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OFFICE OF RESEARCH—DIVISION OF ACADEMIC AFFAIRS
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A FEW WORDS FROM THE DIRECTOR OF THE NRS

The last sixty years of the twentieth century were notable for a series of spectacular technological advances that altered our daily lives and that continue to expand our understanding of planet Earth.

The first Earth-orbiting satellite, Sputnik, was launched in 1957; the first phone conversation and television broadcast via satellite took place in 1962. The global positioning system (GPS) depends on multiple satellites that continually orbit the earth. The first operable laser was invented in 1960. Transistors were invented in 1947, the integrated circuit in 1959, and the world's first single-chip microprocessor in 1971. These latter advances, along

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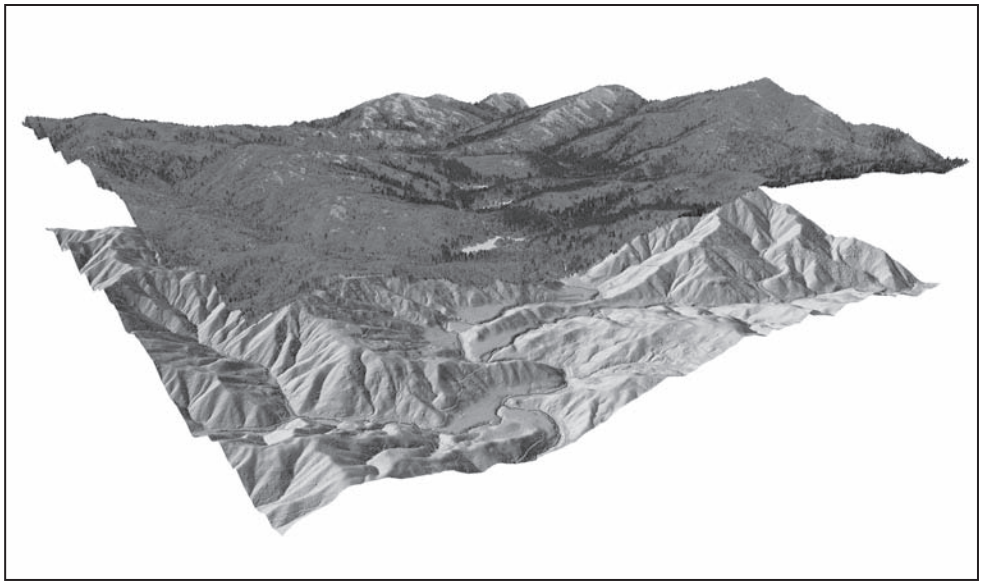

THIS THREE-DIMENSIONAL LIDAR MAP REVEALS, IN GREAT DETAIL, A PORTION OF THE NRS'S ANGELO RESERVE — BOTH "CLOTHED" AND "UNCLOTHED." IMAGE COURTESY OF THE NATIONAL CENTER FOR EARTH-SURFACE DYNAMICS (NCED)

NEW LASER-MAPPING TECHNOLOGY ENABLES "AERIAL GROUNDTRUTHING"

When UC Berkeley professor Mary Power invites you on a "flyover" of the NRS's Angelo Coast Range Reserve, she's not planning a plane ride through the rugged mountains of northern Mendocino County. Instead, she's asking you to drop by her campus lab to take a virtual tour of the reserve on a computer. Don't be disappointed. The experience provides a vivid demonstration of the power of LIDAR — Light Detection and Ranging — a laser-based technology that creates 3-D maps of unmatched accuracy and detail.

Collin Bode, a GIS/Informatics researcher in Power's lab, will be your pilot for this virtual tour. A gifted technology whiz, he's even added an animated introduction to the trip (courtesy of "Google Earth" software) that begins somewhere on the edge of the solar system, zooms in on North America, makes a left turn at Berkeley and another left at Laytonville, before arriving at Angelo. For scientists, at

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New laser-mapping technology

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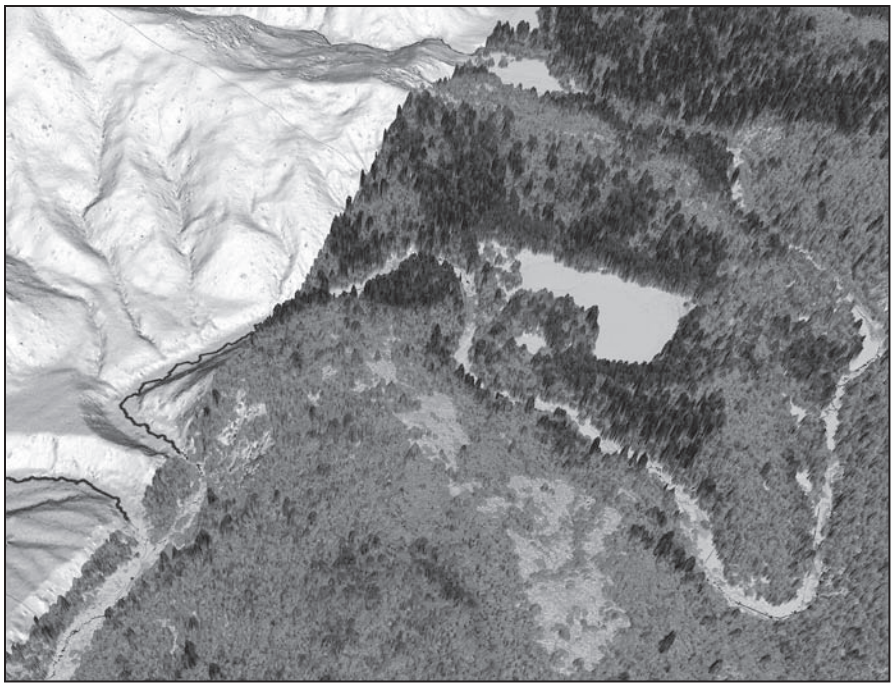
least, that's where the fun really begins. LIDAR maps of the reserve reveal details down to 15 centimeters — individual trees in the forest canopy, small divots on the forest floor, sand banks in the stream channel. With a few keystrokes, Bode can even peel away the green layer of trees and brush to reveal brown, bare-earth details, like trails and a web of old logging roads and skid tracks.

As Bode "pilots" the computer, Power plays backseat driver, directing him to specific areas of research interest. There's a lot to see these days, as the reserve has become a major research site for the National Center for Earth-surface Dynamics (NCED), a National Science Foundation (NSF)-sponsored Science and Technology Center that seeks to develop an integrated understanding of the forces shaping the Earth's surface. Our first stop is a small creek, where one of Power's graduate students is investigating the role of caddisflies in different parts of the stream. Then it's over to a terrace meadow, where another grad student is looking at the impacts of global warming. Finally, off we go, down to a channel in the Eel River where a third student researcher is studying the interactions of algae and bacteria.

As Bode zooms over to Ten Mile Creek to look at a landslide that reshaped the area thousands of years ago, Power explains how her team is using LIDAR. "Humans are visual animals," she notes, "so these maps are very powerful. Many of the things ecologists want to study are channeled or limited by topography. The maps help us locate areas with specific parameters — perhaps lightshed, or water noise, or the morphology of the channelbed — which then become the basis for field investigations."



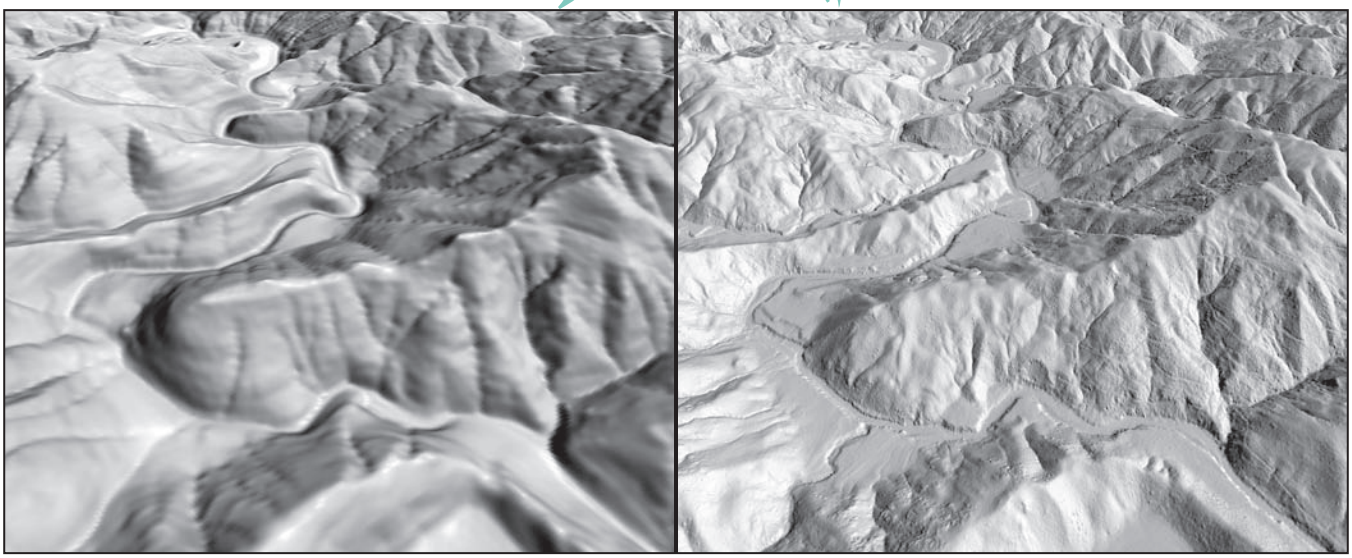
LIDAR's view of the Angelo Reserve — a smaller section in greater detail — shows individual trees. Image courtesy of the National Center for Earth-surface Dynamics (NCED)

For Power, the LIDAR maps have not only revealed a new perspective on her specific study site, they've also given her a better understanding of how engineers perceive the world generally. NCED colleague Miki Hondzo, an engineer based at the University of Minnesota, works closely with the Power team. Power explains the process:

"Based on the maps, Miki might predict that an organism should exist in a specific spot where conditions are tolerable and resources are adequate. But engineers tend to be more optimistic than ecologists about predictions. Field observations sometimes show that organisms — like algae growing on the streambed — may be absent where they 'should be.' Or present where they 'shouldn't be.' The first mismatch between prediction and observation can occur if a competitor, a predator, or simply dispersal limitations exclude the organism. The second mismatch might arise because of previously undetected fluxes of resources or organisms to an otherwise unsuitable spot. In either case, we learn as much from these mismatches as from the original simple predictions about the factors that actually control the distribution and abundances of organisms throughout the watershed."

The Technology

LIDAR works very much like radar. But where radar uses radio waves, LIDAR uses light waves produced by a laser mounted in a small aircraft. As the plane flies over an area, the laser emits tens of thousands of short pulses of light per second. These pulses bounce off a scanning mirror and race downward. Each pulse illuminates an area, called a "footprint," about 15 centimeters in diameter. In vegetated



A comparison of standard topographic mapping and LIDAR images. The detail shown on the left is a 10m DEM (Digital Elevation Model) taken from a USGS 7.5' quad. It seems blurred and inaccurate when compared with a crisp 1m DEM of the same area created through Airborne Laser-Swath Mapping. Images courtesy of the National Center for Earth-surface Dynamics (NCED)

environments, the pulse of light may first reflect off plants, and, if there are sufficient gaps, a portion will penetrate to the ground, then be reflected back to the airborne sensor. A computer uses the light's round-trip travel time to compute three-dimensional locations of the points on the ground, relative to the aircraft. The first returns (of light that traveled the shortest distance) are high in the forest canopy. The last returns (of light that traveled the farthest distance) may represent the ground, the roof of a building, or some penetration into dense foliage. Typically, the last returns are used to estimate the ground surface, and, in compiling LIDAR maps of vegetated areas, filtering must be done to remove those points that do not penetrate to the ground.

When mapping an area, the researchers "mow the sky," flying overlapping swaths back and forth over the terrain to ensure that each point is covered from multiple angles. This becomes crucial later when the filtering team begins to sort through the billions of data points to eliminate anomalies and to construct models of the ground surface and canopy. As the plane moves, extremely precise GPS and Inertial Measurement Units continuously record its exact location. In this way, the aircraft becomes the point of known elevation above the earth's surface.

Compared to conventional ground-based surveying or the construction of topographic maps from aerial photographs, airborne laser-swath mapping is astonishingly quick. Flying 128 square kilometers at the Angelo Reserve took just three days. A much larger project that covered 1,100 square kilometers in the Napa River watershed took ten days. Processing the data to apply the best calculations of the aircraft's location (using GPS, and accounting for the pitch and roll of the aircraft), and to filter the data to determine the ground surface, takes much longer. In densely forested environments, few data points penetrate the canopy. Bode's maps of the heavily forested Angelo Reserve, for example, are made up of only 8 percent of the points actually returned to the aircraft. A map of an open area like Furnace Creek in Death Valley, on the other hand, will use 100 percent of the points generated, with spacing between the points less than one meter.

The Mappers

Geomorphologist Bill Dietrich has played a major role in promoting the use of LIDAR for scientific research. A professor in UC Berkeley's Department of Earth and Planetary Sciences (and, coincidentally, Power's husband), Dietrich and his colleagues from the University of Florida's Department of Civil and Coastal Engineering have established the NSF-funded National Center for Airborne Laser Mapping (NCALM).

The motivation for establishing NCALM really began in the early nineties, as Dietrich became increasingly frustrated with USGS topographic maps. "They're crude representations based on aerial photography," he notes. "And in a heavily forested area like the Angelo Reserve, the person making the map has to try to see down between the trees and sort of average things out."

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New laser-mapping technology

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Backpackers might draw comfort from contemplating smooth topo contours. But this same averaged-out view drives geomorphologists like Dietrich crazy, because they're looking for details that reveal how the landscape formed. When Dietrich walks the rugged upper Eel River canyon, he can see it's anything but average. On the contrary: it's amazingly irregular.

In the mid-1990s, Dietrich arranged for a flyover of one of his study areas in the Oregon Coast Range by a commercial company with the first generation of airborne laser-mapping systems. He had been working in the Coast Range since 1973 and was surprised at the fine-scale topography this survey revealed. His graduate students were even more impressed. Three of them quickly incorporated the data into their research, and Dietrich found himself trying to arrange additional flights. That's when he realized the importance of making LIDAR available to the scientific community.

Dietrich was confident LIDAR could revolutionize his field. "Technology can do two things," he explains. "It can either finally let you address a question you've thought about but couldn't do, or it invites you to ask new questions." He realized that precise mapping technology could allow geomorphologists to test and revise theories on landscape evolution that had long eluded them. He was sure it would have a similar effect on other basic science fields — in addition to contributing to such practical concerns as land-use planning decisions.

LIDAR has even proven valuable in legal cases. For example, four people were killed by a landslide from a deforested hill slope in the Oregon Coast Range. Dietrich persuaded the leading attorney in the case to have a LIDAR survey done, and the resulting data proved vital to documenting both the location and the cause of the debris flow.

Though hugely promising, LIDAR developed slowly. Other than a few special, NASA-operated research projects, commercial companies were doing the work, usually for landowners, power companies, and major developers. But progress was slow and the work quality uneven, because these same commercial companies were unwilling to share analysis techniques or involve students in data-gathering and analysis.

Then Dietrich heard about a unique program at the University of Florida: two professors – one who'd spent his career working with lasers and another interested in improving mapping software – were collaborating on pioneering work that was making significant advances in LIDAR technology. Florida was the only university to have an advanced LIDAR system *and* a plane, a twin-engine Cessna 337 Skymaster. Dietrich approached them with his ideas for promoting LIDAR's use in scientific research, they responded enthusiastically, and collaboration was begun. With NSF funding, NCALM was established in 2003. Today the center is working on three fronts: improving LIDAR techniques and technology, producing high-quality maps for the scientific community, and providing an educational program that involves students in all aspects of the work. While the plane is heavily booked, much of the team's research focuses on creating new algorithms and filtering techniques to remove unwanted vegetation, buildings, and other anomalies from finished maps.

For Dietrich, it's a great team. Florida U has the engineering experience, as well as the LIDAR system and the plane. UC Berkeley provides scientific perspective, contributes to the filtering, and makes data available to researchers via the Web from a server mounted in Berkeley's Seismological Laboratory. NCALM works exclusively with NSF-funded researchers. If a scientist wants to use their LIDAR system for a project, he or she must write a competitive grant to the NSF. Now in its third year of operation, NCALM's business is booming. By the end of 2005, they will have completed 24 projects. These projects range from studying the chinook salmon and steelhead habitat on the Napa River, to documenting slumping features on Arizona's Lake Powell, to calculating the incision rate on the upper stretches of the Potomac River near Washington, D.C.

Working at Angelo

In one sense, the topsy-turvy terrain of the Angelo Reserve played a key role in the creation of NCALM. Dietrich has a cabin near the reserve, and he spent years studying topographic maps and hiking the area's mountains and canyons, trying to make sense of what he was seeing. A number of factors have shaped this stretch of the watershed. The area is tectonically active, subject to rapid uplifting and cut by faults. Its steep hillsides are formed largely of weak, tectonically deformed rocks, and its heavy rains cause massive landslides. Human disturbances, mostly road building and logging, are a more recent factor, but not an insignificant one. On top of all of this, the entire area is cloaked

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A conversation with marine scientist Dan Costa — TOPP that!

UC Santa Cruz professor Dan Costa is chair of the Universitywide NRS Advisory Committee and a noted expert on northern elephant seals. From his early days as a graduate student working at the NRS's Año Nuevo Island Reserve in San Mateo County, Costa rose to fill the UC Santa Cruz faculty position that opened up when his mentor, NRS founder Ken Norris, retired.

These days Costa is a difficult man to catch up with as he races between international symposia and meetings with potential funding sources. This summer alone, he's traveled to Scotland, Washington D.C., Brazil, and Queensland, Australia, usually to talk about the Tagging of Pacific Pelagics (TOPP) project. Established in 2002, the TOPP project has four principal investigators — Costa, fellow marine biologist Barbara Block of Stanford University's Hopkins Marine Station, oceanographer Steven Bograd from NOAA's Pacific Fisheries Environmental Laboratory, and Randy Kochevar, the science communications manager at the Monterey Bay Aquarium — and over 120 associates, including marine biologists, oceanographers, engineers, and computer scientists.

The goal of TOPP is to use microprocessor-based archival tags to capture biological and environmental data on 21 species of animals that inhabit the open waters of the Pacific Ocean. Species include tunas, sharks, pinnipeds (California sea lions and elephant seals), mola molas (ocean sunfish), various cetaceans, albatrosses, squids, and sea turtles. Currently, TOPP scientists have tagged more than 2,000 individual animals, allowing researchers to track their travels across the ocean, while also capturing never-before-available oceanographic data.

UCSC professor and Universitywide NRS Advisory Committee Chair Dan Costa has worked with northern elephant seals for decades. Now he is also a principal investigator for the TOPP project, which has more than 120 associates tracking 21 species of ocean-going fauna. Photos courtesy of Dan Costa

Transect caught up with Costa during a short break in his travels to talk about TOPP and the changes underway in the field sciences. Though exhausted after his twice-delayed flight from the East Coast, Costa soon warmed to the topic.

Q: What's the current status of TOPP?

Costa: The first three years have focused on accelerating the development of tags and tag technology. We're working with animals that have a proven capability to carry tags, so we want to push the conceptual framework for how you tag them, where you tag them, and what you do with the tagging data. During this initial phase, we worked with the Sea Mammal Research Unit in St. Andrews, Scotland, to develop a new GPS-positioning tag, salinity/temperature/depth tags, and a chlorophyll tag. All these technologies are now coming to fruition and being fed into the TOPP field phase, funded by the David and Lucile Packard Foundation and the Gordon and Betty Moore Foundation.

Q: GPS helps you track the animals, but what do the other tags do?

Costa: Chlorophyll tags are designed to use changes in light level as

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Conversation with Costa

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the animals dive to provide information on where primary production is taking place in the ocean. Temperature and salinity are the signature of a water mass. If an oceanographer has temperature and salinity depth profiles, he or she can tell you where that water came from. Other things are important, like oxygen content and nutrients, but if you give them temperature and salinity, they have 90 percent of what they need.

Q: People have been tagging animals for a long time. How is TOPP different?

Costa: What makes TOPP unique is that we're looking at 21 species at the same time in the same ocean. You can look at each species separately, but you'd never learn what we're going to learn. And there's no way that a single investigator could pull together a program that could tag 21 different species of animals from a single lab. We already know how top predators, like elephant seals and white sharks, use the ocean, because we've studied those species for 10 to 15 years. Burney LeBoeuf, Dan Crocker, and I have been studying elephant seals at the Año Nuevo Island Reserve for decades, but that's just a single species. Now we want to see how an elephant seal's use of the ocean compares with that of a salmon shark. And if their uses are different, then *why* are they different? Or, how do they compare with California sea lions or blue whales?

Q: What's the value of looking at multiple species at once? How does that change your perspective?

Costa: You begin to see commonalities among divergent groups of organisms. We're already finding that elephant seals, albatross, and salmon sharks have many similarities in the extent and range over which they use the north Pacific. We're seeing that bluefin tuna, California sea lions, and blue whales are all coastal species that tend to aggregate in hot spots where there are lots of krill. We're starting to see these very broad patterns of association across broad groups of organisms. Off the top of your head, you wouldn't expect a bird, a shark, and a pinniped to have anything in common. But they do.

So, part of our approach is to ask the questions: what do different species have in common? where are they different? and why are they different? For example, seals and sharks are very different. Seals are full endotherms, while a salmon shark is a partial endotherm — it keeps its body warm, but breathes through gills. So there are fundamental differences in the physiologies of the two organisms. Both use the ocean and share a lot of convergent features, but there are only a few solutions to how you make a living in the ocean, so ultimately what we'd like to ask is: if you have a shark physiology, or a seal physiology, or a bird physiology, does that basic physiology put you on a different trajectory

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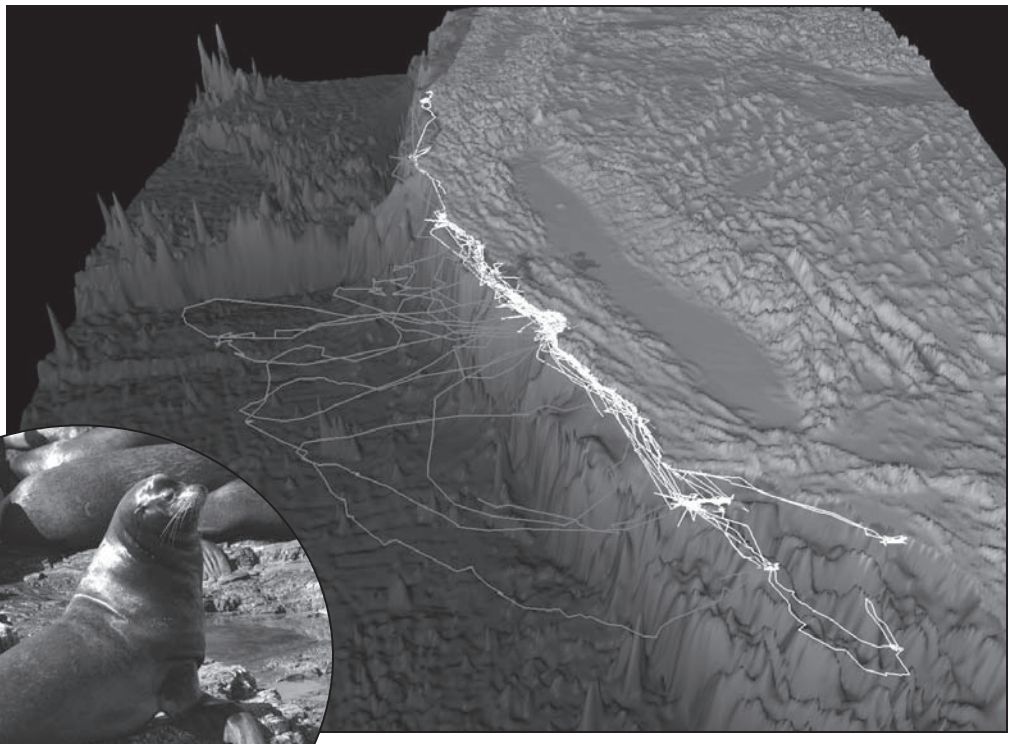

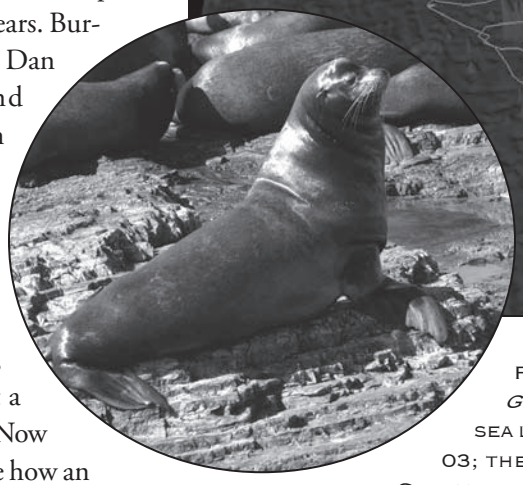

Inset left: Male California sea lion. Photo by Dan Costa

Graph above: TOPP data visualized: tracks of California sea lions. The lighter tracks, close to shore, are males, 2002-03; the darker, farther-ranging tracks are males, 2004-05. Chart courtesy of Michael Weise and Dan Costa

Summer at Sagehen Reserve transforms teens through program of Adventure • Risk • Challenge

Few teenagers willingly get up at 6:15 each morning to exercise and go for a run. But that's exactly what eight teenagers were doing on an early August morning at the NRS's Sagehen Creek Field Station in the high Sierras north of Truckee. And while we might have expected to hear prolonged groans and complaints, in fact the cool morning air carried giggles and laughter through the trees. Even by the end of the run, this group of kids glowed with accomplishment and self-confidence. At the program's start, they ran two miles; by its end, they covered seven.

During a Project Discovery ropes course, ARC student Karen Duran takes the central position for a trust and spotting activity called "Wind in the Willows," in which she closes her eyes, falls back, and allows her body to be passed around the protective circle of her teammates. Photo by Colin Carpenter

This is ARC — Adventure • Risk • Challenge — an intensive six-week program that combines outdoor adventures and leadership activities with English and science classes. The program serves eight to ten, incoming 10th- and 11th-grade students whose first language is Spanish, and who are potential leaders in their communities, actively seeking new challenges and opportunties to improve their English skills. In its first two years, ARC has demonstrated to be effective in improving the students' language skills, while also building self-confidence, leadership, and environmental awareness.

ARC is the brainchild of Katie Fesus, a dynamic, thirtyish woman whose dedication to teaching is as intense as her blue eyes. "Our focus is on kids on the cusp," she explains. "Some might not be able to graduate high school because they can't pass the English proficiency test. Others have tremendous drive to excel, but still are struggling. A main strength of the program is that there are not many such intensive programs — and none locally — for motivated students to study and improve their English during the summer."

An avid rock climber and backpacker, and an Outward Bound instructor since 1992, Fesus developed her educational vision while working on her master's degree at Stanford University in Palo Alto. At the time, she heard about a New York City Outward Bound program that took inner-city students into the Adirondack Mountains of upstate New York for outdoor education combined with academic study. These Outward Bound students raised their English proficiency by one to two grade levels. Not a bad way to spend their summer vacations.

These results confirmed many of the ideas that Fesus held. After she received her teaching credential from Mills College in Oakland and taught in San Francisco Bay Area schools for two years, she traveled to the East Coast to work for the same New York City Outward Bound program that had impressed her while she was a student at Stanford. A year later, in late 2003, she returned to California, determined to establish a similar program back home.

Of the many places that Fesus has lived and worked — including not only coastal California and New York, but also Colorado, Montana, and Texas — Lake Tahoe is her all-out favorite, and she sensed it would be the right place to make her life's contribution. When she arrived in the area, therefore, she began at once to develop a two-year plan for getting her program off the ground. She would spend the first year planting the seeds: designing the curriculum, identifying potential funding sources, making contacts with local educators, and getting to know prospective students. Then she would pull everything together in the second year and launch the program.

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ARC TEENS TRANSFORMED

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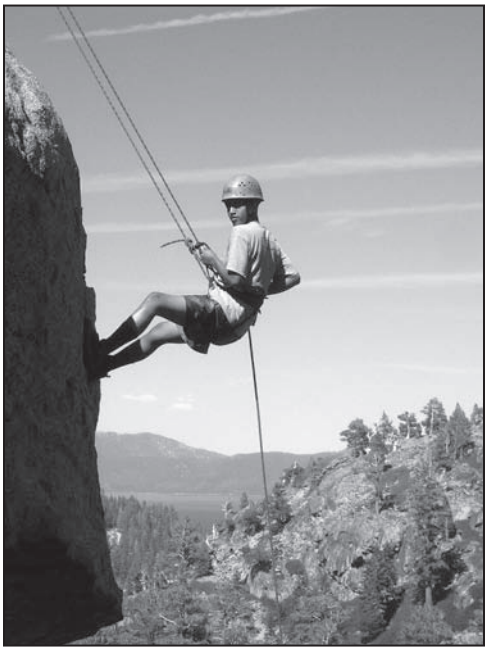
TWO VIEWS OF ARC STUDENT FABIAN DEL VILLAR TAKING ON DESOLATION WILDERNESS, HIKING (*PHOTO ABOVE*) AND RAPELLING (*PHOTO BELOW*). PHOTOS BY COLIN CARPENTER

Fesus knew one of her biggest challenges would be finding a facility where she could house the students. "You can take the kids into the backcountry for adventures and leadership," she explains, "but they need to have a place to come back to for the academics. You can't do the whole program in the backcountry. The students can't focus. They're not comfortable. They need to take a shower and eat a good meal."

A friend suggested that Fesus talk with Jeff Brown, energetic manager of the NRS's Sagehen Creek Field Station, administered through UC Berkeley. After one conversation with Brown, Fesus found herself with both a base camp and an accelerated one-year schedule. Brown recalls his decision to support the ARC program with Sagehen's resources as a "no-brainer." He explains: "One of the things Beth Burnside [UC Berkeley's Vice Chancellor for Research] told me when I took this job is that we need to find ways to keep young students interested in science. So, when someone like Katie, who obviously has the energy and drive and skills to make it happen, drops a program like this in your lap … from a selfish perspective, this place had a whole lot to gain from what she was offering."



Climbing these mountains /
Is teaching me /
That every difficult obstacle
can be overcome if I believe /
In Myself
— Israel Carrillo

And Sagehen Creek Field Station had a lot to offer ARC as well. First, there were the facilities, from the computer lab where the kids could work on their writing projects, to a kitchen, showers, and a laundry. Second, there was the commitment of Brown and Sagehen's assistant manager, Faerthen Felix. Both Brown and Felix are experienced wilderness guides who love taking challenges head-on. For example, after ARC's first year at Sagehen, they decided the program should have its own dedicated "campus" at the reserve — so they built one, installing temporary tent platforms, complete with bunk beds, near an isolated cabin.

After her conversation with Brown, Fesus had to move fast: raising $40,000 from local businesses and foundations, hiring staff, recruiting students, and organizing the outdoor activities. "We were both naive about how much it takes to pull something like this off," Brown admits. But they did it. Nine students from local school districts took part in the program that first summer. Katie and one other teacher, Victor Insera, handled both the classroom instruction *and* the adventure activities. Brown recalls the results were worth the effort: "The first year's success was dramatic. Watching the kids change and grow was inspiring."

Fesus also calls attention to the fact that the students' post-program, English-proficiency test scores improved significantly — by 10 to 18 points out of a possible 100. She continued to meet with the students throughout the next school year to monitor their progress. Four out of five students who were eligible to take a proficiency test did in fact pass it.

The Program

This year Fesus and two teachers, Beth Gross and Colin Carpenter, worked with eight students from both the Tahoe area and Petaluma.

Once again, the program presented formidable challenges, both physical and academic. It began with an eight-day backpacking trip into the Desolation Wilderness. "That sets the tone," Fesus explains in her matter-of-fact way. "Eight days is no problem. I can guide the kids, no matter what their experience (most have none). They can do it. During the trip, they set up their group culture, so when it's over and they come back to base camp, everything seems bright and new — the showers especially!"

I am a girl who jumped onto a trapeze high up in the air, missed but did not get discouraged, and jumped again — a girl who made it the second time.
— Jennifer Martinez

During this trip, the students took their first steps on a steady journey towards self-reliance. In addition to learning backcountry camping skills, they began to take on group tasks. Each evening each student got a new assignment. One day a student might be the "Top Banana," making sure the group stays on schedule and on task. The next day, that same teenager could be "House Mouse," leading the camp clean-up and making sure no gear is left behind. Other jobs included the "Great Eye" (handling the compass and maps), the "Prolific Pen" (journal keeper), and "Kitchen Wallah" (preparing meals). The names were fanciful, but the kids took their responsibilities seriously, because they knew the group depended on them.

Tone-setting continued during the first stay at Base Camp. Each day started with an early morning run; camp chores continued to rotate among the students. Fesus refuses to be amazed by the students' unflagging enthusiasm. "They love the exercise," she states plainly. "It's a tangible goal. Many of them have never run, but it gets easier quickly. They're doing 20 minutes now, but soon they'll be doing 35. It's a goal they can set and achieve."

Right after breakfast, English instruction began with "Grammar Blast," an hour focused on spelling, grammar, and common mistakes that trip up English-language learners. A two-hour writing class took up the rest of the morning. After lunch, the students read aloud from the now-classic fantasy by Norton Juster, *The Phantom Tollbooth*, a novel Fesus selected for its imaginative content and sophisticated wordplay. Oral reading was followed by a science class that continued until the time came for dinner preparations, which the students helped with. After their meal, when the dishes have been washed and put away, the students got a bit of free time to themselves, as individuals, before they met again, as a group, at seven o'clock. During that group meeting, they reviewed the day, shared concerns and accomplishments, handed out daily awards and job assignments, and talked about upcoming events. By 10:15 p.m., everyone was in bed.

The weeks were filled with a wide range of adventures — rock climbing, a three-day kayaking and camping trip on Lake Tahoe, whitewater rafting on the American River, a day-long ROPES course, a second backpacking trip that included the option of a 24-hour solo camp-out, and a final off-trail peak ascent. On each succeeding trip, the students took on more and more

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Top photo: ARC student Josie Briviescas gets some assistance from Sagehen Assistant Manager Faerthen Felix during a Project Discovery ropes course. Photo by Colin Carpenter

Bottom photo: ARC students Celina Benitez and Jennifer Martinez, sea kayaking on Lake Tahoe. Photo by Katie Fesus

Summer 2005 ARC students tell a bit of what they learned about themselves in the world

Fear is my worst enemy, and here at ARC, I overcame it. Now I am stronger and nothing can bring me down. My point of view has changed; it has grown more expansive. What used to be dull, now seems interesting. Nature has woken me up and shown me how beautiful the world is. I will always appreciate music, my computer, and long hot showers, but I know I can live without them (at least for a little while).

— Celina Benitez, from "My Worst Enemy"

Not only did I face my fears, but I also faced aspects of myself I wasn't proud of. On day two of our Desolation Wilderness expedition, we were at the partly frozen Lake Lucille. Beth, one of our teachers, asked us to think about one aspect of ourselves we wanted to leave behind and one aspect we wanted to bring with us on the trip. I had ten minutes to write. One by one, we walked into the freezing lake that still had an iceberg floating in the middle. I was last to go and had my rock ready. I said out loud what I wanted to leave behind: the fact that I judge people before I get to know them. I threw the rock, watched it splash against the water, and sink all the way to the bottom of the lake. And that's where this part of myself has been ever since. After leaving that part of the old me at the bottom of the lake, I have been more willing to get to know my teammates and build a great relationship with them. I've become one of leaders of the group, friends with everyone, and a positive motivator and influence.

— Israel Carrillo, from "Courage: The Path to Leadership"

Picture me: Tania Cabrera, a girl always at home and really close to her family. Always depending on her mom. Thinking she was strong, but never proving it. Picture me, a girl who watched TV every day for four hours. A girl always thinking about the future, but mostly not enjoying the present; always trying hard, but never out of the cage, always safe.

But now try to picture me: The "home girl," camping for eight days in Desolation Wilderness. The girl who depends on her family, 40 days away from home. The girl that relies on her mom, now cooking for herself and others. The girl in the gold cage, leading 20 people, adults and teens, in a group game. The girl who used to be lazy, motivating others to wake up in the morning. The one who was always safe, jumping to catch a trapeze. Picture the new me, the new Tania Cabrera.

… Now I expect to do things by myself, don't wait until somebody comes to help me, and remember to do things for others. I have learned how to manipulate my fears when I need them to go away, how to concentrate on what I'm doing and still have fun at the same time. I have learned how to control my feelings — for example, to cry when I need to, to tell my body that I'm not tired, and to tell my mind that I can do more when I am running or hiking. This helps me to not feel the pain that can come between me and fun hard experience. Also this summer, the experience of being a leader has made me more responsible and more mature. I have tried to be a good example and to keep everyone happy. Leadership is difficult, but with practice, I have learned not only to be independent, but how to motivate other people. …

— Tania Cabrera, from "My Independence Calls Out"

Jennifer Martinez used to be a girl with uncontrollable anger. She used to be a girl who would shout at her dad. A girl who would backtalk her mom, even if she knew she was wrong. One who would never listen to other people's reasons for their actions, but who just wanted to feel safe from things that went wrong in her life.… I, Jennifer Martinez, used to be the girl who hurt her family by hurting herself and then blamed them for her self-inflicted pain. I used to be the girl who did not know her true self, but still expected others to know me. I used to live in the past, never letting go of memories and not caring for the future.

Now Jennifer Martinez is a girl who knows how to control her anger when people make her upset. She is a girl who regrets shouting at and not appreciating her mom and dad's hard work. She is a girl who has blossomed into a calm and cheerful young lady. She is a girl who has learned to listen to others and tries to understand their point of view. … I am the girl who is trusted by her ARC family to show them the right way. I am a girl who was chosen to be a Guardian Angel on the final expedition because of my natural leadership abilities. My role was to see the Big Picture, watch after the group, and make sure everyone stayed safe and happy. I am a girl with the voice that other people listen to and follow. I am a girl who is determined to get over any challenges and a friend who motivates others to do the same. Jennifer Martinez, who looks forward to the future, appreciates the present, and lets go of the past.

— Jennifer Martinez, from "The New ME!"

The ARC Class of 2005, with their instructors and rafting guides, on the American River during a day of river rafting donated by Bio Bio Expeditions. Photo courtesy of ARC

Being afraid of trying is just what can happen in life, but it won't let you achieve your dreams. … Back home, I remember sitting in science class, struggling while my friends helped me out with difficult and frustrating information, believing the entire time, "I can't do this alone." Sitting in a chair and watching the teacher talk about electrons and neutrons made my frustration with science worse. However, this summer, being in the forests, measuring trees with tape measures and researching fire for a science project, I saw myself succeed in science for the first time. My fears with science slipped away after I saw the poster I had worked so hard to create, and I felt confident in my ability to learn in science. I realized that science was interesting to me, because I was able to let go of that fear once again. …

— Fabian Del Villar, from "Treasures to Remember"

Before I came to the ARC program of 2005, I was like any other kid, depending on my parents when I fell or could not get up. They would always be right there, holding onto me, making me feel safe. I was always in my comfort zone where no one could harm me. Here at Sagehen, I have stepped away from the protection of my family. The experiences I have had here have made me stronger, and now the world can't harm me, because I know anything it throws at me, I am confident, I can handle.

— Karen Duran, from "The Leap Of Faith"

My biggest challenges for the summer were not giving up on something right away, trying to trust the people I was going to live with for six weeks, learning that it is good to have support in the group, and that I have to be the one to push myself, because no one else is going to do it for me. I am a different Josie than when I first came to this program. I am still me, but I am more of me. I'm more outgoing, I joke around more, I can write better than I used to, and most importantly I can share more of myself. When I go home, I wish to keep these traits with me for the rest of my life. When I get home, I will try hard in school, follow my goals, keep trying new things, help my community, help my own family more, and, last but not least, always stay positive and shine in everything I do.

— Josie Briviescas, from "Learning to Trust Myself"

I am a river
Conceived by snow and sun rays
I can be a clear, calm stream
Or a roaming, rough, white waterfall
I am a river
Illuminating your way
A wild river
Surging, searching where I belong.

— Javier Espinoza, from "My Soul"

ARC TEENS TRANSFORMED

Continued from page 9

responsibility for their own experiences. By the program's conclusion, they handled their own logistics and hiked on their own — finding and keeping to the trail, selecting campsites, preparing meals — while their teachers followed at a distance.

Just as these outdoor activities were planned and scheduled to gradually teach leadership and survival skills, the complementary academics built step-by-step to a cumulative event that carried the students far beyond what they had thought was possible. The science program, for example, began with a simple research project — this year's topic was forest health. The students produced bilingual posters, which were installed at intervals along an interpretive trail (and Brown plans to make these trails a permanent feature of the reserve). The students then hosted a visit from local Boys and Girls Clubs, at which time they explained, in English, their findings to the younger students.

What I have learned about myself is that, if I don't try, I don't have the chance to prove what I can do.
— Fabian Del Villar

The English program built in a similar way. The first assignment began on their start-up, eight-day trip into Desolation Wilderness, where teachers encouraged the students to observe nature. "It's great," Fesus says. "Almost before they know it, they're writing poetry about the things they're seeing. And they're proud of their poems, so this gives them confidence as they move into the next assignment."

The next writing assignment was more complex: each student interviewed an adult about his or her life experiences and wrote a narrative biography. Their final assignment was a self-reflective essay on how the program has changed them (*see pages 10-11* of this *Transect*: "Summer 2005 ARC students tell a bit of what they learned about themselves in the world"). "Kids like writing about themselves," Fesus explains. "They use all the descriptive writing techniques they learned from the first assignment, the organizational structure they learned from the second assignment, and the self-reflection they've used in the journals they keep, and tie it all together in their final testimonial. It's exciting. The kids are invested in every writing piece, and they have a lot to write about, so they care about it, and what they write actually expands what they've learned." The students also read much of their work aloud, first to each other and then, as their confidence grew, to the public and to their families at graduation. All their poems and testimonials are published in a final ARC publication.

Most outsiders don't immediately see a connection between outdoor education and English proficiency. For Fesus, it's obvious. Although most outdoor education classes include a verbal debriefing about what participants have learned, such lessons can soon be forgotten. By encouraging students to *write* about their experiences, however, ARC presses the learning to

Top photo (l-r): Students Fabian Del Villar, Israel Carrillo, and Celina Benitez cross a lake mouth in Desolation Wilderness. Photo courtesy of ARC
Bottom photo: ARC director Katie Fesus works closely with student Karen Duran at Sagehen Reserve. Photo by Amanda Deutsch

Students Jennie Martinez and Karen Duran, ready to backpack into Desolation Wilderness. Photo courtesy of ARC

a deeper level. As Fesus explains: "It pushes their thinking, because we ask them how the lesson might apply when they get back to school. And once they write it down and we publish it, it becomes more than just something they said. It becomes something they're going to make true. That's where literacy and adventure education really link."

The program's tight group dynamics are another reason for its success. "English teachers often try to create a peer feedback community in the classroom," Fesus continues. "With ARC, all the adventures and leadership curriculum create that peer feedback. The students learn how to give feedback every night. It becomes part of their culture. So when we start doing poetry readings, the kids trust each other. They're taking risks in terms of what they say to each other. They're already set up to make that an effective part of learning."

As the weeks pass, Fesus and the other teachers observe the students closely. "We look for the spark in each of their eyes and the moment they push themselves beyond their comfort level, whether it's in a writing assignment, or on the ropes course, or on a sea kayak — and we've seen every student do that. I think that's why they all leave so much stronger. They're all taking risks. They're all pushing through fear. They're all committed to transformation and growth."

The ARC Class of 2005 reaches its first peak: Mount Tallac in Desolation Wilderness, overlooking Lake Tahoe. Photo by Katie Fesus

Today ARC is supported largely by the vision and energy of Fesus, Brown, and a small group of volunteers. All the support staff are volunteers. The teaching staff is temporary. The funding is year to year. Fesus must be planner, fundraiser, teacher, backcountry guide, and administrator. But she's determined to build on the program's two years of initial success and secure more funding, sufficient teaching and support staff, and stronger links with Spanish-speaking communities in Northern California. Fesus sees the connection with the Sagehen Creek Field Station and the University as a major step in this process, because the association between this NRS reserve and ARC "opens a million more doors in terms of where we can take these resources and ideas, and ways to support staff. For the students, having [the name of] UC Berkeley on their high school transcripts can really help them when they want to go to college. The model is structurally sound. It's designed to make an impact on kids, so now we can look at expanding it to other NRS reserves, or adapting it to different populations or different cultural groups. There's tons of potential." — *JB*

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Kid Vid Plugs Bugs

Kids and bugs go together like peanut butter and jelly!" observes Kristie Reddick, teacher in the Valentine Eastern Sierra Reserve's (VESR) Outdoor Science Education Program. She should know. She spent much of her summer teaching sixth- through eighth-graders how to produce video programs on the insects and spiders found at the reserve.

Reddick's class, "Totally Buggin': Lights, Cameras, Insects," is the latest offering from VESR's extensive science education program that provides programs for local schools as well as summer classes. "We developed the idea for the class over the winter," explains VESR Education Coordinator Leslie Dawson, "when Kristie was working as an assistant in Dave Herbst's lab at SNARL (Sierra Nevada Aquatic Research Laboratory). With her background in both theater [she has a degree from the University of the Arts in Philadelphia] and entomology, she really connects with the kids."

Producing a complete program in eight four-hour sessions would be a challenge for anybody, but doing it with kids who have little or no video production background seems especially tough. Reddick was undaunted. Using the local school district's camera and Macintosh computers borrowed by SNARL director Dan Dawson, she greeted her first class with the ambitious goal of making a "professional-quality production."

The first challenge was teaching the kids how to collect their co-stars — the bugs — without injuring them. Fortunately, most of the students in the class were already familiar with the reserve. "I hadn't been to Valentine before," Reddick admits, "but many of the kids had taken a number of classes there, so they knew where to find the insects."

Each student then selected a specific insect and spent a day researching its most interesting characteristics. "They had to become experts fast," Reddick explains. "Talking on camera can be tough, so they really had to know what they were going to say before we started shooting."

The students handled all facets of the production: shooting the footage, directing the shots, checking the focus, and capturing the sound. Reddick, meanwhile, busied herself off-camera: coaching performances, offering advice on the camera work ("Don't zoom too fast, you'll make people sick!"), and wrangling the insects. The kids got great close-up footage by chilling their bugs in a cooler for a few minutes. When the students weren't shooting or performing, they worked on a myriad of other essential tasks, like collecting new specimens, designing graphics, and selecting music for the soundtrack.

Insect cinema in the making: teacher Kristie Reddick coaches student Kathy Kirkby on her caddisfly presentation. Photo by Leslie Dawson. For more about VESR's Outdoor Science Education Program, go to: <http://vesr.ucnrs.org/pages/Outreach.html#OSEP_outreach>

The process had pitfalls. "At times, it was hilarious," Reddick recalls. "We were using my DVD player as a monitor connected to the camera. So all these kids were wired together. At times, the director and camera person would be arguing over whether a shot was in focus, while the person on camera was trying to control the insect and remember lines."

The footage was assembled and edited using iMovie software. Again, the students took the lead. "All of the kids can edit anything now," Reddick notes proudly. "I really wanted to give them those skills, and they were so into it. One girl became my master editor. She watched me for a while and then spent twelve hours straight over the last three days editing."

Reddick achieved her goal with style. She taught the class twice and both productions, though very different, are engaging and informative. Viewers attracted by the youthful creativity, delightful bloopers, and upbeat soundtrack soon find themselves intrigued by the insects themselves. Next year's middle-schoolers will be glad to hear that Reddick plans to return to the reserve in 2006 for an encore. — *JB*

New laser-mapping technology

Continued from page 4

in a thick layer of brush and trees, so analyzing it is a bit like trying to put together a jigsaw puzzle while blindfolded.

It was fitting, then, that one of the first projects flown by the newly established NCALM team was the Angelo Reserve. The moment Dietrich saw the resulting maps, he realized why he'd had so much trouble sorting out Angelo's formation. "It was like being an ant on the back of an elephant," he recalls. "I couldn't see that I was on an elephant, I could only see these weird things." Dietrich realized he'd been looking at the wrong scale. LIDAR allowed him to stand further back, and suddenly it hit him: "My God, this whole landscape is flowing down toward the channel!"

In his campus office, Dietrich calls up one of the LIDAR maps on his laptop to illustrate his discovery. Pointing to a stretch of the river where a number of reserve buildings are situated, he explains: "See this flat area? That is the former riverbed. Some time ago, the river cut down, abandoning this bed and moving laterally into the adjacent hill slope. This undermined the weak bedrock in the slope and caused the hillside to just sort of flow down into the river, creating a kind of 'melted ice cream' topography."

The process Dietrich describes has been going on for hundreds of thousands of years. As the Eel River cuts down and undermines the hill slopes, it causes enormous landslides, tens of meters deep and many kilometers long, that send huge pulses of sediment into the river, at times overwhelming it. When this happens, the river shifts back and forth, building up a flat plain (like the one on which the reserve's new science center stands). Then, when the discharge changes a bit or the sediment supply goes down, the river is released and begins to cut down again. This process forms the steps or terraces that characterize the Eel today. These were the meadows that early homesteaders found so attractive — and tried to farm, without much success — when they reached the area in the late 1800s.

This process also accounts for another characteristic of the river: numerous large boulders that seem randomly strewn along the channel. If the soils are the melted ice cream in a sundae, the boulders in the riverbed are the nuts. They too were drawn into the river from the steep canyon walls by the frequent landslides, but because they consisted of harder material, they remained in the channel, slowly moving downstream with rare flood events or being worn away in place, providing shelter for fish and insects.

One particular section of the reserve had long perplexed Dietrich: that point where the Eel connects with Ten Mile Creek, a major tributary. The trail through the area follows the spine of a narrow ridge, then descends to a big pile of sediment. After studying LIDAR maps of the area, Dietrich now believes that, thousands of years ago, an entire mountainside collapsed into the canyon, completely blocking the river. When the river finally cut through the block, it released a huge amount of sediment down the canyon. But he plans to check his theory: "Again, it's the ant phenomenon. When you walk around and see this big pile of dirt, you can't tell it's a landslide. It doesn't show up in topographic mapping. You can't see it with aerial photographs, because it's too densely forested. But with LIDAR, it stands out like a sore thumb."

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UC Berkeley GIS/Informatics researcher Collin Bode installing panels for a solar power system at Angelo Reserve. This power system supports a sensor network that — in collaboration with LIDAR — is contributing to an effort called "Desktop Watershed." Scientists creating this Desktop Watershed hope to change the way people in the natural sciences think about and collect data related to the earth's surface and systems. LIDAR maps of the Angelo Reserve were used to assess the area's viewsheds and to determine where relay stations for its wireless network should be placed. Photo by Peter Steel

New laser-mapping technology

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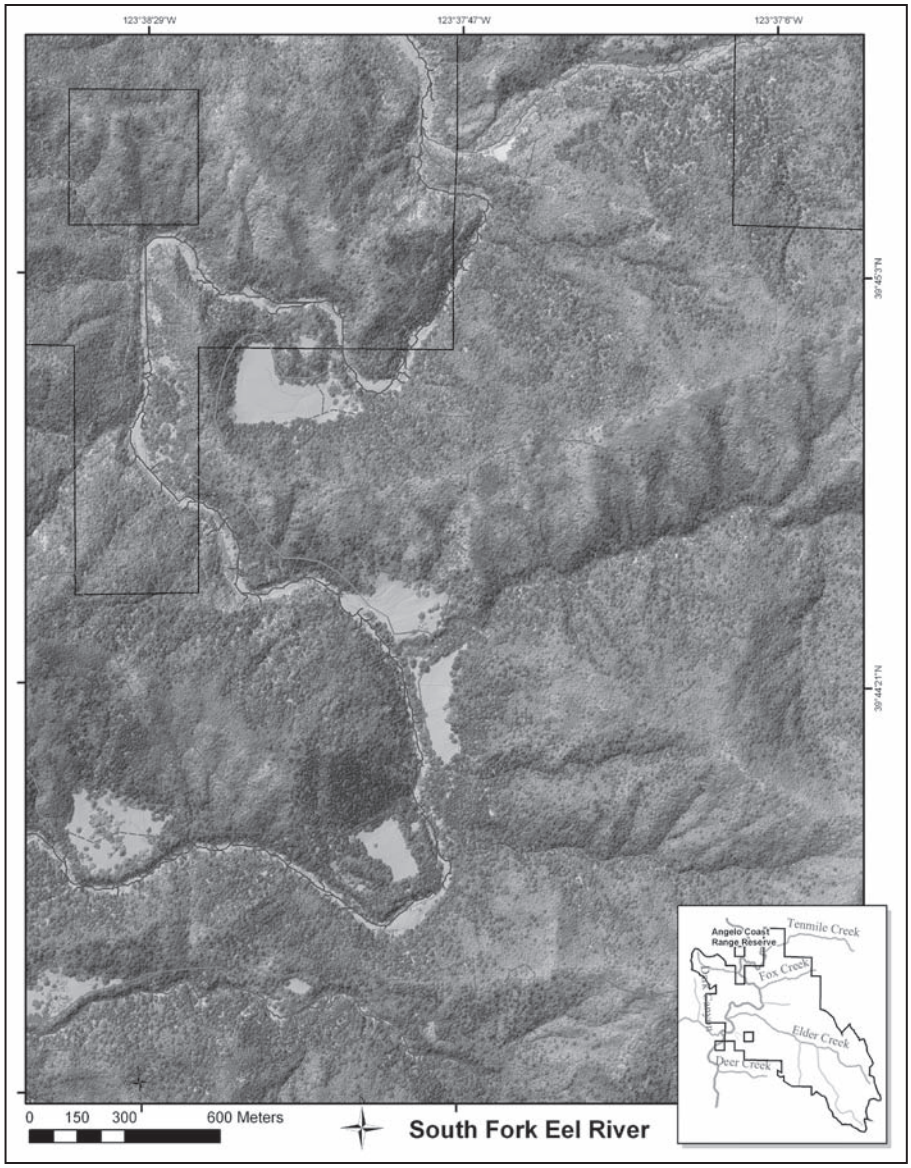

Map of Angelo Coast Range Reserve created using LIDAR data. Courtesy of the National Center for Earth-surface Dynamics (NCED)

LIDAR can also provide a perspective on the human factors that are shaping the landscape today. Just above a major landslide, Dietrich points out a dense web of roads. "It looks like what would happen if a spider had a bulldozer!" He exclaims. The strands of the web consist of logging roads and skid trails for hauling logs. Wherever they intersect a channel, they shed fine sediments into the stream. Studies in the area suggest that they account for half of all the sediment now carried by the river. He points to the map as evidence. "This LIDAR really captures it. First, it shows just how many roads there are. And, second, there's a high probability that they're going to influence the amount of sediments in the channels."

To this point, geologists and geomorphologists have led the way in using LIDAR for scientific research. Dietrich predicts this will change in the near future, as ecologists discover its capabilities. Mary Power's work at Angelo is a first step in expanding the use of LIDAR. "The geomorphic processes set up the theater stage for the ecology to play itself out," Dietrich explains, "and it's very particular. Ecologists are moving more and more toward understanding ecological processes in a watershed context, realizing that the river networks are hierarchical structures that potentially impose a structure on the food web."

Dietrich argues that the power of high-quality LIDAR images is a major factor driving this trend. "It's really hard to be inspired to think about ecological connections in a watershed context when all you have are maps that lack channel detail. Whereas with LIDAR, you have the actual channels there, quantitatively in the data, and you have the full channel network, so you can start visualizing where your ecosystem processes are relative to others. … I think it's going to stimulate exploration into the question of how river networks structure food networks in a way that couldn't be done before." —*JB*

For more information, visit the Web at:
National Center for Airborne Laser Mapping (NCALM) —
http://www.ncalm.ufl.edu/
http://calm.geo.berkeley.edu/

— *and* —

National Center for Earth-surface Dynamics (NCED) —
http://www.nced.umn.edu/

Conversation with Costa

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in terms of how you use the ocean? Or, maybe it doesn't matter. Maybe making a living in the ocean is so constrained that all ways converge on the same solution. Whichever answer it turns out to be, the question is very interesting, and TOPP will help us address it.

Q: So birds and pinnipeds are similar in the way they make their livings?

Costa: The similarity between an elephant seal and an albatross is that they both have very economical ways of moving through the north Pacific. Elephant seals are large and have a breeding strategy that allows them to accumulate resources over a long period of time, first storing them up, then giving them to their pups on the beach at Año Nuevo Island in a very, very short period of time. They have nine months to swim around the ocean, slowly collecting resources. Albatrosses are also very economical at making a living, but they take a different approach: they're gliders. They use the tremendous winds of the north Pacific as their power source. They have the advantage of speed, so they can make flights of one to three weeks when they have a chick in the nest.

Q: How have oceanographers responded to the idea of using animals as mobile data-collectors?

Costa: At first, they thought the idea was a joke. But now they're really grasping it big-time. The French oceanographic community has gotten solidly behind the idea of using animals as oceanographers, and they are incorporating data from southern elephant seals into their database. In the U.S., the physical oceanographic community is just starting to incorporate data from TOPP tags into their thinking.

Q: From an oceanographer's perspective, what are the advantages of using animal tags?

Costa: Animals will never replace traditional oceanographic platforms. That's not our desire. But we think we have a strong role to play in providing data sets that would be hard to obtain otherwise. The traditional way of getting out there is by ship — very expensive — or by using floats. The most recent ARGOS float goes down to a thousand meters and drifts around on the deep-ocean currents for ten days. Then it surfaces. On the way up, it takes a profile, hits the surface, and transfers the information. These tags are programmed to do that every 10 days for 100 times. But once they're dropped off by boat or plane, we have little control over where they go.

We don't have control over exactly where an animal goes, either, but we have a general idea. Elephant seals, for example, provide tremendous coverage of the north Pacific. And whereas the ARGOS float takes one profile every ten days, an elephant seal female performs sixty dives a day. Plus, they're self-propelled and self-fueling. For us, the only power problems are getting the information back … having a package [i.e., a tag] small enough that we can get all the information transmitted to a satellite.

Q: How does TOPP fit into international efforts to understand the ocean?

Costa: We're one of dozens of pilot projects working under the Census of Marine Life (CoML), a cooperative international effort to assess the diversity, distribution, and abundance of life in the ocean. Most of the efforts tend to be censuses of unique habitats — transects across the Gulf of Maine, looking at

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Above: Female northern elephant seal equipped with a satellite tag on her head.
Left: UCSC graduate students collect data for the TOPP project on mother and pup northern elephant seals at Año Nuevo Island Reserve.
Photos by Dan Costa

Conversation with Costa

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seamounts, the mid-Atlantic ridge, or chemosynthetic deep-sea organisms. One Danish project is looking at the history of marine animal populations, while another based in Nova Scotia is trying to predict future populations. The newest effort, CoML, based out of Tasmania, is set to examine the Southern Ocean. CoML was envisioned by the Alfred P. Sloan Foundation to provide the administrative infrastructure for all these efforts. If a program can get its own research funding, they can use Sloan money for their infrastructure. It's a bit like NEON* in that it funds the infrastructure, then the scientists have to bring in the science budget to make it work. It's a concept most environmental scientists in the U.S. are not accustomed to.

Q: The oceanographic community seems very open to large-scale collaborations, like TOPP and CoML. Could any of these ideas be adapted to terrestrial ecology?

Costa: ORION (Ocean Research Interactive Observatory Networks), which is essentially the NEON of the ocean, is moving along big-time. The oceanographic community, because they often have to share resources, such as a ship, have been working collaboratively for much longer. They've put a lot of thought into what information one needs to collect to establish long-term data trends. Actually, in many respects, the NRS provides a beautiful model for these concepts as well.

Q: What do you mean? How does the NRS figure into this?

Costa: With the NRS, we're now getting to the point where the system can be integrated, and the data can be systematically acquired to provide baseline information. That's why we're constantly stressing the importance of minimum data sets and data archiving. Long-term data sets give a context for anything a researcher wants to do at a reserve. The fifty years of weather patterns stored at Hastings Reserve, for example, provide invaluable context for a researcher who might only have a single season to collect data on an animal population. It tells that investigator whether or not it's been an unusual year.

That's the common conceptual framework we need to keep in mind at the NRS. I get excited about TOPP and NEON. The NRS has the potential to do similar things in an integrated way. Of course, it's not easy. I spend lots of time bringing together various components of the TOPP effort, coordinating PIs, talking to funders, doing paperwork, and promoting collaborations with the engineering community. So it's my students and colleagues who are actually having all the fun, doing the science that I got into this business to do. That's the downside.

Q: And what keeps you going?

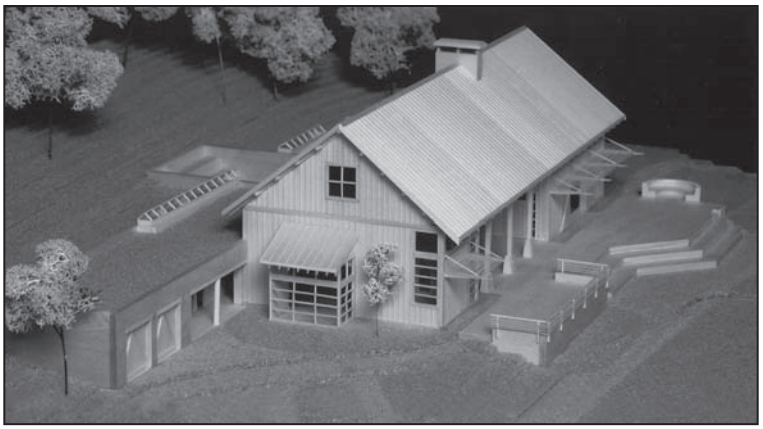
Costa: Hopefully, a couple of years down the road, I can start putting together some of those observations I spoke to you about earlier. I've done similar work in the past, and it's been well received. The beauty of TOPP is that we want to move the field forward significantly and very quickly.

For more information, see the TOPP website at:
http://toppcensus.org/

Some Año Nuevo Island inhabitants who may contribute data to the TOPP project. Año Nuevo Island Reserve is a 25-acre portion of the 4,000-acre Año Nuevo State Reserve, all of which is owned and operated by California State Parks. Due to the highly sensitive habitats and protected marine mammals at the island, reserve use is restricted. Photos by Dan Costa

**Editor's Note: NEON, the National Ecological Observatory Network, is a National Science Foundation-funded program to develop an integrated system of natural observatories across North America. These linked observatories will track natural processes at all spatial scales, time scales, and levels of biological organization.*

Major facilities upgrades in the works at NRS sites



Model of the all-green Tipton Meeting House under construction at Sedgwick Reserve, near Santa Barbara. Designed by Leavengood Architects of Seattle, WA

In June 2005, ground was broken at the Sedgwick Reserve, located near Santa Barbara, for the Tipton Meeting House, a new learning and administrative center. The 6,600-square-foot building — funded completely by the J. E. and Lillian Tipton Foundation — represents a major achievement for the Sedgwick Reserve and the entire UC Natural Reserve System.

The sustainable design features of the Tipton Meeting House — including a solar-power array, a vegetated roof planted with native flora, rainwater cisterns to supply the building's low-flow toilets, and passive heating and cooling systems — reflect the values of the reserve system. The facility's primary use — to serve Sedgwick's rapidly expanding K-12 outreach program — reflects the public service component of the NRS mission:

To contribute to the understanding and wise management of the Earth and its natural systems by supporting university-level teaching, research, and public service at protected natural areas throughout California.

But there is much to be done throughout the reserve system. As NRS Director Alex Glazer notes, "At the majority of the reserves, researchers and educators still use the original buildings that were on the site prior to its inclusion in the system. These facilities are very limited in scope and suitability, and place a real limit on a reserve's usefulness for research and teaching."

Perceiving this need, especially in light of the increasing technical sophistication of field research, staff and faculty that support a number of NRS reserves are working on plans for new facilities. These projects include:

• A "reserve village" at the Sedgwick Reserve that will include, in addition to the Tipton Meeting House, an ecological research laboratory, a student housing complex, and small residences for reserve staff and long-term researchers. To support these future developments, the reserve's access road was recently rebuilt and its water system is being upgraded.

• A laboratory and classroom building at the Boyd Deep Canyon Desert Research Center in the Coachella Valley, near Palm Springs. Boyd is one of the seven original NRS reserves, established in 1965, yet the site still lacks lab facilities, and all classes are conducted outside. So far, over $250,000 has been raised for this 2,500-square-foot project, but additional funds are needed.

• A research and engineering laboratory and a housing compound for 12 full-time researchers at the James San Jacinto Mountains Reserve in Southern California, near Idyllwild. These 3,000-square-foot facilities are critical, as the reserve, established in 1966, has become a major test center for a number of national research projects, including CENS, the Center for Embedded Networked Sensing. Plans also call for renovation of the reserve's existing structures for teaching, for upgrading the manager's residence, and for expansion of the site's solar-photovoltaic system.

• A science/education center to provide housing, living, teaching, and meeting space for classes and public seminars at the Hastings Natural History Reservation in the Carmel Valley. For 70 years, Hastings has been a center for the study of oak woodland and grassland savanna ecosystems. The reserve's long-term data sets and collections, which date back to 1935, are invaluable and irreplaceable to both researchers and teachers; it is critical they be protected in a modern facility.

Most of the funding for facilities development at NRS reserves must come from external sources, primarily foundations and private donations. To find out more about these projects, visit the NRS website at: <**http://nrs.ucop.edu/Facilities-Planning.htm**>. Or call the NRS systemwide office at: 510-987-0159. — *JB*

A FEW WORDS

Continued from page 1

with rapidly burgeoning development of software, made possible the personal computer. Such computers and the Internet now dominate the way and speed at which we communicate and share humanity's store of knowledge.

Advances such as these, singled out from the tidal wave of invention that characterized the twentieth century, represent the underlying foundations for the laser-mapping technology described in the lead story of this issue of *Transect* (*page 1*: "New laser-mapping technology enables 'aerial groundtruthing'"). This laser-mapping technology, called LIDAR, is being employed by UC Berkeley professor Bill Dietrich to map, in extraordinary detail, the topography of the NRS's Angelo Coast Range Reserve. In turn, Dietrich uses this information to understand the way the Angelo landscape was created and to predict the changes it will undergo in the future. LIDAR allows simultaneous mapping of the underlying terrain, stripped of its ground cover, and of the vegetation structure patterns, based on height. Analyzed along with extensive biological studies, LIDAR mapping leads to a sounder understanding of the genesis and functioning of the ecosystem.

These technological advances also enable the research on "Tagging of Pacific Pelagics," which is explored in an engaging interview with UC Santa Cruz professor Dan Costa (*page 5*: "A conversation with marine scientist Dan Costa — TOPP that!"). This research exploits small microprocessor-based data storage tags that collect data and transmit them to satellites. Miniature data collectors attached to pinnipeds at the NRS's Año Nuevo Island Reserve provide information on the migration behavior of these deep-sea diving mammals and on nutrient-rich spots in the oceans. The tags also collect a wealth of information on the geo-location of each animal, along with concurrent measurements of light, depth, ambient temperature, and salinity. These data are combined with information gathered by remote-sensing satellites to gain a holistic understanding of the interplay between the physiology and behavior of the animals, the location and extent of nutrient-rich areas, and patterns in the physical environment in the open ocean.

— Alexander N. Glazer
Director, Natural Reserve System

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