOUNG GROUPE**
ROOM TO **GROW**, HELPING
TO ENSURE A **HEALTHY**
POPULATION LONG INTO
THE **FUTURE**

Joe Richard



Reef Relief



BY JOSEPH KAYS



Anybody who's ever wrestled with a grouper on the end of their line knows these monsters don't take well to having a hook in their mouth. But the reward for a half hour of fighting that will leave your arms sore for a week can be a fish that offers some of the best eating in the ocean.

Unfortunately, the growing demand for grouper sandwiches and improved technology like GPS that can put a charter captain right on top of his favorite grouper spots every time have led to concerns this species is being overfished.

Zy Biesinger, a UF doctoral candidate, installs a submersible data logger on the seafloor as part of an array to record the movement behavior of gag around reefs.



Bill Lindberg (left) and Doug Marcinek, research coordinator, rig for research diving.

The gag grouper's growth and maturation rates, penchant to congregate around easily identified seafloor outcroppings and unusual biology — all grouper start life as females and only a fraction change to reproductive males — only adds to the risk that fishing will outstrip their ability to reproduce.

So Bill Lindberg, a UF professor of fisheries and aquatic sciences, and his team are working to give gag a fighting chance by creating more of the habitat they love. The artificial reefs they've created by dropping nearly 3,000 concrete cubes in the waters of the Gulf of Mexico off Florida's Big Bend coast over the past 15 years are meant to ease overcrowding around natural reefs that limits their ability to grow and reproduce.

Gag grouper are born at sea, then carried on the current into the coastal sea grasses, where they spend their first year growing in relative safety. But as young adults, they must make a precarious journey across the mostly flat ocean floor to reach their spawning grounds. It is during this journey that Lindberg theorizes competition for the limited amount of rocky habitat they prefer causes an ecological "bottleneck" in their ability to reproduce.

"Gag place such a premium on finding and staying on habitat that provides shelter from mortality that their densities can cause lower growth rates, which affects subsequent reproductive potential," Lindberg says.

In other words, the more fish crammed onto a reef, the greater the competition for food and the less they will grow. And the less they grow, the fewer babies they will have.

"For grouper, size matters a great deal," Lindberg says. "The number of babies they have is directly proportional to their length."

So the artificial reefs provide a way station, primarily for young females who meet the minimum catch limits, but have not yet reproduced.

"The reef system is intended to enable them to occupy quality shelter at lower densities so they can maximize their growth rates and reproductive potential," Lindberg says.

The reefs also serve as natural laboratories for studying the grouper life cycle and the impact of reef habitats on grouper populations, data that is vital to determining just how many grouper can be fished out of the Gulf of Mexico without causing the species to collapse.

"Artificial reefs have long been popular among recreational fishermen because they increase their catch and create reef fishing sites where there had just been sand bottom," Lindberg says. "But if artificial reefs simply attract fish from elsewhere, making them easier to catch, they don't benefit the grouper population."

Lindberg says this "attraction-production" question has been debated in fisheries management for decades, but became even more important after Congress passed the Sustainable Fisheries Act of 1996, which required the identification and management of essential fish habitat for all federally managed fisheries.

Like so many other fish, demand for grouper has exploded in the last two decades, especially along Florida's west coast. In 2004, west Florida fishers hauled in 7.5 million pounds of gag grouper, up from less than 2 million pounds in 1987.

Historically, fisheries assessments have been based on actual catch as reported by commercial and charter captains, but Lindberg says those numbers can be deceiving.

This so-called "fisheries dependent" data doesn't necessarily take into account what's happening within the grouper population. Only recently, at the urging of scientists like Lindberg, have regulators demanded more "fisheries independent" data of the kind the UF team is gathering.

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— BILL LINDBERG

Lindberg says plugging this data into computer simulations has produced some “pretty scary” scenarios for the grouper fisheries, reminiscent of the collapse of the cod fisheries off New England in the early 1990s.

“Even though the general population may be going down, fishermen can find new spots and maintain their catch,” Lindberg says. “As the simulated fishing fleet becomes more precise, the catch rate actually goes up as the population is falling off a cliff. That’s a really spooky outcome. The implication is that a grouper fishery such as gag may be vulnerable to the same outcomes cod experienced. Figuring out whether or not that’s the reality requires us to have information at a much finer scale of resolution.”

GapResearch

Lindberg has been focusing in on the grouper picture his entire career, using new technologies and techniques to get a better understanding of how fish live and how fishing affects their populations.

“I’ve been scaling-up research projects my whole career,” says Lindberg of the research he began as a doctoral student at Florida State University in the late 1970s. “My dissertation at FSU looked at these questions in a small, model system. But there’s always a question of how such model systems translate to the much broader natural scale. Relevance of ecology on the small scale to management on the large scale requires someone to work in the gaps.”

Since the early 1990s, Lindberg and his team have been filling those gaps by using artificial reefs as experimental treatments to turn the ocean into a natural laboratory.



Zy Biesinger (left) and Doug Marcinek weigh a gag collected for tagging and release.

Between 1991-93 the team constructed the Suwannee Regional Reef System, placing 1,350 one-ton concrete cubes on the ocean floor in a 26-mile-long strip about 20 miles off the coast of Florida’s Levy and Dixie counties.

In the second phase started in 2005 — the Steinhatchee Fisheries Management Area — the researchers placed 1,600 cubes in groups of four as a line of standardized reefs that brackets the Big Bend region of Florida. These are sites for fisheries independent monitoring to aid gag stock assessments, and to evaluate the output of “conservation” reefs to be built in a 100-square-mile triangle about 18 miles west of Steinhatchee, Fla.

Florida has more artificial reefs off of its coast than any other state, but Lindberg says the Steinhatchee reefs are

examples of a new approach for Florida's artificial reef program. In the past, the stated goal of artificial reefs was to enhance fishing success. While that's still true, the Artificial Reef Strategic Plan adopted by the state in 2003 also includes an explicit goal of using artificial reefs as a component of ecosystems management.

"Previously, the coordinates of every permitted artificial reef had to be advertised for easy access by fishers," he says. "Now, if a project's objective is fisheries conservation rather than public fishing, such advertisement is not necessary."



Gag lined up in the shelter of a reef designed for research and fisheries conservation.

The specially designed concrete blocks Lindberg's team uses have holes in them where the grouper can sit to await their prey without having to worry about becoming prey themselves.

Fisheries management is a complex and often contentious process in which federal and state regulators try to balance short- and long-term economic and ecological concerns. Often these regulations result in fewer opportunities to catch less fish, and that invariably leaves people unhappy.

For example, the most recent rules approved by the Gulf of Mexico Fishery Management Council in August prohibit gag grouper fishing during February and March, doubling the current one-month spawning season closure. Recreational anglers can keep only two gag grouper a day, down from five. And commercial fishers face a gag grouper quota, which will be 1.32 million pounds in 2009. The quota on red grouper was increased from 5.31 million pounds to 5.75, but if commercial fishers exceed either quota, all grouper fishing must stop for the year because it's impossible to catch one species without catching the other.

UnderTheSea

"Conducting fish conservation research is like tracking butterflies under 80 feet of water," Lindberg says. "It may be straightforward in concept, but difficult to pull off."

But researchers are able to do things today they couldn't have imagined 20 years ago thanks to technologies like GPS and sonar. These new technologies have enabled researchers to monitor grouper faster, more accurately and more economically.

In an environment where all the landmarks are hidden beneath the waves, Global Positioning System, or GPS, technology has been one of the biggest breakthroughs, Lindberg says.

"In the past we would get in the vicinity of a marker we had put on the seafloor, then do circle searches until we found it," Lindberg says. "Now, with GPS, we can land right on the stake every time. GPS gives us the ability to do more precise positioning of our sampling and mapping of the habitat."

Another new tool is side-scan sonar.

"We don't have the advantage of having aerial photography and satellite imagery like terrestrial ecologists to see the landscape characteristics of the seafloor," Lindberg says. "Twenty years ago we were putting divers in the water to do manual mapping on a very small scale; now we're using hi-resolution, side-scan sonar to collect large amounts of data over a broad area. We're beginning to develop better capabilities for mapping the seafloor in order to get at the questions we need answered."

Lindberg says researchers can "mow the lawn" in 150-meter-wide swaths with the sonar.

"In the past, all we would have is a chart that would show the depth; now we have an actual picture of what the bottom looks like."

In addition to mapping the habitat, new tools allows the researchers to actually track fish as they go about their daily business.

Graduate student Zy Biesinger is using state-of-the-art hydroacoustic telemetry to map how individual fish move about their home range. Receivers placed in the water record data every two seconds from transmitters implanted in fish.



Bill Lindberg records data between research dives.



Kristen Barillet Grace

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— BILL LINDBERG



Every few weeks the researchers retrieve the receivers, bring them back to the laboratory and download data that maps all of the fish’s movements during that period.

Because virtually all of the grouper researchers’ work involves repeated dives to depths from 50 to 80 feet, UF has become one of the few universities in the country to use sophisticated rebreathing technology instead of SCUBA gear.

“For safety, logistical and scientific reasons,

we decided to move from traditional SCUBA to closed-circuit rebreathers,” Lindberg says.

Rebreathers essentially act as second lungs, capturing a diver’s exhaled air, scrubbing out the carbon dioxide and replenishing the spent oxygen. Because gas is not expelled, there are

far fewer fish-scaring bubbles. And, modern systems optimize the breathing gas mix to minimize decompression concerns.

“One day I did 11 dives to 65 feet,” Lindberg says. “That kind of up-and-down diving adds a risk factor, but by going to closed-circuit rebreathers, we’re actually diving a physiologically safer profile.”

And logistically, closed-circuit rebreathers require far less oxygen to be filled and carried on the boat.

“We couldn’t carry enough regular SCUBA bottles to supply our whole team on a typical day,” Lindberg says. “With the rebreathers, we need just a few small tanks. It saves money, time and wear and tear on the crew. The equipment was expensive, but in all respects it was a justifiable investment.”

“We have lots of questions we want to answer, but if you don’t have the logistical and technical skills to extract the data, the questions sit on the shelf,” Lindberg says. “In recent years we’ve been able to integrate technologies into our field operations that were unavailable a decade ago, so we are now able to address some questions that we posed a decade ago but didn’t have the technology to address.”

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Photography by Nigel Smith



Nuts of macambo, a relative of cacao, roasting in a street market in Iquitos, Peru. Roasted macambo nuts may one day be found on supermarket shelves next to peanuts, cashews and macadamia (they taste like a blend of all three).

BY HAYLEY RUTGER

In the rain forests of Peru's remote Pacaya-Samiria National Reserve, mothers don't make kids eat their carrots. Instead, kids munch on aguaje — a crisp, neon-yellow palm fruit covered in maroon scales. It tastes a bit like a carrot, but packs three times the vitamin A punch.

Aguaje is just one of more than a hundred wild and domesticated fruits available to people each year in this 8,000-square-mile chunk of protected Amazon wetland at the confluence of two rivers in northeastern Peru.

And with so much variety and abundance, it's not surprising that these fruits form the centerpiece of the local diet. The reserve's 100,000 residents depend on them for many nutrients — like vitamins, protein and oils — that the rest of us normally get from a variety of other foods, including vegetables and nuts.

Fruits also serve as an important source of income for the residents — especially aguaje. It generates \$4.6 million every year in the markets of Iquitos, the nearest city — more than any other indigenous fruit from the Peruvian Amazon.

While U.S. farmers markets might sell a dozen or two different kinds of fruit in any given week, the Iquitos market boasts nearly 200, with varied tastes, colors, shapes and textures: spiky yellow rinds, crunchy seeds and orange pulp.

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UF GEOGRAPHER NIGEL SMITH
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Fruits of the aguaje palm, known as buriti or miriti in Brazil, are rich in vitamins A and C.

rella Fruits





Açai palm fruits are rich in antioxidants and the fruit pulp now flavors drinks and ice creams the world over. Many other Amazonian fruits are waiting their turn in the global marketplace.



Yumanasa fruits are a welcome treat along rivers in the Amazon.

But outside the Amazon region, their popularity is limited. Although the Amazon has occasionally yielded commercially valuable fruits — such as the antioxidant-rich açai added to gourmet juices and the caffeine-charged guarana used in energy drinks — international markets have yet to plumb most of the bounty of indigenous fruits growing in lush forests along rivers.

Beyond Peru and parts of Brazil, the aguaje's supercarrot possibilities remain largely unknown.

Could that change? One expert thinks it's possible. Outside the Amazon, few know more about this region's wild and cultivated fruits than Nigel Smith. The Venezuelan-born geographer, a professor at the University of Florida, has devoted much of his four-decade career to the Amazon region.

In recent years he's examined just about every aspect of the obscure fruits that blanket Peru's rich floodplain forests: how, where and why they're grown; who consumes them; their nutritional and cultural value; and, of course, how they taste. (The sweet, "sublime" pulp of wild macambillo, a dull orange fruit, is his favorite.)

Whether it's the aguaje or a tangy-sweet relative of the cacao called the cupuaçu or macambo seeds — a crunchy new alternative to peanuts — Smith has studied them all with an eye toward promoting conservation, boosting sustainable farming in a threatened region and supporting local residents' livelihoods.

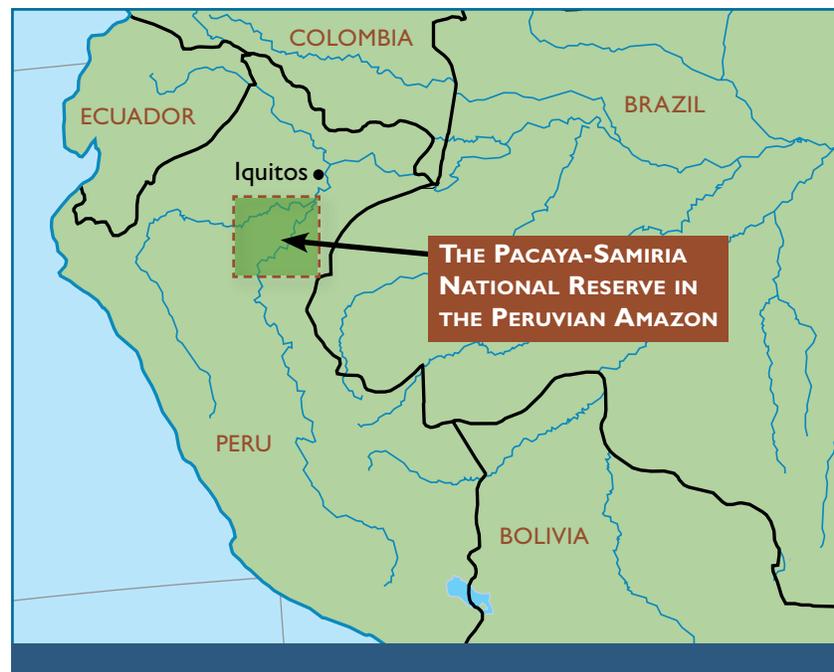
The past three decades have seen unprecedented human migration into the Pacaya-Samiria reserve, part of an area Smith calls the "epicenter of wild-fruit consumption in the Amazon."

Other pressures, like hunting, logging and unsustainable fishing, are on the rise as well. As these pressures grow, Smith believes small farmers hold a key to managing and protecting the region.

With support from the National Geographic Society's Committee for Research and Exploration, the MacArthur Foundation and the Moore Foundation, he and his team, including Peruvian botanist Rodolfo Vazquez, spent six months in Pacaya-Samiria over several years documenting 148 different fruit species.

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— NIGEL SMITH

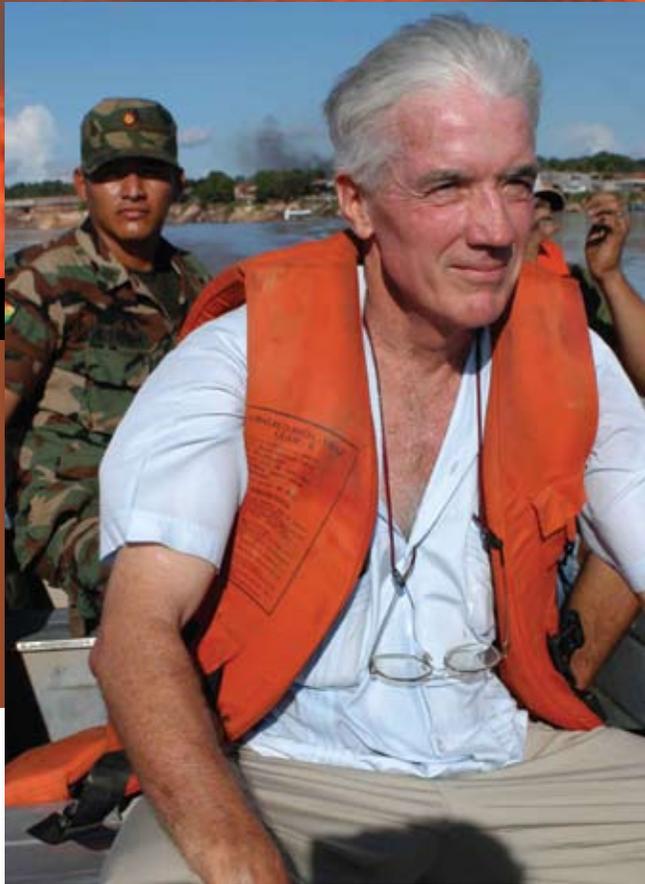
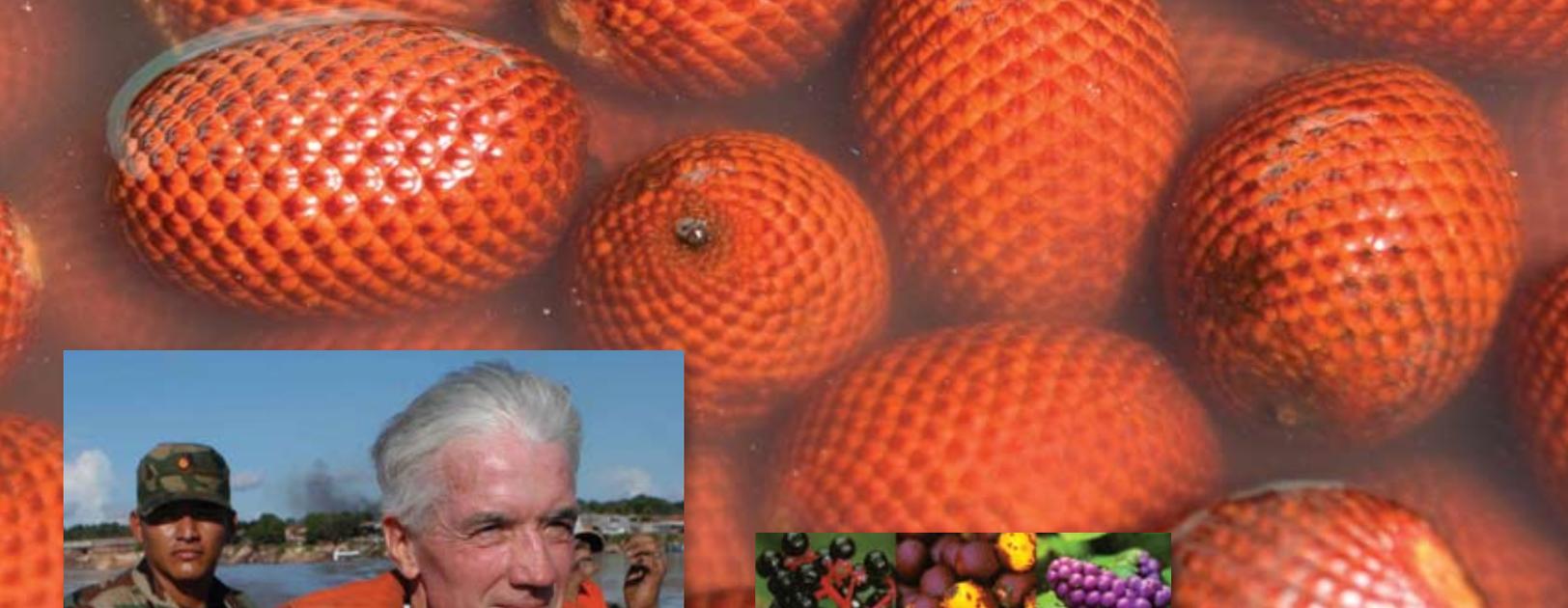


They studied how small landowners in a dozen communities use and depend on these fruits, many of which large-scale farmers ignore.

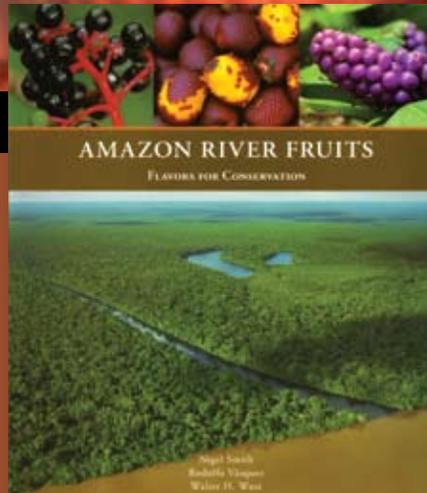
“I'm interested in landscapes where individual landowners are in control,” Smith says. “I think that's the great frontier for Amazon conservation.”

Over the years, he notes, small-scale farmers have helped shape the forests where they pick and cultivate fruits by “rearranging the biological furniture” in ways that encourage biodiversity.

These farmers “have retained a biologically diverse landscape that benefits not only wildlife but also their own livelihoods,” Smith adds.



Nigel Smith — whose research has been supported by the National Geographic Society, the MacArthur Foundation and the Moore Foundation — heads down the Beni River in the Bolivian Amazon in search of new fruits.



Fruits of aguaje palm (above) soaking in order to soften the pulp prior to making juice.

In Amazon River Fruits: Flavors for Conservation, Smith and collaborators Rodolfo Vasquez and Walter H. Wust have produced a comprehensive guide to the region's bounty.

One way Pacaya-Samiria residents have accomplished that is by domesticating potentially valuable wild fruit species, including macambo seeds and vitamin A-rich sapote.

They often plant and grow several at once in diverse forested plots, a strategy known as agroforestry. The combination of crops, both annual and perennial, helps the farmers avert risk.

Should one crop succumb to inclement weather, disease or a pest outbreak, the other crops would likely survive, ensuring that the farmers have both food and income.

But Amazon experts agree that more needs to be done.

So far the Peruvian Amazon has been spared much of the deforestation caused by the timber trade and cattle ranching in Brazil, yet Smith warns that the “floodplains are going to come under increasing development pressure in the next few decades.”

Overharvesting of fruits would threaten trees. And logging is of enormous concern throughout the entire Amazon region, says Douglas C. Daly, an expert on Amazonian botany at the New York Botanical Garden.

That’s one reason Smith’s work is important. “If we can educate people about the wealth of diversity, as opposed to just the wealth of timber, we can change things,” Daly says.

This is where native fruits may come in to play. Some of the Amazon’s little-known produce has flavor, nutrition or novelty to tempt commercial producers abroad, and Smith hopes that growing international awareness of the dietary importance of fruit could help create a new hit.

His knowledge is helping at least one entrepreneur take steps to market bottled water flavored with Amazon fruits. Jeff Moats, CEO of the Equa Water Corporation in Naples, Fla., plans to begin building a factory next year in Brazil’s Amazon region to process fruits local residents can grow sustainably within forests.

But competition from carbonated soft drinks, a \$40-billion industry in the U.S. alone, presents a formidable obstacle to anyone wanting to sell Amazon fruit juices. Entrepreneurs “cannot match the marketing muscle and advertising dollars of the major soda producers,” Smith says.



“THE PRODUCTION OF FRUIT IS VITAL TO THE LIFE OF AN AMAZONIAN PERSON AND IS OF ENORMOUS NUTRITIONAL IMPORTANCE.”

— WALTER WUST
Peruvian Forester

Beyond this, fruit supplies can be erratic, and the Amazon region is still struggling with the basic issues of hygiene, infrastructure and quality control.

So what are the chances you'll someday see vitamin-rich aguaje in your supermarket's produce section alongside carrots, tomatoes and apples?

It's hard to predict, but Smith is encouraged by the example of the once obscure açai, which was enjoyed in Brazil long before becoming a hit in eco- and nutrition-savvy foreign markets.

He also notes the success in Japan of the camu camu, a sour maroon berry with 30 times the vitamin C of oranges. The aguaje might become what he calls a “Cinderella fruit” because it fits some of the criteria that have made these other two fruits successful: It's already popular and abundant locally, easily incorporated into products like juice and relatively simple to transport.

“The production of fruit is vital to the life of an Amazonian person and is of enormous nutritional importance,” emphasizes Walter Wust, a Peruvian forester and environmental journalist who helped Smith document the Pacaya-Samiria fruits.

If Smith has his way, more of that bounty will someday nourish the rest of the world as well. ✕

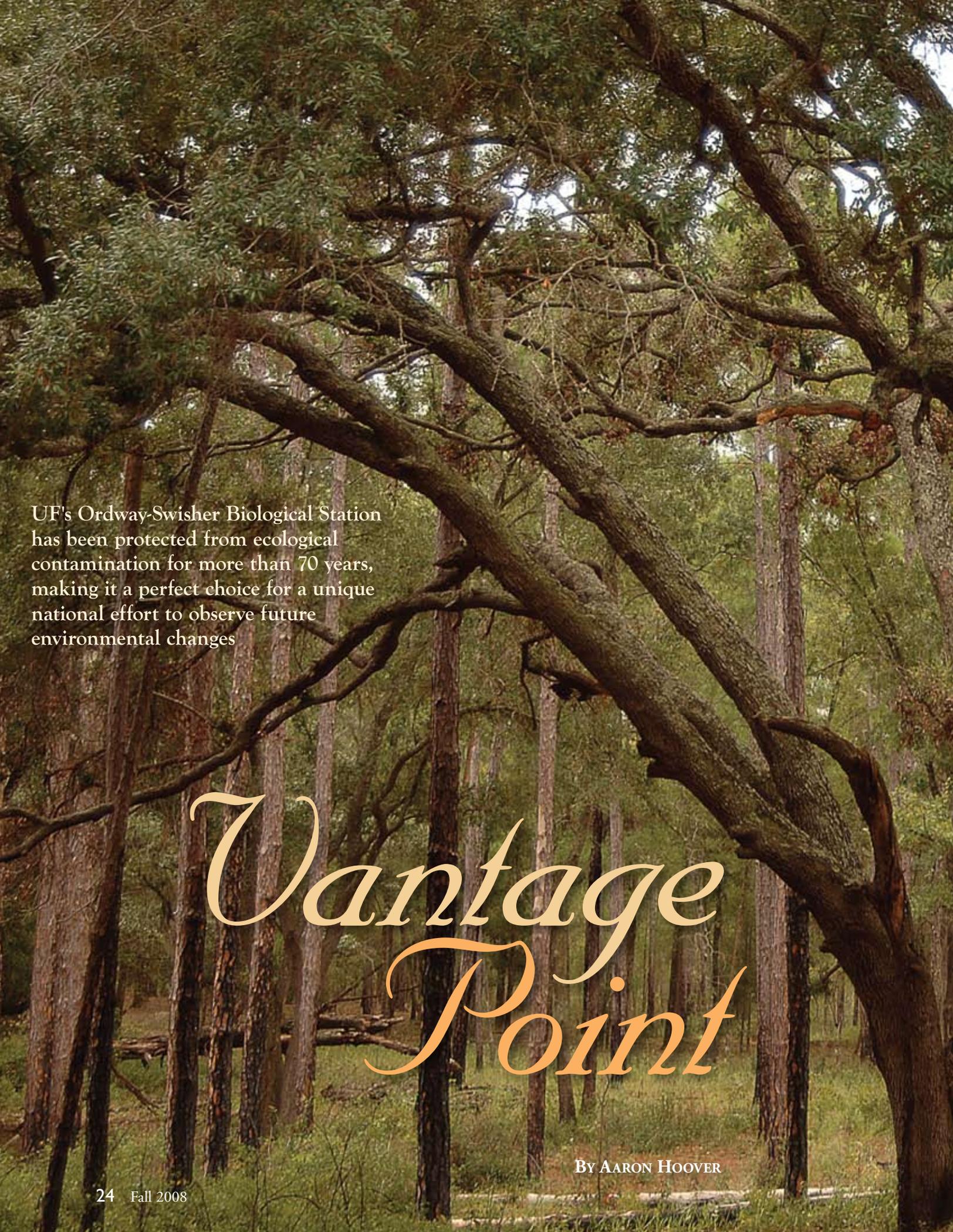
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Removing the pulp from macambo seeds in a street market in Iquitos, Peru.

A photograph of a forest. In the foreground, a large, gnarled tree trunk with thick, dark bark curves across the frame from the left towards the right. The background is filled with many tall, thin, vertical tree trunks, likely pines or cypresses, extending into a dense canopy of green leaves. The lighting is soft, suggesting a slightly overcast day or a shaded forest interior.

UF's Ordway-Swisher Biological Station has been protected from ecological contamination for more than 70 years, making it a perfect choice for a unique national effort to observe future environmental changes

Vantage Point

BY AARON HOOVER



Kristen Bartlett Grace

*H*ydrylla
covers

the lakes, and condos
cover the land — welcome
to Florida circa 2008,
population 18 million.

But, just east of the small north
Florida town of Melrose a dirt road leads
to a different Florida, the one that existed in
the early part of the 20th century.

For researchers at the University of Florida's 9,100-
acre Ordway-Swisher Biological Station there are ...



“Fire is very natural and needed here. The disturbance would be if we took fire out of the system.”

— Stephen Coates



Prescribed burns mimic the natural fire patterns of a pine forest.

... more than 50 lakes and ponds greened only with paspalum grass, bladderwort and other native plants; old pine forests with trees whose gnarly trunks still bear the “cat face” scars of 1930s-era turpentine gatherers; 140 bird, 35 mammal and 26 fish species, including the pearlescent indigo snake and gopher frog; two Native American burial grounds; and the decaying estate of the cigar magnate who fortuitously amassed the land beginning more than 70 years ago as his private fishing and hunting reserve.

Since 1980, the University of Florida has managed Ordway-Swisher as a field research station to be used by scientists studying the flora, fauna and ecosystems of original Florida.

But Ordway-Swisher is due for a major change. As part of a National Science Foundation-sponsored initiative, it will be one of 20 sites in the National Ecological Observatory Network, or NEON. The goal: To put together what one scientist termed a Hubble Space Telescope for the environment — a continental-scale observatory through which ecologists can observe, from coast to coast and in real time, the impacts of global warming, invading species, land development and so on.

Each of the 20 sites lie in different climates. With Ordway-Swisher’s hardwood hammocks, swamps and sand hills, its out-of-the-way setting and lock-down protection, the station was a shoe-in to epitomize the natural Southeast.

“We were looking for locations that are very representative of their areas, and we had always been thinking about Ordway,” says Hank Loescher, a staff scientist at NEON’s home base in Boulder, Colo.

Within the next few years, NEON workers at Ordway-Swisher will build three tall observation towers equipped with a gaggle of sensors and computers. Their purpose: To extend an electronic finger to environmental winds, continuously monitoring thousands of parameters of ecosystem health and quality.

For now, though, Ordway-Swisher remains little changed from when Jacksonville’s Carl Swisher, owner of Swisher Cigars, began buying the pieces of land in the 1930s that make up the station.

Swisher, an avid fisherman and outdoorsman, eventually amassed 25,000 acres. He built a weekend home and clay roads to his favorite fishing lakes. Perched in his Cadillac, Swisher wanted to pass through different scenery heading out and returning from an expedition, so he built two roads to many lakes. He employed a full-time caretaker, Truman Perry, whose jobs included rowing Swisher to his favorite fishing hole in each lake. Although he is retired, Perry still works at Ordway-Swisher, just as he has since 1954.

After Carl Swisher died, his family gradually sold off pieces of the land. But in 1979, the family’s Swisher Foundation donated 3,000 acres to The Nature Conservancy. A year later, the private Goodhill Foundation gave a grant to UF to buy a second, contiguous 6,000 acres from the Swisher Foundation. That land was preserved in the name of Katherine Ordway, a



Veterinary doctoral candidate LeAnn White is studying gopher tortoise nutrition and health.



Christine W. Miller

Entomologist Christine Miller and her students study the ecology of cactus bugs.

3M Corporation heiress who bequeathed more than \$40 million through Goodhill to support efforts to protect biologically diverse landscapes in the United States.

Although scientists and students have had access to both parcels since 1980, the full station only became official in August when The Nature Conservancy formally donated the Carl Swisher Memorial Sanctuary to the university.

Real estate experts place the value of the 3,000-acre Swisher tract at \$11 million, but as UF President Bernie Machen said at a ceremony marking the donation, Ordway-Swisher's "natural value is difficult to put a price on."

"The Conservancy's transfer of 3,000 acres to the Ordway-Swisher Biological Station is an important milestone in the ongoing work at this outstanding conservation site," says Jeff Danter, Florida state director of The Nature Conservancy. "Equally important to protecting this site is developing the next generation of conservation scientists and managers who will help make Florida and the world a more sustainable place for us all."

Machen calls the station "a precious rarity that makes it the perfect laboratory for measuring the effects of environmental change."

A ride around the property with Ordway-Swisher research coordinator Stephen Coates in his green Ford pickup makes that clear.

Heading into the station, the single-lane dirt roads passes Ross Lake, one of the property's bigger lakes. Ross' tannin-stained waters typify Ordway-Swisher's surface water-fed,

nutrient-rich lakes. Native plants green its shores and shallow zones, and alligators, otters and largemouth bass abound. Ross and Ordway-Swisher's other lakes owe their hydrilla- and water-hyacinth-free waters to one of the station's many rules of self-preservation: Only boats kept there permanently are allowed in Ordway's waters.

From Ross Lake, the road climbs through hills interspersed with longleaf pine from the grass stage to 80- to 100-year-old giants stretching high into the sky. Pale yellow wiregrass carpets the ground beneath them. Such land is prized by developers because it is high, dry and easily drained. As a result, although longleaf pine once blanketed an estimated 90 million acres across the Southeast, fewer than four million acres remain today.

"What you are seeing here," Coates says, "is old Florida. This is what it looked like."

Threatened gopher tortoises and gopher frogs, which make their homes in the tortoises' burrows, live in the longleaf forest. So do impressively large Sherman fox squirrels, uncommonly common at Ordway-Swisher, says Coates. Rafters of notoriously shy wild turkeys stroll fearlessly through the woods and white-tail deer are common sights.

Also common are reminders of the seasonal burns Coates and his colleagues conduct, deliberately setting in motion a natural process that keeps hardwood seedlings from maturing and edging out the pine forest and its wildlife.

"Fire is very natural and needed here," he says. "The disturbance would be if we took fire *out* of the system."

“We want to enable ecological forecasting — where infectious disease will spread, or where invasive species will spread. We also want to project regional water use, carbon balance and what may happen to species with a changing environment across time and space scales.”

— Hank Loescher



Kristen Barlett Grace

The road swings by a declivity where rains create a temporary pond, providing frogs and amphibians key breeding conditions — a wet spot with no fish to eat larvae or tadpoles, Coates says. Eventually his truck finds its way to Lake Barco. Contrasting Ross Lake, the nutrient-poor Barco is gin clear, with no submerged plants or alligators and only the leanest of fish.

Ordway-Swisher contains other typical Southeastern habitat as well. On its western side broods a large, dark cypress swamp. There are hardwood hammocks, sandhill upland lakes and a majestic Florida prairie.

The station’s high state of ecological preservation is the main draw for biologists, ecologists and others who spend anywhere from an afternoon to weeks or months on projects there.

This past summer, one scientist studied the population ecology of greater sirens and two-toed amphiumas, both large aquatic salamanders. Another surveyed native bees. A third examined sexual selection in large, colorful, but harmless, golden orb spiders. All told, the station hosts on average 25 projects at any given time.

According to John Hayes, chair of UF’s Department of Wildlife Ecology and Conservation, 58 UF graduate projects — 33 master’s degree and 25 doctoral degree — have been conducted at the station since 1982. About 220 research publications and reports have been generated from university, state, federal and private research studies at the station. Hayes describes Ordway’s lakes as especially valuable for researchers.

“Ordway-Swisher is not pristine. Nothing in Florida is pristine. But it is in very, very good ecological condition,” he says. “The lakes are exceptionally pristine and they really provide an ecological baseline for aquatic systems in the state of Florida.”

Hayes adds Ordway-Swisher is already on a path to becoming a “globally significant research and education site.” NEON will only accelerate that transition.

Like other scientists, ecologists routinely work together, but they have never collaborated on the scale of physicists, with their mammoth particle accelerators; oceanographers, with their ocean research vessels and deep-water submersibles; and astronomers, with their multimillion-dollar telescopes, says Loescher, the NEON staff scientist.

Aware of the gap, a group of ecologists began pursuing the project that became NEON well over a decade ago, Loescher says. The group submitted the most recent formal proposal to the National Science Foundation in 2006. The federal government allocated \$25 million this year for planning and development, he says.

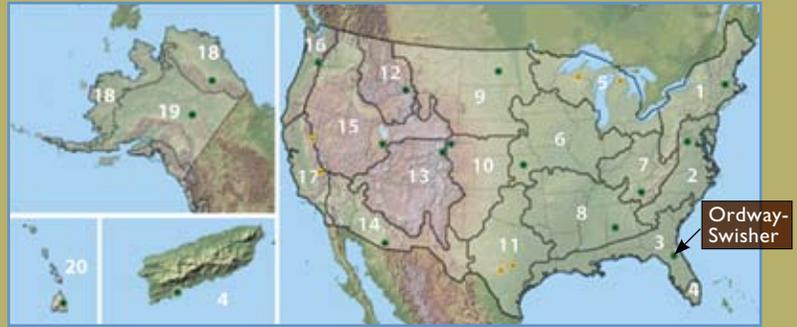
Just as physicists turn to particle accelerators to study the nature of matter, so NEON scientists have targets: “Continental scale” research transects where instruments will measure how the environment is responding to climate change, land development, forest management, the growing use of biofuels and invasive species and infectious diseases.

Key to each are the automated observation towers.



neon

NATIONAL ECOLOGICAL OBSERVATORY NETWORK



NEON CLIMATE DOMAINS

The observatory partitions the United States into 20 ecoclimatic domains using a statistical analysis of ecoclimatic state variables and wind vectors.

Each domain will host a core site consisting of a fully instrumented wildland landscape located in a small watershed, and the mobile capacity to record additional data in other parts of the domain.

For more information, visit www.neoninc.org

Loescher, who is in charge of NEON’s instrumentation efforts, says each site will likely have three towers equipped with a vast array of sensors and monitors. The sites will also have at least two aquatic arrays — underwater “towers” immersed in lakes or streams — as well as several below-ground soil monitors.

All told, Loescher says, the sensors and monitors will collect terabytes of data from at least 2,000 sources. Some are as mundane as temperature and humidity, others as exotic as real-time stable isotopes, below-ground carbon dioxide and integrated water vapor. NEON will also have portable towers that can be relocated for special projects, such as gauging the environmental effects of hurricanes. Additionally, NEON scientists will have access to airplanes and satellite sweeps.

Coates says Ordway-Swisher already has years of baseline data garnered from throughout the property. Water levels and water quality are checked monthly on all the lakes. An extensive inventory of the flora and fauna has been maintained for years.

The information has been gathered by on-site biologists like Coates and students in countless classes. In September, for example, a mammalogy class spent several nights trapping and recording critters in the forest. They camped at one of the station’s two campgrounds, equipped paradoxically with Wi-Fi.

And while that same connectivity will be a conduit for some of the NEON data, project scientists will also rely on “the sneaker net,” in Loescher’s words. To coordinate, NEON

will bring in several new full-time employees, including at least two managers, an education and outreach coordinator and technicians. Loescher says NEON expects to develop a first test site near its Boulder headquarters in the next two years. Starting in 2012, the organization will likely develop two sites annually. None are scheduled yet, but Loescher suggested Ordway-Swisher may well be one of the first.

“Your guys are ready to go. You understand what NEON is,” he says.

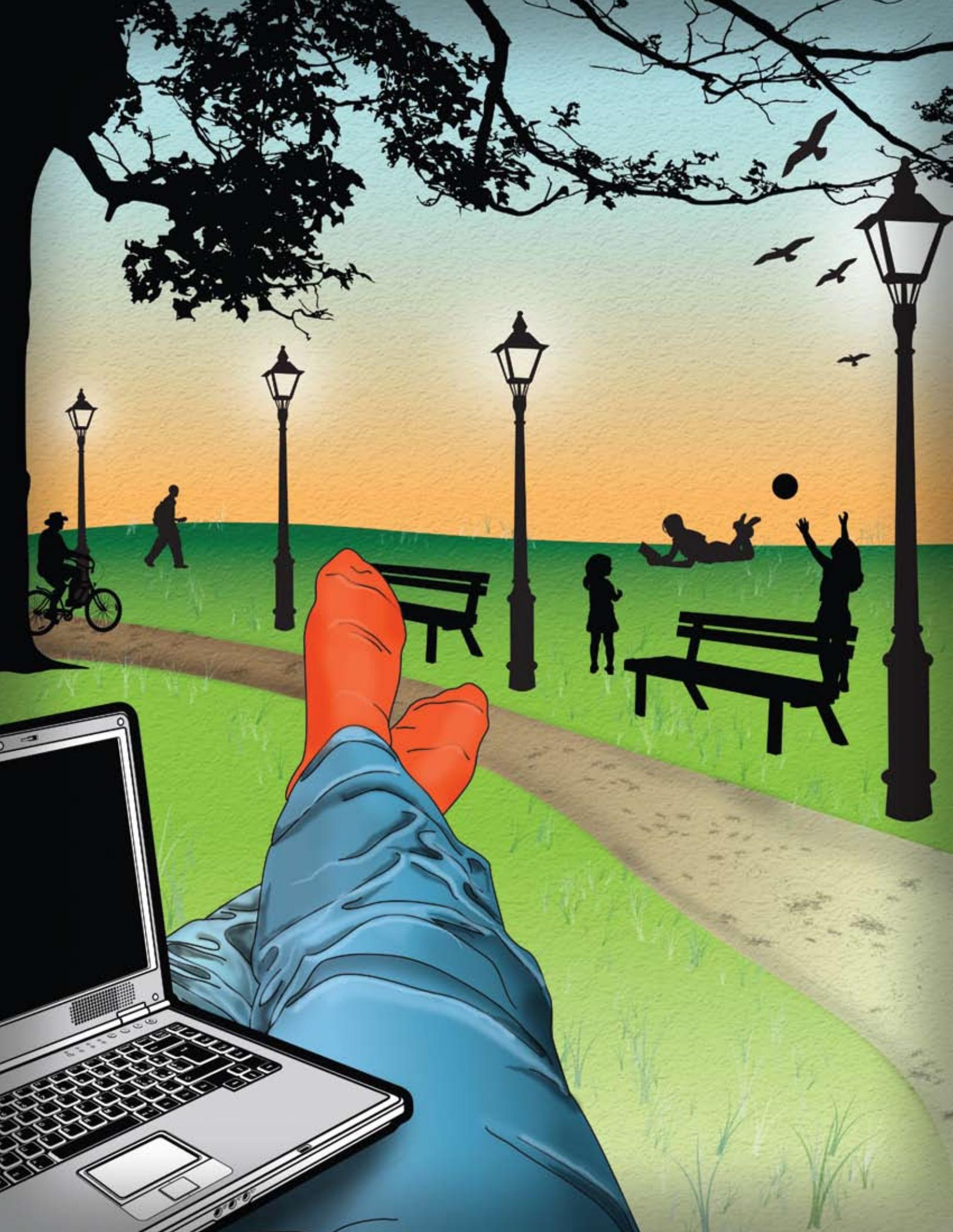
Whenever it occurs, NEON can hardly come too soon.

Loescher notes that the National Weather System decades ago built a national system of identically calibrated thermometers, barometers and anemometers so that it could more accurately forecast the weather. Today, he says, climate change is a gathering force, but scientists have no uniform metric to compare the northward migration of animals and plants, population die-offs or other changes or to predict what might happen down the road.

“We want to enable ecological forecasting — where infectious disease will spread, or where invasive species will spread,” he says. “We also want to project regional water use, carbon balance and what may happen to species with a changing environment across time and space scales.”

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SCHOOLS WITHOUT WALLS

BY TIM LOCKETTE

EDUCATION PROFESSOR RICK FERDIG SEEKS TO UNDERSTAND THE IMPACT OF VIRTUAL ENVIRONMENTS ON GAMING AND EDUCATION

If you grew up geeky in the 1980s, Rick Ferdig's workplace may closely resemble your idea of heaven. Here in the Educational Technology lab in the basement of Norman Hall, you'll find rows of Macintosh computers where, every summer, middle-school kids design their own video games. A 4-foot-tall stuffed Sonic the Hedgehog lounges on a well-worn sofa near a rack filled with *Wired*, *GamePro* and other computer-oriented magazines. In a side room, you'll find a row of PlayStations, set up for a Tecmo Bowl tournament. It's a Gen-Xer's idea of an after-school paradise.

Your grandmother might not approve, but there is a method to all this computer madness. Ferdig, a 35-year-old associate professor in UF's College of Education, is at the vanguard of a new generation of scholars who understand that video games just might be good for you. Rather than rotting kids' brains, those "wasted" hours in front of a glowing screen may actually have helped build better problem-solving skills, or so the new theory goes. And Ferdig is literally taking that idea

to school, exploring the ways video games — real, *fun* video games — can help teachers get their ideas across.

"Computers have been in the classroom for a couple of decades," he says. "But we're just now beginning to understand how to really use them."

Ferdig is the editor of the *Handbook of Research on Effective Electronic Gaming in Education*, the first-ever comprehensive compilation of research on what has become a hot topic: the educational benefits of video games. Drawing on research from 150 authors in 15 countries, the 1,759-page, three-volume collection goes far beyond the old "skill-and-drill" approach that characterized early efforts at educational computing — efforts like Oregon Trail and Reader Rabbit — and asks deeper questions about the games people play. Why do some kids struggle to learn their ABCs but have no problem memorizing the names of characters in Pokemon? How can we make educational games with the appeal and addictive power of Super Mario? Better yet, how can we turn existing games into teaching tools?

“People are beginning to realize that when kids disappear into an online world, they’re learning at an amazing rate,” he says. “But most of us don’t realize that they’re also developing self-confidence and identity, and maybe even trying a new job.”

Ferdig has been conducting in-depth research on the psychology of video gaming for most of his life, though for much of that time he didn’t know it was research. As a kid in Holland, Mich., he whiled away the snow days in front of a video console. As a graduate student at Michigan State University and later as a visiting scholar at WSP Teacher Training College in Krakow, Poland, he would study and teach educational psychology by day, then spend his nights blasting his colleagues to smithereens in networked games of Doom and Duke Nukem.

One of Ferdig’s friends suggested his gaming might be, well, unhealthy. It might have been meant as a warning, but Ferdig and his gaming buddies took the question more philosophically.

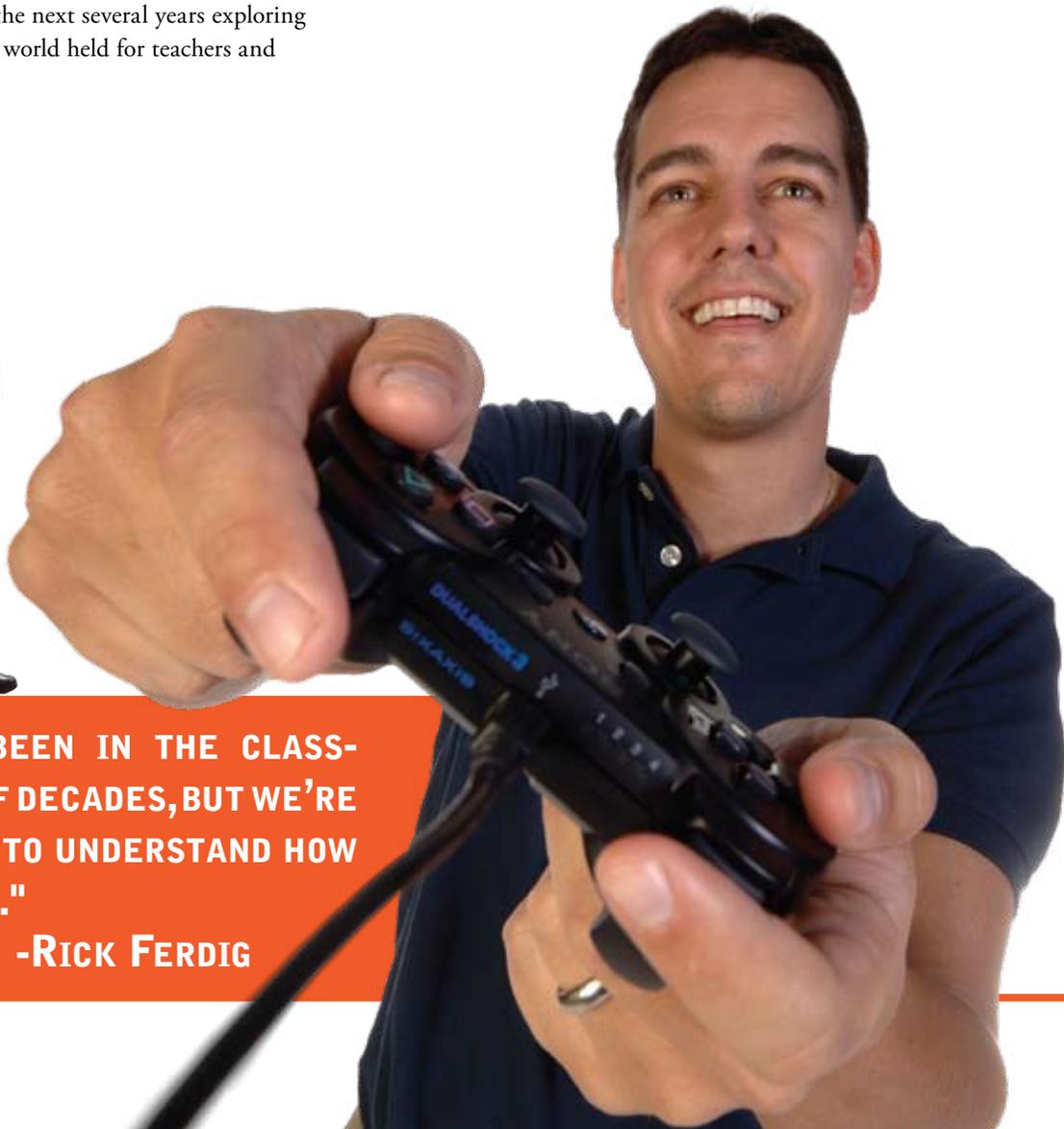
“We started this in-depth conversation about what we were accomplishing by doing this,” Ferdig says.

For Ferdig, that conversation grew, and is still growing. Applying his background in educational psychology to the evolving Internet, Ferdig spent the next several years exploring the implications the new online world held for teachers and students.

Pioneering though it is, gaming is not Ferdig’s only avenue of research, or even his best known. As the principal investigator on a \$600,000 grant from the AT&T Foundation, Ferdig is heading the first comprehensive assessment of practices in the nation’s growing number of virtual K-12 schools.

More than a decade has passed since states across the U.S. began investing in “distance education” programs for K-12 students — programs that would use the Internet to allow students anywhere to take courses from teachers qualified in hard-to-find subjects such as Latin, macroeconomics or Advanced Placement physics. The boom in online learning has opened new academic doors to home-schooled kids and students in rural areas, but there is little data to show whether the rising tide has lifted all boats.

“In most virtual schools, the final grades are sent to the schools and are stored and tracked by the schools,” Ferdig says. “Most states haven’t done a detailed analysis of which courses are really effective in producing learning gains, or which techniques are working.”



"COMPUTERS HAVE BEEN IN THE CLASSROOM FOR A COUPLE OF DECADES, BUT WE'RE JUST NOW BEGINNING TO UNDERSTAND HOW TO REALLY USE THEM."

-RICK FERDIG

"IT WAS REALLY EASY TO LEARN BECAUSE I GOT TO DO IT AT MY OWN PACE. I COULD WORK OUT ON MY TREADMILL, UNDER THE FAN, WITH MY MUSIC ON."

-ALEX BROWN

Ferdig isn't accusing the virtual schools of selling "silicon snake oil." There's already research to show that, in general, online students learn just as much or more than students in traditional classrooms. What's lacking in virtual high schools, however, is a detailed look at who is learning, how much, and why.

"Florida, for instance, may know that its online students generally do well on standardized tests," Ferdig says. "But does virtual schooling work as well for students in Miami as it does for students in Gainesville? And if it doesn't, why not? That's what teachers really want to know, and that's the kind of data we're collecting."

The project reaches well beyond Florida, however. In all, 22 states are participating, offering Ferdig data on millions of students. And Ferdig is looking at more than just grades and lesson plans. The most important elements in online learners' success, he says, may not be the things you see on the computer screen.

"Learning online takes more than a teacher, a student and a couple of computers," Ferdig says. "We're very interested in the support the students receive. How much help do they get from parents, and from mentor teachers in their schools? Do administrators understand the role of virtual schooling, and how does their understanding affect the results their students have in online courses?"

Alex Brown, a 17-year-old senior at Santa Fe High School, has taken two virtual classes and knows what is necessary to succeed in them. Brown took Personal Fitness and Life Management Skills through Florida Virtual School, a 90-course virtual school that served 60,000 K-12 students in the '07-'08 school year. She received an A in both classes.

"My teacher was really nice and helpful," Alex says. "It was really easy to learn because I got to do it at my own pace. I could work out on my treadmill, under the fan, with my music on."

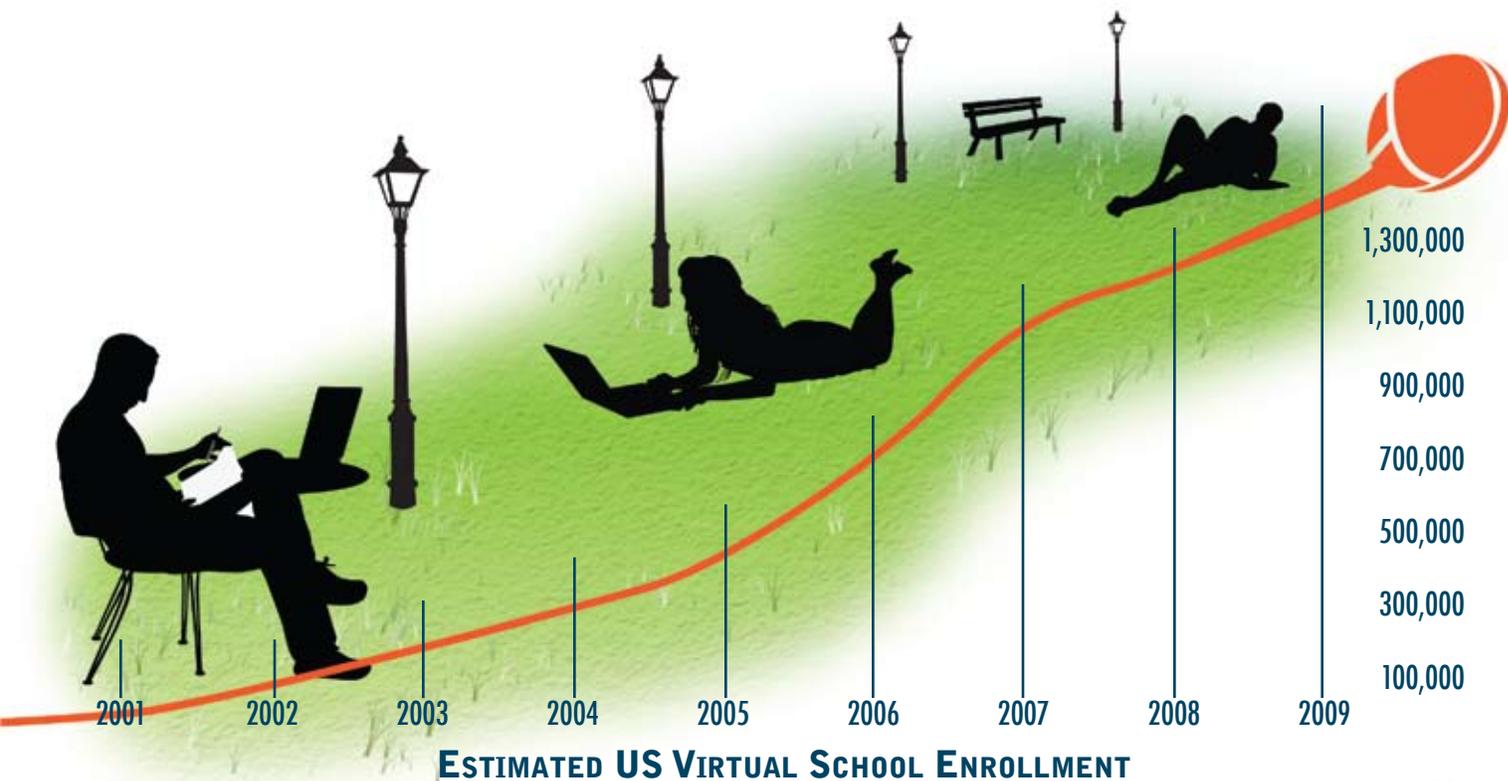
Alex would study modules online and converse with fellow classmates in message boards. She also would speak to her instructor on the phone to discuss that week's topic.

"I liked the setup a lot," she says. "It was easy to express yourself and work on your own schedule."

That's an aspect Alex's mother, Chris Brown, liked as well.

"The teacher was available throughout the day," Brown says. "I could talk to her about how Alex was doing whenever I needed to."

Alex had to exercise regularly and record her activities in a work log. Brown would then sign off that the log was accurate.



It was never a problem making sure Alex did the work, Chris Brown says.

“I think the flexibility was key. She would have had to drop anatomy or art, which she really loved,” if the classes hadn’t been available online.

Chris Brown acknowledged that engaged parents are essential to virtual schooling, though.

“A student without an involved parent could make the work logs up.”

While many virtual school teachers have successfully made the transition from the classroom, as the program grows Ferdig worries that there won’t be enough technically savvy instructors. That’s why Ferdig is working with colleagues at UF and bucking tradition by piloting the nation’s first online teaching internship.

“The old adage was that you needed to have three to five years of classroom experience in order to excel in an online teaching environment,” Ferdig says. “But it’s really kind of hard to see why that face-to-face teaching requirement is in place.”

In the traditional classroom, Ferdig notes, an expert teacher is one who can diagram sentences or do long division while monitoring 15 to 30 kids in a single room. Anyone who has tried that can tell you that it takes a special talent, and most teachers look unfavorably on any teacher preparation program that doesn’t require its students to get some experience in the classroom.

Teaching online requires special talents, too, but not necessarily the ones you need in a face-to-face classroom, Ferdig says.

“Online, I don’t have to worry about whether Johnny is throwing paper at Sarah, or Sarah is sticking gum under her chair,” Ferdig says. “But I do have to worry about a number of other things — like creating community among students who can’t see each other and moderating discussions online.”

In cooperation with the Florida Virtual School (the nation’s largest virtual K-12 school), Ferdig recently supervised a group of education majors in an on-the-job training experience that had them looking over the shoulders of the state’s best online teachers, all without leaving Ferdig’s lab in the basement of historic Norman Hall.

The virtual internship may go against the grain of the teaching profession, but it’s just one example of Ferdig’s outside-the-box approach to education and technology. For another, just follow Ferdig on one of his trips to Rwanda, where he is helping school officials come up with ways to bring 21st-century educational technology to schools that sometimes can’t even afford pencils and paper.

“Rwanda is probably the last place most Americans would expect kids to be using computers in schools,” Ferdig says. “After all, we’re talking about a place where students sometimes have to practice writing in the dirt because they can’t afford school supplies. But they’re ready.”

Known to most of the world for the brutal civil war it endured in the 1990s, Rwanda is looking for ways to start over, rebuild and attract foreign investment. As in many African countries, Rwanda’s educators have big dreams for public education, but they lack the infrastructure to make those dreams a reality.

"ONLINE, I DON'T HAVE TO WORRY ABOUT WHETHER JOHNNY IS THROWING PAPER AT SARAH, OR SARAH IS STICKING GUM UNDER HER CHAIR, BUT I DO HAVE TO WORRY ABOUT A NUMBER OF OTHER THINGS — LIKE CREATING COMMUNITY AMONG STUDENTS WHO CAN'T SEE EACH OTHER AND MODERATING DISCUSSIONS ONLINE."

-RICK FERDIG



**"IF KIDS AREN'T CREATING SOMETHING,
THEY AREN'T LEARNING."**



But the Rwandans see their under-resourced schools as clean slates, ready to be converted into 21st-century wired classrooms. Provided, of course, that someone finds computers they can afford.

Ferdig, whose travel was funded by UF's Center for African Studies, has been looking for ways to use handheld computers to meet those needs. While people in the United States use PDAs mostly as portable address books, the tiny devices have far more computing power than the Apple IIe computers American schools were using in Ferdig's high school years. PDAs are easily transported from school to school, and unlike the famed "\$100 laptop," they're readily available right now.

Ferdig is also looking for ways to introduce software that meets the Rwandans where they live. Too often, when educational books or computer games make their way to crowded African cities and remote rural villages, they're hand-me-downs from the West, depicting suburban environments that are alien to many Africans. Ferdig is looking for ways to Africanize the content of the educational software the Rwandans use in the future.

While Rwanda may seem worlds away from his lab in Gainesville, Ferdig sees a common theme in all of his work in educational technology. Whether you're bringing handheld computers to Africa or setting up a virtual high school in the U.S., he says, educational computing is about more than devices with bells and whistles. The computer works as an educational tool because it gives kids a chance to use their knowledge to create new things — and the power to show those creations to the public.

"If kids aren't creating something," he says. "They aren't learning." ✕

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**RWANDANS SEE THEIR UNDER-
RESOURCED SCHOOLS AS CLEAN
SLATES, READY TO BE CONVERTED
INTO 21ST CENTURY WIRED
CLASSROOMS.**



Under the dome of the Kika Silva Pla Planetarium at Santa Fe College in Gainesville, Susan Milbrath compares the Codex Borgia eclipse image with a planetarium projection of the solar eclipse in August 1496.

Codex Mōmicēnt

SUSAN MILBRATH COMBINES ART AND ASTRONOMY TO UNRAVEL A 500-YEAR-OLD MYSTERY ABOUT AN ANCIENT MEXICAN ARTIFACT

BY DELENE BEELAND



Half a millennium ago, a farmer in central Mexico was tending his crops when suddenly the summer heat beating down on him lessened. He looked to the sky, expecting storm clouds. But what he saw filled him with fear and wonder. The sun's familiar disk was disfigured, as if something was swallowing it.

Day gave way to night and a new light shone brightly — Venus. The farmer's mind raced, confused. To his people, Venus was an important god who traveled in a carefully measured way between the heavens and the underworld, and at this time of day he was supposed to be in the underworld.

He dropped to his knees in awe. Venus — resurrected from the underworld — was attacking the sun!

Ancient people all across central Mexico witnessed this epic sky battle. In fact, the event made such a deep impression that the Aztecs later told their Spanish conquerors it was the single-most important eclipse event during their reign, which spanned nearly 200 years from 1325 to 1519.

It was so important that the farmer's people recorded it for posterity in an elaborate book. For centuries, that book —

known as the Codex Borgia — has fascinated and frustrated scholars like Susan Milbrath, a curator of Latin American art and archaeology at UF's Florida Museum of Natural History.

A codex is a painted manuscript, made in pre-Conquest Mexico of bark paper or plaster-coated deerskin with pages that connect end-to-end, like a folding screen. Scholars say that most codices are similar to farmer's almanacs, and were likely used for tracking seasonal cycles, agricultural festivals and religious rituals.

The Codex Borgia is unique because it is one of the few codices from central Mexico known to have survived the Spaniards' massive book burnings and destruction. But it is also enigmatic. Though most of its 76 pages of pictographs and glyphs have been decoded, the middle section from page 29 to page 46 has defied logical explanation ever since the codex was rediscovered in Rome in 1805 among the possessions of Roman Catholic Cardinal Stefano Borgia and acquired by the Vatican.

"Everybody recognizes that it is a unique narrative sequence," Milbrath says, flipping through a life-size replica of the 11-inch-

by-11-inch codex. “That is why it has been difficult to interpret. There is simply no other codex to compare it to.”

But now Milbrath — an archaeoastronomer who studies astronomical imagery embedded in archaeological artifacts — thinks she has solved the riddle of the Codex Borgia.

MISSING PIECES

At first glance, the Codex Borgia is a visual delight. Reds, greens, blues and oranges leap off the centuries-old pages. Beautiful and grotesque expressions adorn humans and gods who appear to be characters in a narrated story. Elaborate and colorful counting systems frame certain pages, documenting time. Even the untrained eye can immediately appreciate that only a sophisticated culture with a complex belief system could have created such an inventive work. But which culture and when?

Milbrath has been fascinated with the Codex Borgia for most of her professional life. In 1989 she published a chapter in an academic book, “Imagination of Matter: Religion and Ecology in Mesoamerican Traditions,” suggesting that pages 29 to 46 documented real seasonal and astronomical cycles within their intricate imagery.

“At that time, I suggested that we were looking at a year sequence,” Milbrath says, “and that Venus was very important in the imagery, and that the people who created it were tracking a Venus cycle over the course of a solar year.”

Milbrath sought to link that Venus imagery to the planet’s known astronomical cycles, but at the time she was missing two key elements: the time frame the codex documented, and which central Mexican culture had made it.

These pieces of the puzzle were necessary in order to search data for what the night sky would have looked like at a certain point in time, from a certain vantage point on Earth. Back then, scholars disputed which central Mexican culture had produced it. And though they knew it was created before the Spanish Conquest, they weren’t sure of the exact years it was meant to represent.

In the intervening decades, new evidence has mostly settled these questions. In 1991-1992, a team of archaeologists working in Ocotelolco — in the state of Tlaxcala, Mexico — uncovered murals containing artwork identical to the Codex

Borgia. Even better, they were dated to the same pre-Conquest time period as the codex.

“I think the murals provide irrefutable evidence that the Codex Borgia originated in Tlaxcala,” Milbrath says. She visited the murals in 1993 and said she was immediately convinced that the same people who had produced them had also painted the Codex Borgia. She said that most scholars today agree on this point.

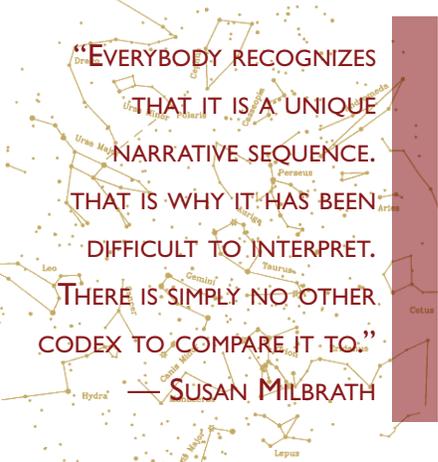
Historically, the Tlaxcala nation-state was surrounded by the Aztec Empire. The Tlaxcala endured periodic raids by Aztecs who captured their warriors and dragged them to Mexico City for ritual sacrifice, which they believed would relieve famine. The Tlaxcala and Aztecs shared the same nahuatl language and used similar calendars for agricultural festivals and cycles of religious rituals, but the neighboring groups held starkly different beliefs, Milbrath says.

When the Spanish arrived, the Tlaxcalans struck an alliance with the invading Europeans. The Spanish burned and sacked the Aztec empire, but left the Tlaxcala unmolested. It was this alliance that ultimately led to the Codex Borgia surviving the Spanish Conquest, whereas Aztec codices did not.

While Tlaxcala gave Milbrath a place and a cultural context for her theory, it wasn’t until 1999 that a leading scholar identified the time frame the Codex Borgia represented. Tony Aveni — an astronomer and anthropologist from Colgate University who is considered a founder of Mesoamerican archaeoastronomy — determined that the manuscript documented the 52 years between 1467 and 1519.

The new, widely accepted contextual information — a time frame and a location — gave Milbrath the missing data needed to revisit the Borgia’s cryptic meaning.

Careful examination of the glyphs and images in the Codex Borgia — and Milbrath’s years of work with Mayan codices — led her to believe each of the 18 pages in the narrative sequence corresponded to one of the 18 festival periods the Tlaxcalans and the Aztecs used to track their solar years. These ancient cultures had an agricultural calendar called the “xihuitl” that was based on 18 “months” of 20 days, with each month corresponding to a festival.



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— SUSAN MILBRATH





CAREFUL EXAMINATION OF THE GLYPHS AND IMAGES IN THE CODEX BORGIA — AND MILBRATH'S YEARS OF WORK WITH MAYAN CODICES — LED HER TO BELIEVE EACH OF THE 18 PAGES IN THE NARRATIVE SEQUENCE CORRESPONDED TO ONE OF THE 18 FESTIVAL PERIODS THE TLAXCALANS AND THE AZTECS USED TO TRACK THEIR SOLAR YEARS.



Eric Zamora



“NO ONE HAD EVER INTERPRETED THIS PAGE AS AN ECLIPSE EVENT. BUT THEN IT BECAME QUITE CLEAR ... THEY WERE TELLING US THAT VENUS BECAME VISIBLE DURING THE ECLIPSE EVENT, DURING THE DAY, AT A TIME WHEN ... VENUS HAD ALREADY MOVED INTO THE DARKNESS OF THE UNDERWORLD.”

— SUSAN MILBRATH

VENUS RISING

Venus is an easy target to spot. The planet shines so brightly in the night sky that it is clearly visible to the naked eye. From Earth, Venus seems to disappear from the sky when it passes in front of or behind the sun, and these two phases of seeming invisibility are known to modern astronomers as inferior and superior conjunction. But the ancients would not have known this. In their cosmology, Venus passed from the sky to the underworld and back.

Venus was very important to the Aztecs and Tlaxcalans alike, Milbrath says, and scholars know from multiple lines of evidence that its astronomical cycle was often shown pictorially as a male Venus god acting out different scenes.

When the ancient Tlaxcalan's depicted Venus's absence from the sky, they showed him in a skeletal form, undergoing death, and passing into an underworld. When Venus reemerged in the morning or evening sky, the god emerged from the underworld, refreshed and alive once again.

Using these accepted interpretations of the Venus cycle, Milbrath carefully tracked the astronomical imagery on pages 29 through 46, mapping them under her hypothesis that each page represented one “month” in the Tlaxcala solar calendar. She was particularly intrigued by the imagery on page 40, which depicted nine different incarnations of a Venus god in the sky around a ray-studded disk cut by red wedges that spurted blood. Milbrath remembered seeing a similar depiction on a later Aztec codex showing a series of eclipses.

“There it was all this time, and we just didn't know what it meant,” Milbrath says. “No one had ever interpreted this page as an eclipse event. But then it became quite clear ... they were telling us that Venus became visible during the eclipse event, during the day, at a time when ... Venus had already moved into the darkness of the underworld.”

Milbrath next designed a test for determining exactly which year the 18-page sequence documented. She created a list of six astronomical events she'd identified in the codex: the solar eclipse and various transitions in Venus's cycle. She arranged these in a rough chronology based on the premise that each page in the sequence represented a month and then compared this chronology of events against astronomical data spanning from 1350 to 1521, but paying special attention to the years within Aveni's 52-year time frame of 1467 to 1519. She needed to find one year within this framework where the historical astronomical data matched the rough chronology of astronomical events she'd extracted from the Codex Borgia.

The Tlaxcalans started their calendars during the month of the winter solstice, so Milbrath used this as a starting point to test key years known to contain solar eclipses. Only one year matched the eclipse event's chronology precisely. Beginning the 18-page calendrical sequence of the Borgia in the month of the winter solstice of 1495 led the August 8th eclipse of 1496 to land squarely on page 40, which contained the eclipse imagery Milbrath had decoded. The intervals of the Venus cycle within the year 1496 also matched the pictorial transformations of the Venus god depicted in Borgia's chronological imagery.

Her results strongly suggest that the most cryptic section of the Codex Borgia is a pre-Conquest month-by-month documentation of the year during which the most important solar eclipse of the era is known to have occurred.

"It's an elegant solution because it's simply so logical," Milbrath says, reflecting on the strength of her findings. "Page 40 was the key. No one had previously interpreted it as an eclipse."

Only time will tell if scholars will embrace this newest interpretation. But Aveni, the esteemed Mesoamerican archaeoastronomer, has already given it his stamp of approval.

"I have great respect for Susan Milbrath's work," Aveni said in an e-mail. "Her interpretation of B29-46 appeals to me for two reasons. First it is a real-time study, which I believe is the proper framework for many of the almanacs and tables in the codices. Second, it works. The Venus/eclipse references fit the iconographic/calendrical data. Will it hold up? Who can really answer that one? I think it's solid work. She has thought about, explored and expanded on it for a long time. Presentations of it have generally been well received. That's about all one can ask."

In modern times, it's difficult to conceive of living in such intimate connection to the natural rhythms cycling around us. Most people probably don't know the current moon phase, much less when or where Venus will next rise. But to the ancients, like the farmer in the field, such celestial details were the marrow sustaining human and spiritual life. And they painted it all in their marvelous, mysterious books. ✕

Susan Milbrath

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IN 1991-1992, A TEAM OF ARCHAEOLOGISTS WORKING IN OCOTELOLCO — IN THE STATE OF TLAXCALA, MEXICO — UNCOVERED MURALS CONTAINING ARTWORK IDENTICAL TO THE CODIX BORGIA. EVEN BETTER, THEY WERE DATED TO THE SAME PRE-CONQUEST TIME PERIOD AS THE CODIX.

TLAXCALA
Origin of the
Codex Borgia



Entomology doctoral student Court Whalen holds up several rows of butterfly pupae. These soon-to-be butterflies were raised at the Rearing Lab of the Butterfly Rainforest at the Florida Museum of Natural History. The species shown are Blue Morphos and Banded King Shoe Makers.

Kristen Bartlett Grace

Doctoral Student Promotes Nature Through Travel

When Court Whelan finally made it to the Pacific island village after two jostling hours in a tiny airplane, one of the first things he saw was a pack of crouching, creeping zombies.

He flicked on his high-definition video camera and started filming as they surrounded a hapless family. When the family fled in terror, the creatures, shaking their massive heads and clacking their long fingernails, started toward Whelan and his group.

Whelan was thrilled.

The UF graduate student had just filmed a traditional “mud men” dance of a tribe in Papua New Guinea. Legend says the tribe had reclaimed its land after an attack by painting their bodies white, wearing masks and emerging from the cemeteries to terrify their captors.

“It left an impression on me that I will never forget,” he said.

Whelan is a doctoral fellow in UF’s entomology program and the general manager for Expedition Travel, an agency that organizes educational trips for the Florida Museum of Natural History.

He is also the first graduate student in his specialization — ecotourism entomology, which promotes the study and conservation of insects through tourism. The program was Whelan’s idea, but it became a reality with the help of

entomology professors Tom Emmel, Jaret Daniels and John Capinera.

Through Expedition Travel, Whelan organizes six to eight trips a year to study wildlife around the world.

Whelan has led ecotourism trips to Belize, Mexico, Panama, Costa Rica, Ecuador, the Galapagos Islands and Madagascar. When he’s not taking classes or traveling, he makes films and postcards from his footage.

In Mexico, he’s filmed hundreds of millions of butterflies blocking out the sun as they crowded into just a few acres of land. The flit of their collective wings produced a powerful whoosh, Whelan remembers.

“It’s more moving than just about anything you can imagine,” he said.

Whelan said his two favorite places are Madagascar and the Galapagos Islands. Many of the animals in these places are found nowhere else on the planet.

On the Galapagos Islands, he was able to snorkel next to Galapagos penguins, marine iguanas and sea lions that blew bubbles underwater at him. Because the islands are home to very few natural predators, the animals have almost no fear of humans.

Whelan wants to make more moments like these, which most people see only on the Discovery Channel, available to everyone.

“I’m just enthralled with the natural world,” he said.

Lindsey Robinson

Mary E. Warrick

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