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A few words from the
NRS systemwide office

Exotic species pose major intractable problems worldwide. The NRS is not immune. Thousands of feral pigs roam free on Santa Cruz Island, Mediterranean grasses blanket the Hastings Reservation, fountain grass marches up the slopes of Boyd Deep Canyon Desert Research Center — the list goes on. Three important studies, published in the year 2000 by researchers connected with NRS sites, deal with introduced and invasive species.

The first of these studies was motivated by the widespread concern about the worldwide decline of amphibians. Particularly puzzling is their disappearance from within protected areas. Roland Knapp (based at the Sierra Nevada Aquatic Research Laboratory) and his

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Master hummingbird-bander Barbara Carlson counting beak striations on one of the 1,850 hummingbirds she and her team banded this year. Photo by Elaine Miller Bond

A bird in the hand is worth ... banding!

Tiny hummingbirds are yielding big data for the team of bird banders led by Barbara Carlson, manager of the NRS's Motte Rimrock Reserve in Riverside County. Carlson stands out as one of only eight certified hummingbird banders in the United States. She and her banding team recently wrapped up their third year of a six-year hummingbird monitoring project. Each year they catch more and more "hummers" (as these tiny birds are known in the trade). This year they banded and collected data from 1,850 birds.

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Bird in the hand

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From June through October, Carlson's team bands hummingbirds at the Motte Rimrock Reserve and three other regional sites: the Audubon Society's Bear Paw Sanctuary (San Bernardino Mountains), the U.S. Bureau of Land Management's Big Morongo Preserve (north of Palm Springs), and Carlson's own residence in the city of Riverside. Banding is conducted every ten days at each of the four sites, often in sweltering heat. True early birds themselves, team members begin trapping and banding at one-half hour before sunrise (before it gets too hot outside) and continue for an intensive five hours. The team does not band when winds are over 8 to 10 miles per hour, because the birds get stressed too easily.

To attract the birds, the team hangs eye-catching red hummingbird feeders inside a large, enclosed mistnet canopy that is open on one side. The hummers fly in and eat. At this point, a minimum of four people is needed to process each bird. First, when the bird has finished eating, the *extractor* gently shepherds it into the nearly invisible net. The extractor then removes the bird from the mistnet and places it in a mesh bag, which is suspended from a hanger while the hummer awaits processing. The maximum queue is five birds; any additional birds that fly into the mistnet are immediately

released so that they will not be subjected to a lengthy capture.

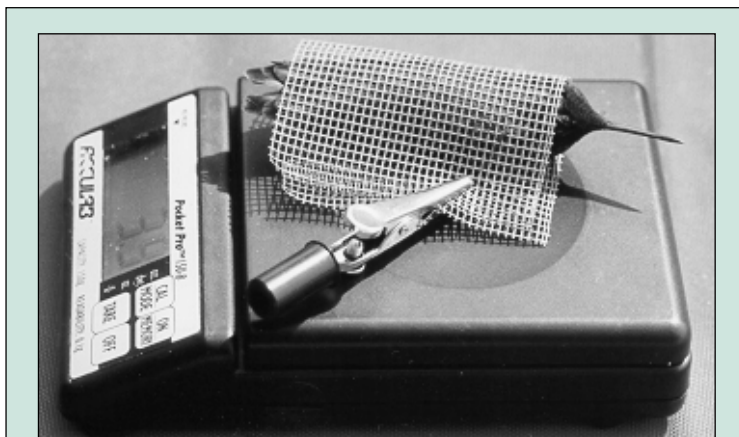
At this point, the *bander* takes over, delicately holding the hummer by hand. Two different methods for holding the bird are used during the banding process: the "bander's grip" — in which the bird's head pokes out between the bander's index and middle fingers — and the "three-finger hold" — in which the bander's thumb and middle finger grasp the outside of each wing, with the index finger placed on the back.

Working quickly, the bander identifies the species, age, and sex of each bird in order to determine which band size to use. (For black-chinned humming-

birds, the females need a larger band.) The bander then fits the hummer with a leg band, which contains an identification number that will now be unique to that individual bird. To ascertain the hummer's well-being, the bander also looks at weight, fat, body molt, and wing molt. In fact, for each bird, the bander checks fourteen different characteristics, some as subtle as primary wear on the wing feathers, striations on the beak, and whether the width of the inner primary feathers is equal to the width of the outer primary feathers. These birds only weigh from 3 to 4 grams — less than a nickel — so precise measurement is key. To help identify the species of some hummers, the wing chord (that distance from the bend in the wing, or wrist, to the tips of the feathers) must be measured to the nearest millimeter.

As the bander calls out the data, the *recorder* writes it all down. Later this information, along with the date, location, and bander's name, is entered into Carlson's database network and sent to the U.S. Geological Survey's Bird Banding Laboratory in Maryland, which manages nationwide data on all bird species.

By now, the hummer, with its high metabolic rate, is probably getting hungry. Previous studies using isotope-labeled water indicate that food passes through the bird's speedy system in just fifteen minutes. So, when the bander and recorder have finished their tasks, the *feeder* holds the bird



A hummingbird being weighed during a banding capture. First, the hummer is wrapped gently in a sheet of lightweight nylon on screen, secured by an alligator clip — then the entire "bird burrito" is weighed on a precise scale. Photo by Barbara Carlson

How many hummers can you mail with a first-class stamp?

You can write a three-page letter that weighs 1 ounce, stuff it in an envelope, stick a first-class U.S. postage stamp on it, and mail that letter anywhere in the United States.

Or, instead of sending a letter, you could use the same postage stamp to mail six or seven hummingbirds.

But please don't try this, as these birds manage to migrate thousands of miles on their own each year, and they prefer to arrange their own transportation.

and offers it sugar water. Feeding the bird not only makes capture less stressful, but also discourages it from making a beeline right back into the beak-watering feeders under the mistnet.

“The health and safety of the hummers are our first priorities,” emphasizes Carlson. From capture to release, it takes approximately twenty minutes to process a hummingbird, and that includes the waiting time in the mesh bag. At its peak, the team of six people (two banders, two recorders, one extractor, and one feeder) can process more than twenty birds per hour.

This year Carlson caught 115 hummers that had been previously banded by her team or by others, some from as long ago as six years and some from last year. Recapturing banded birds helps determine their lifespan as well as their movement patterns.

Carlson’s six-year monitoring project, titled “Southward Migration of the Hummingbird in Southern California,” is intended to help track the movements of two hummer species: Allen’s and rufous. However, two additional hummingbird species — Costa’s and black-chinned — have snuck their way into the project and are revealing trends in their movements as well.

Allen’s and rufous hummers do not nest in the Riverside/San Bernardino region. However, they do stop there to feed on large flower patches as offshoots from the well-documented “racetrack migration.” This migratory loop moves for thousands of miles — northward along the California coast, cutting inland, swooping southward through Colorado to New Mexico, and returning back to the coast.

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Making bands by hand

With tweezers and magnifiers in hand, master banders Barbara Carlson and Ruth Yoder spend countless hours pecking away at the task of making their own hummingbird leg bands. It takes 2.5 hours to make just 50 bands, and this year alone they made 1,100!

The bands come lined up in rows, on super-thin aluminum sheets with preprinted numbers. Each sheet is only 4.5 inches square — smaller than a CD case — and contains 300 bands.

Yoder uses scissors to cut out the rows of bands into long strips. She then sands the sides of the strips smooth for maximum comfort on the hummers’ legs. Carlson cuts the long strips down into individual bands of different lengths. The bands range from 5.2 millimeters long for the teeniest 3-gram birds to 6 millimeters long for the slightly heftier 4-gram birds. Carlson finishes the job by using a jig to shape each band into a perfect circle.

Regulations from the USGS Bird Banding Laboratory require that leg bands weigh no more than 3 percent of the bird’s weight — 90 milligrams for the smallest band. Each miniscule band is imprinted with five digits, plus an alphabetical character that stands for four more digits. Many banders use magnifiers to read the fine print, which is smaller than four-point type (this is four-point type). To see it with the naked eye, you almost need hawk-eyed vision. — *EMB*

Actual size of a hummingbird band before it’s formed into a circle → ■



Ruth Yoder (left) and Barbara Carlson (right), here working together in the field as recorder and bander, respectively. Hours of prep work were required to make the tiny leg bands needed for this single banding session. Photo by Elaine Miller Bond



Deanna Smith-Turnage joined Carlson's team of banders this year as part of the NRS's pilot teacher-education program, HOST (Hands on for School Teachers). Here she uses the traditional "bander's grip" while fulfilling the role of feeder. Photo by Elaine Miller Bond

Bird in the hand

Continued from page 3

Allen's and rufous nest in different regions along the migratory loop: Allen's hummers nest along the coast from Palos Verdes to the Oregon border, while rufous hummers nest in the Cascades and the Rockies. Costa's hummers have a shorter migration. They nest in the deserts and pass through Carlson's study area along their travels throughout the south. Black-chinned hummers nest in California and Oregon and migrate through Arizona and the southern states to Mexico.

Each year, the numbers of hummers, the species caught, and the timing of their appearances varies according to temperature, rainfall, blooming of flowers, and other factors. The numbers of birds also build, peak, and decline during the banding season, indicating the beginning, middle, and end of migration through the region. Peak migration can fluctuate year to year by as much as one month.

During some banding seasons, the team catches numerous Anna's hummingbirds. These hummers have an upslope/downslope dispersal. They nest in the higher elevations of the San Bernardino Mountains and, during cold spells, escape to the lower elevations of Carlson's other three study sites. Calliope hummingbirds, the smallest species in the United States, are also banded. They nest in local mountains and the Sierra Nevada.

"The major thing we're providing is data that will show the important areas needed for these hummers," explains Carlson. "Some may be getting to be species of special concern." Of the 320 New World species of hummingbirds, nineteen live in the contiguous United States; three live in Latin America, but make rare U.S. appearances, drawn here perhaps by atmospheric warming and feeders provided by bird lovers.

Carlson has been banding birds of every feather since 1976 and hummingbirds in particular since 1988. Her lifetime banding total, thus far, is approximately 20,000 birds. Every spring she trains her team, teaching an intensive hummer banding course that lasts one weekend plus two Saturdays. The trainees learn everything they need to know, including all four essential roles of the banding process, which they will practice in rotation in the field.

Carlson and her team give frequent banding demonstrations to interested groups in the region, including college and high school classes. Carlson's team consists of more than twenty volunteers from the community, the youngest a high school freshman and the oldest a bird enthusiast in her seventies. Two banders in particular have provided decades of assistance: Ruth Yoder, for 24 years, and Cin Greyraven, for 22 years. One of the newest members is Deanna Smith-Turnage, a science teacher from

nearby Arlington High School, who began her adventure in hummer banding with Carlson as part of the NRS's pilot HOST (Hands On for School Teachers) Program.* "I feel energized and really had a lot of fun," exclaims Smith-Turnage. "I've developed a new love for hummingbirds that I will have for my whole life." — *EMB*

For more information, contact:

Barbara A. Carlson
Department of Biology
1208 Life Sciences Building
University of California
Riverside, CA 92521
Phone: 909-657-3111
Email: bcarlson@citrus.ucr.edu

*For more information on the HOST Program, turn to pages 8-9.

How long do hummers live?

Retrapping of banded hummingbirds has helped researchers determine the lifespans of different species. Most North American hummers live approximately three years. Their short lifespans are probably due to their fast metabolisms. However, banded birds as old as seven years are occasionally recaptured.

One broad-tailed hummingbird lived to be an ancient 13 years and three months old — over four times as old as the average hummer. This remarkable fact was discovered because the well-traveled bird was trapped in Colorado, during the course of her annual migration to Mexico and back, every single year of her long life! Was she a bird brain or a wise owl that she managed to find the same feeder (and trap) thirteen years in a row? — *EMB*

Out on a Limb: New forest canopy walkways at Angelo

Scientists can now see the forest from the trees. A new system of platforms and bridges — the first of its kind on California's west coast — has recently been installed high in the tops of redwood trees at the NRS's Angelo Coast Range Reserve in Mendocino County.

This canopy access system enables researchers to become "arbornauts" by setting foot and bringing equipment up to nearly 197 feet (60 meters) in the treetops. "It opens up study of what is probably the biologically most active region of the forest," says Mary Power, UC Berkeley professor of integrative biology and NRS faculty reserve manager for the site.

The access system was built by husband-and-wife team Kevin Jordan and Stephanie Hughes, founders of an environmentally friendly company called Arbornaut Access. They have constructed similar systems for scientists around the world and found a way to build bridges and platforms in trees without penetrating the bark with screws, nails, or bolts. To access trees during construction, they used ropes rather than climbing tree trunks. Platform building materials were hauled into the treetops and the platforms custom-built right in the canopies. Finally, the platforms were secured to the trees with nylon trucking straps, which will be loosened as the trees grow.

Platforms in six trees are connected to each other by a system of five "Burma bridges." More akin to a tightrope than a typical walking bridge, each Burma bridge consists of one cable for walking on and two chest-high cables that serve as hand railings. Bridges range in length from 26 to 118 feet (8 to 36 meters); the highest one is 134.5 feet (41 meters) off the ground. They sway from side to side, which adds to the natural "high" of crossing treetop walkways.

Any scientist interested in using the system *must* be trained and supervised by an authorized safety officer — currently, either on-site reserve steward Peter Steel or faculty reserve manager Mary Power. From a user's first step off the ground

to the last, he or she is secured by a full-body harness to a system of safety ropes. To secure the system's entrance, access is available only by rope ladder at a single tree named "Access Tree." (Each tree in the system has a descriptive nickname, such as "Double Trunk," "River Tree," and "Flat Top.")

Trees in the system run a transect from a bank of the South Fork Eel River to halfway up a steep slope. This will give researchers the ability to investigate biotic communities in canopies both near and far from the biologically rich streambed. According to Power, scientists are planning to use the system to study insects, bats, prey flux from the river, predator movements, energy and nutrients, gas fluxes, tree physiology, forest moisture sources, and mosses, lichens, and other epiphytes. Some trees will not have human access, but be fitted with a system of cables for pulling into the trees such research equipment as insect traps, acoustic bat recorders, cameras with triggers, and meteorological monitors.

Most of the canopy access system was constructed last summer; it will be finished next summer. Installation was supported by the Richard and Rhoda Goldman Fund as part of the \$1.2 million Center for Environmental Sciences under construction at the Angelo Reserve. When the center is completed, it will provide laboratory and computer facilities that will enable scientists to examine canopy biota in greater detail. — *EMB*



For more information, contact:

Peter Steel
 Angelo Coast Range Reserve
 42101 Wilderness Road
 Branscomb, CA 95417
 Phone/Fax: 707-984-6653
 Email: psteel@nature.berkeley.edu

"It's exhilarating to be up in the trees," says resident steward Peter Steel. "You know you're in a different environment that's not your own but belongs to the birds and insects. In the upper platforms you can't even see the ground." Steel also serves as safety officer for the system and enjoys the physical rigors: "I have to admit, when I think of having to go up and inspect the system, I don't groan. It's a really fun part of my job." Photo by Leann Tourtilot

It's no picnic: Diverse NRS reserves support multiple ant studies

Researchers are conducting mounds of ant studies at seven NRS reserves across the state. By focusing on ants, they are helping to tackle some of today's most pressing environmental issues, ranging from invasive non-native species to habitat conservation.

A main problem in conserving and researching ants and other insects is that scientists know the distribution of only about 1 percent of the world's insect species — and only about 10 percent of the world's ant species — according to Brian Fisher, assistant curator of entomology at the California Academy of Sciences. For part of his recently completed post-doctoral work at UC Davis, he used the NRS's McLaughlin Natural Reserve, in Napa/Lake Counties, to invent and test the first standardized tool for collecting ground-foraging ants, a device that can be used virtually anywhere in the world.

This inexpensive new tool, called the “mini-Winkler,” quickly sifts 1 square-meter of leaf litter and topsoil into a fine mesh bag. As the smaller bits of organic matter dry in the mesh bag, the ants instinctively try to escape by traveling downward, through a funnel, and into a collection cup.

The mini-Winkler has become popular with many entomologists. Fisher uses it to survey ants in many far-flung countries, including Madagascar, where he discovered over 500 new species of ants. In South Africa, he discovered the world's only known adult ant that produces silk.

“Ants are like plants,” says Fisher. “They stay in one place year after year,



Entomologist Brian Fisher in the field. Photo by Marius Berger



A battery of mini-Winklers collecting ants in the field. Photo by Brian Fisher

so surveying them helps to identify patterns of biodiversity and prioritize specific areas for conservation.”

Fisher is currently using the McLaughlin Reserve as a model for developing protocols for monitoring species at other NRS reserves, in collaboration with UC Davis professors James Quinn and Susan Harrison (who also serves as NRS faculty reserve manager for that site). Fisher's goal is to assure that insects, including ants, are central to conservation efforts.

In some parts of the world, ants turn more soil than earthworms, cites April Boulton, a UCD doctoral student in

ecology. She used the McLaughlin Reserve last spring to investigate the significant role ants play in supporting below-ground foodwebs and sustaining soil microbial biomass, a sensitive indicator of soil health for agronomic and natural systems.

She took soil core samples inside and outside ant nests to compare diversity and abundance of major soil microorganisms, including bacteria, fungi, nematodes, mites, and other invertebrates. So far, she has discovered that nematodes are four to six times more abundant in ant-nest soils. The com-

positions of bacterial and fungal communities also vary in ant versus non-ant soils. In support of these biotic differences, Boulton found, ant soils were more acidic and contained more nitrogen, phosphorus, and organic matter. Next spring she will return to McLaughlin to examine how these soil modifications affect foodwebs.

At the NRS's Elliott Chaparral Reserve, in San Diego, Andrew Suarez recently completed his doctoral research on ants with UC San Diego professor Ted Case. There they investigated the rapid decline of coast horned lizards due to the invasion of non-native Argentine ants. “When the new ants move in, the lizards move out,” says Suarez, “and their habitat has already been severely reduced.”

Like pernicious Lilliputians, the exotic ants swarm the larger native harvester and native army ants in far greater numbers than their normal populations in their South American homeland. They also eradicate some native colonies by killing the queens. In doing so, the insect invaders eliminate the coast horned lizard's primary

food source, but do not themselves become a palatable substitute.

Case and Suarez also found that the unwelcome ants establish strongholds in disturbed or disjunct patches of open land more successfully than in healthy native habitat, such as that provided by the Elliott Reserve. Their findings emphasize how important it is to protect California's native plant communities in order to repel exotics.

Editor's note: Suarez's ant/lizard research was supported by the prestigious Canon National Parks Service Scholars' Fellowship, which funded the majority of his doctoral studies. He was one of four scholars to receive this funding in 1997 and the only biologist.

The unique maritime chaparral and grassland habitats at the NRS's Fort Ord Natural Reserve, part of the decommissioned ARMY base near Monterey, also support UC Santa Cruz biology doctoral student Lisa DiGirolamo in her efforts to track the rate and direction of the Argentine ant invasion. She has begun a unique project to investigate how the intruding ants influence the composition of grassland habitats *indirectly* by reducing populations of native seed-harvesting ants. Eventually, her research may help guide the restoration of disturbed grasslands.

Argentine ants indirectly damage crops, too, particularly orchard trees, says UCD entomology professor Phil Ward. Worker

ants form mutualistic associations with aphids, scale insects, and other homopterans, encouraging the proliferation of these smaller crop pests. The ants suck the sugary honeydew excreted by the tiny insects and, while defending this delectable food source, fight off potential homopteran predators.

Ward uses five NRS reserves — four sites in the Putah Creek watershed (the McLaughlin, Jepson Prairie, Quail Ridge, and Stebbins Cold Canyon Reserves) and the Santa Cruz Island Reserve in the Santa Barbara Channel — to survey and classify ants over a wide area. “The real significance of the reserves lies in their being part of a larger network of natural areas in the state,” says Ward. “Only by surveying ants in many such areas all over California can we begin to answer questions about gradients in species diversity, the occurrence of diversity hotspots, areas of endemism, and other issues.” — *EMB*

Editor's note: The NRS Systemwide Office administers a research grant program for UC graduate students using NRS sites, the Mildred E. Mathias Student Research Grants program. Three scientists named in this review — Fisher, Boulton, and DiGirolamo — received Mathias awards for their ant research.



“Don't hate me cuz I'm beautiful!” Head shot of a Madagascar ant species, *Tetraponera grandidieri*, taken with a scanning electron microscope. Photo courtesy of Brian Fisher, California Academy of Sciences

For more information, contact:

Phil S. Ward
Department of Entomology
University of California
One Shields Avenue
Davis, CA 95616
Phone: 530-752-0486 (no voice mail)
Email: psward@ucdavis.edu

Brian L. Fisher
Department of Entomology
California Academy of Sciences
Golden Gate Park
San Francisco, CA 94118
Phone: 415-750-7240
Email: bfisher@calacademy.org

April M. Boulton
Graduate Group in Ecology
Environmental Science & Policy
2132 Wickson Hall
University of California
Davis, CA 95616
Phone: 530-757-3676
Email: amboulton@ucdavis.edu

Ted J. Case
Department of Biology, 0116
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093
Phone: 858-534-2312
Email: tcase@ucsd.edu

Andrew V. Suarez
Department of Entomology
University of California
One Shields Avenue
Davis, CA 95616
Phone (dept): 530-752-0475
Email: asuarez@ucdavis.edu

Lisa A. DiGirolamo
Department of Biology
University of California
Santa Cruz, CA 95064
Phone (lab): 831-459-2533
Email: digirolamo@biology.ucsc.edu

Right on for hands on: NRS reserves “HOST” program teaching K-12 teachers how to take science outside

All students deserve an equal chance to succeed. Yet thousands of K-12 (kindergarten through twelfth grade) students in California are not given access to a full range of educational opportunities, especially outdoor experiences. Recognizing this shortcoming of the state’s educational system, the NRS recently tried out a new systemwide program called HOST (Hands On for School Teachers).

Conceived of and coordinated by the NRS, in collaboration with EAOP (University of California Early Academic Outreach Program), the HOST Program provided one-on-one, field-based training for science teachers from underprivileged schools during the summer of 2000. Six premier teachers from around California spent eight weeks at diverse NRS reserves working directly with NRS reserve managers and on-site researchers. It is estimated this teacher-training program will make a difference for 800 students this school year.

At the beginning of the summer, all six HOST teachers underwent a rigorous five-day field-training course held at the Motte Rimrock Reserve, in Riverside County, and taught by Claudia Luke, former co-manager of the Sweeney Granite Mountains Desert Research Center. During this introductory course, teachers deepened their understanding of the scientific method, practiced techniques for active learning, and completed short-term field research projects.

“I like the idea of training teachers and giving them experiences,” says one HOST teacher, Farr Niere. “I especially liked the crash course on statistics and scientific investigation design. For me, it was a natural and a social experience.”

After the introductory course, each teacher went for six weeks to a different NRS reserve to engage in personalized hands-on training. (See sidebar on the facing page for information on all six teachers and their activities.) Teachers either commuted daily to nearby reserves or, for more remote reserves, lived temporarily on-site. They acquired practical field skills and established close ties with reserve staff and researchers. They also

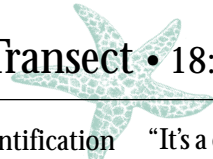
gained new confidence and new strategies for getting their students excited about the environment and involved in exploratory investigation.

“I felt totally rejuvenated,” says HOST teacher Glenda Pepin, who spent most of her summer at the NRS’s Landels-Hill Big Creek Reserve on the remote Big Sur coast. “Throughout the program I was treated with a degree of professionalism that made me feel valued and supported, which teachers don’t get every day. I had a great opportunity to explore particular areas of my own interests, and I also conducted my own in-depth personal explorations. I have made friends for life. This has been one of the best summers of my life.”

HOST teachers also brought their own expertise to the program, by creating original lesson plans for hands-on student activities at reserves. To help with lesson-plan development, the teachers met halfway through the summer with Luke at the Sedgwick Natural Reserve near Santa Barbara for a three-day workshop. The NRS systemwide office is providing funding to HOST teachers for student fieldtrips to reserves, enabling them to employ their new lesson plans and field skills with their classes. Lessons may be conducted at NRS reserves, or other natural areas closer to school, and



The summer 2000 HOST participants at the intensive, five-day introductory course: (left to right) HOST teachers Deanna Smith-Turnage, Farr Niere, Glenda Pepin, Autumn Chapman, Jim Johnson (holding snake), and Michael Collins; HOST trainer Claudia Luke; HOST coordinator Elaine Miller Bond; and manager of the NRS’s Motte Rimrock Reserve Barbara Carlson. Photo by Joseph Messin



will cover a wide range of topics, including identification and native uses of plants, native seed propagation, environmental ethics, invertebrate diversity in kelp wracks, and sensory awareness in nature. They are intended for use by other teachers as well. The NRS systemwide office is in the process of making these teaching materials available on the NRS website: <<http://nrs.ucop.edu>>.

“I’d love to do this all year,” says HOST teacher Autumn Chapman “I had the time to create cool curriculum that I can use, and I made great contacts with professionals working in field sciences. I’m excited about the future experiences I expect to have with my students and the reserve managers.”

At the end of the summer, the teachers gathered again at the Motte Rimrock Reserve for a three-day follow-up workshop, where they shared their wide variety of reserve experiences. As the pioneers of the HOST Program, these teachers had a hard time saying good-bye. However, they formed lasting bonds with each other and with the NRS family, and they have started a new tradition of reserve use that they will share with their students and other teachers.

“It’s a dream program,” says HOST teacher Michael Collins. “The reserves are unbelievable! The chance to learn field techniques with a reserve manager at such pristine places is amazing. Giving students the opportunity to visit reserves with hands-on learning is so important in this world of habitat loss. I am so thankful to be part of this incredible adventure.”

The summer 2000 HOST Program pilot effort was made possible by a grant from University of California School/University Partnerships. The NRS is currently working with EAOP to obtain funding to do it all again during summer 2001. — *EMB*

For more information, contact:

Elaine Miller Bond
 HOST Program Coordinator
 UC Natural Reserve System
 1111 Franklin Street, 6th Floor
 Oakland, CA 94607-5200

Teacher training off to a good start with HOST Program 2000

During the summer 2000 pilot program, HOST teachers visited and trained at 14 of the NRS’s 34 reserves. Listed below are this year’s HOST teachers, their schools and school districts, their primary HOST reserves, and the major emphases of their training:

Autumn Chapman
Oceanside High School
 (Oceanside Unified School District)

Trained at **Scripps Coastal Reserve** (administered by UCSD) in San Diego County and two other NRS reserves administered by UCSD. Emphases on sandy beach monitoring, “killer algae,” stream assessment, coastal sage, oaks, habitat restoration, and environmental ethics.

Michael Collins
Cabrillo High School
 (Lompoc Unified School District)

Trained at **Coal Oil Point Reserve** and **Carpinteria Salt Marsh Reserve** (both administered by UCSB) in Santa Barbara County. Emphases on dune vegetation, kelp wracks, snowy plovers, marine invertebrates, marsh habitats, and geology.

Jim Johnson
Davis Senior High School /
Dixon High School
 (Davis Unified Joint School District /
 Dixon Unified School District)

Trained at **Jepson Prairie Reserve** (administered by UCD) in Solano County. Emphases on native vernal pool habitat and land management, including controlled burning and seasonal grazing.

Farr Niere
Carson High School
 (Los Angeles Unified School District)

Trained at **Santa Cruz Island Reserve** (administered by UCSB) on the Channel Islands off the coast of Santa Barbara County. Emphases on island biogeography, butterflies, native and introduced vegetation, sensory observation, and interdisciplinary island studies.

Glenda Pepin
Dorsey High School
 (Los Angeles Unified School District)

Trained at **Landels-Hill Big Creek Reserve** (administered by UCSC) on the Big Sur coastline in Monterey County. Emphases on stream macroinvertebrates, identification and native uses of plants, stuffing study skins, and outdoor training of other teachers.

Deanna Smith-Turnage
Arlington High School
 (Riverside Unified School District)

Trained at **Motte Rimrock Reserve** (administered by UCR) in Riverside County. Emphases on a long-term hummingbird banding project and native vegetation restoration.

It's a gas! NRS reserve-based research on methyl bromide/chloride has implications for ozone

It's useful to see how and why an atmospheric chemistry researcher does work in the field as opposed to only in the lab," says Robert Rhew, a UC San Diego doctoral student at the Scripps Institution of Oceanography's Geochemistry Curricular Group.

Rhew uses multiple NRS reserves together to develop a larger picture of the environment, extending to the ozone layer. He is quantifying how some terrestrial habitats naturally produce or absorb methyl bromide and methyl chloride, two gases that affect ozone concentration in the upper atmosphere.

To determine which habitats are natural sources of these compounds and which are sinks, Rhew analyzes air samples from four diverse NRS reserves: three in San Diego — the Scripps Coastal, Elliott Chaparral, and Kendall-Frost Mission Bay Marsh Reserves — along with the Boyd Deep Canyon Desert Research Center in Palm Desert.

Under natural conditions, methyl bromide and methyl chloride serve an important role in maintaining the balance of ozone in the stratosphere (the upper atmosphere 10 to 15 miles above sea level). They naturally remove ozone, which was not a problem until human-caused factors dis-

rupted the balance. Because the ozone layer is the earth's primary shield from the sun, it is crucial to life on earth, screening out most of the sun's biologically destructive ultraviolet-B radiation. (Increased ultraviolet-B radiation reaching the ground could damage human health and disturb ecological food chains, affecting agriculture, fisheries, and biological diversity in general.)

Methyl bromide is produced naturally in the environment and also manufactured synthetically by a handful of companies throughout the world using bromide salts from the ocean. In the United States, methyl bromide is one of the most widely used agricultural fumigants. It is commonly injected into soil to sterilize it, but es-

capas to the upper atmosphere where it depletes stratospheric ozone.

In 1992, methyl bromide was officially listed as an ozone-depleting substance under amendments of the 1987 international Montreal Protocol (see *Editor's note*, page 11, bottom of column 1), which mandated a complete phase-out for human use in developed countries by 2005 and in developing countries by 2015. Much sooner, methyl bromide is scheduled to be banned in this country by the U.S. Clean Air Act, and the U.S. Environmental Protection Agency (EPA) classifies it as a Category I Acute Toxin, the most deadly category of substances.

A major goal of scientists is to determine how much methyl bromide in the atmosphere is natural and how much is *anthropogenic* (human caused). Rhew explains: "There are large uncertainties in our understanding of the budget of atmospheric methyl bromide. The ocean is the largest known natural source of methyl bromide, although recently it has been determined to be a much smaller source than previously believed. Therefore, attention has turned toward the *terrestrial* biosphere to find additional sources. My research has identified and quantified natural terrestrial sources and sinks of the compound *in situ* and under natural conditions."



Robert Rhew at Elliott Chaparral Reserve, surrounded by his field research equipment and wearing light clothing so he can spot the deer ticks. Photo by Ben Miller

Rhew wins top graduate award

In recognition of Robert Rhew's excellence in graduate research, the Scripps Institution of Oceanography awarded him the prestigious Edward A. Frieman Director's Prize. Each year, this prize is presented to a Scripps graduate student who has published an outstanding research paper. Rhew, in conjunction with Benjamin R. Miller and Ray F. Weiss (Rhew's advisor), co-authored the paper, "Natural methyl bromide and methyl chloride emissions from coastal salt marshes," which was published in the journal *Nature*, January 20, 2000. — *EMB*

Rhew also studies methyl chloride, which carries natural chlorine to the stratosphere, where it modulates ozone. In the last few decades, human-produced chlorofluorocarbons (CFCs) have far exceeded methyl chloride as the predominant source of chlorine to the atmosphere. Methyl chloride has almost no industrial uses and is far less damaging to ozone, molecule to molecule, than methyl bromide, so no restrictions are placed on it.

To measure natural methyl bromide and methyl chloride in the air, Rhew collects air samples from field plots representing a variety of reserve habitat types, ranging from wetland to desert. He traps air near the ground using a large aluminum flux chamber

Editor's note: The Montreal Protocol on Substances That Deplete the Ozone Layer, a landmark international agreement designed to protect the stratospheric ozone layer, was originally signed in 1987 and substantially amended in 1990 and 1992. By the end of March 1996, 155 countries had ratified the protocol. The protocol not only sets a time schedule for the freeze and reduction of Ozone Depleting Substances (ODS), but also requires all participating parties to ban exports and imports of ODS from and to nonparties. A multilateral fund was established by parties to the protocol, mainly developed countries, to assist developing countries meet protocol-specified control measures. Fund-assisted activities are carried out through four implementing agencies: the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the United Nations Industrial Development Organization (UNIDO), and the World Bank. As of December 1998, the protocol's fund had approved \$661 million to eliminate a total of 105,263 tons of potential ODS per year.



Rhew at the Kendal I-Frost Mission Bay Marsh Reserve in the midst of capturing an air sample. Photo by Toste Tanhua

that covers a surface area of 1 square meter. The flux chamber holds 850 liters of air — roughly the same volume as a refrigerator — and Rhew must rent a cargo van to haul it from site to site. At each of his field plots, Rhew takes two to four samples to make a flux measurement. In total, he takes approximately thirty samples during a field trip.

To collect air, Rhew seats the base of the empty flux chamber in the soil with its lid off and allows it to equilibrate. Then he places the air-tight lid on the chamber to completely seal in the air. He extracts his air samples from the chamber through an air-tight tube into an evacuated, silica-lined, stainless steel flask. In order to analyze differences in the air over time, Rhew draws samples from the chamber when he first collects the air, then two more times, at intervals of between 15 and 20 minutes.

For every field outing, Rhew follows up with approximately 100 hours of analysis back in the lab. He measures a suite of gases in each sample twice using three different gas chromatographs. These machines, which are connected to the sample flask through a tube, were developed in order to make high-precision measurements of trace gases in background air. Since Rhew measures two subsamples on each machine and compares them to known standards, it takes him about 100 minutes to analyze the methyl bromide and methyl chloride, another 100 minutes for methane and nitrous oxide, plus 40 more minutes to measure carbon dioxide.

Rhew has discovered that, over time, the amounts of methyl bromide and methyl chloride in the flux chamber either accumulate or disappear in the enclosed air, depending on the flux of gases in and out of the plant/soil system. If the compounds taken from a particular field plot increase with time, then that field plot represents a *source* — that is, a habitat that naturally produces these compounds. On the other hand, if the compounds taken from a plot decrease with time, then it is a *sink* — a habitat that naturally absorbs the compounds. Rhew performed con-

Continued on page 12



Waiting to exhale? Field research calls for patience, as this image of Rhew at the Scripps Coastal Reserve demonstrates. Photo by Ben Miller

It's a gas!

Continued from page 11

trolled experiments to determine that the observed fluxes were due to the habitats under study rather than chemical reactions influenced by the aluminum chambers themselves.

Rhew says, "Fluxes of these compounds vary tremendously by site, by vegetation type, by season, and even by time of day." Hence he takes samples often and at numerous field plots throughout the year. At each of the four NRS reserves Rhew uses, he has established several field plots in order to survey different habitat types: salt marsh at Kendall-Frost, chamise chaparral at Elliott, coastal sagebrush at Scripps, and creosote bush scrub at Boyd Deep Canyon. He has also conducted this work in tundra and a boreal forest in Alaska, in an old-growth forest in Washington, in a desert in Arizona, and in the model ecosystems at Biosphere II.

"Salt marshes are, by far, the largest source among the biomes I've studied," explains Rhew. "In fact, they may be the largest natural terrestrial source of methyl bromide and methyl chloride identified thus far." He also discovered

Robert Rhew (left) and lab mate Martin Vollmer double-check their equipment on site at the Boyd Deep Canyon Desert Research Center.

Rhew commented at length on the advantages of conducting research at this and other NRS sites: "The reserves are extremely valuable resources and excellent examples of different terrestrial ecosystems that exist in California. The ecosystems are relatively undisturbed, and there is typically a good record of land-use history. Because they are part of the UC system, it is very easy to organize field research without having to go through too much red tape." Photo by Gisela Strassburg



that shrublands can have a mixed effect on gases: "My recent work suggests that certain plants are sources, while the soils are a sink."

Rhew's work is helping to fill important gaps in our understanding of natural methyl bromide and methyl chloride. "The discovery of globally significant terrestrial sources for these compounds has helped in efforts to balance the global methyl bromide and methyl chloride budgets," says Rhew. "And it will help guide policymakers who regulate the use of methyl bromide in the United States and abroad."

Rhew reflects on his use of reserves for atmospheric chemistry: "My research on trace gas emissions may represent an uncommon use of the UC natural reserves, but it demonstrates some of the diversity of research that can be conducted at these important sites."

— EMB

For more information, contact:

Rob Rhew
Scripps Institution of Oceanography
University of California, San Diego
9500 Gilman Drive, Mail Code 0244
La Jolla, CA 92093-0244
Email: rrehew@ucsd.edu

CHiPS off the old Rob

In 1997, Robert Rhew co-founded a graduate student volunteer group called CHiPS — Committee for Humanity and Public Service — which has thus far participated in 43 public service projects and logged over 1,800 person-hours of public service work.

Unlike the 1970s TV show of the same name, this CHiPS does *not* co-star motorcyclist heart-throb Erik Estrada. Rather, it features a cast of up to 100 UC San Diego graduate students and Scripps Institution staff devoted to making a difference for the community and the environment.

Several CHiPS projects have benefited NRS reserves, such as habitat restoration at the Scripps Coastal Reserve and Kendall-Frost Mission Bay Marsh Reserve. Other volunteer efforts include: building a wolf pen for the Julian Wolf Preserve (east of San Diego), maintaining trails at the Torrey Pines State Reserve (north of the Scripps Institution), and working on renovation and construction projects for Habitat for Humanity.

For more information or a chance to volunteer:

Visit the CHiPS website at —
<<http://siochips.ucsd.edu>>

Or email CHiPS directly —
siochips@sio.ucsd.edu.

Thanks and keep your motors running!

New science education center opens at Valentine Camp

Imagine leading second graders through a subalpine forest. Ask them to stop, close their eyes, and take in the smells and sounds. Hand them feathers, leaves, bones, and rocks to touch. Encourage them to talk about their experiences. Awakening children to nature and helping them articulate their impressions is what the Outdoor Science Education Program at the NRS's Valentine Camp is all about. And to support this reserve-based outreach program, a new facility — the Valentine Reserve Education Center — was constructed at the site and opened this summer.

With no other science centers in the Eastern Sierra region, this new educational facility at Valentine Camp, near the Mammoth Lakes, provides a unique and much-appreciated resource for Inyo and Mono Counties. Simple and sturdy, the new classroom building was designed to resemble the reserve's existing log cabins, built in the 1920s and now serving as researcher residences.

The new structure is larger than an average classroom, with 912 square feet of space inside, and 386 square feet of covered porch outside. It comes complete with lab benches, video and projection equipment, and dry-erase boards. Construction was supported by donations from the Mammoth Mountain Ski Area, Intrawest Mammoth Corporation, and Carol Valentine, the original donor of the reserve.

“Before the new classroom was built, Valentine Camp had no indoor facilities for class use,” explains the reserve's on-site manager, Dan Dawson. “Teachers had no place to store materials and were literally forced to work out of the backs of their cars. Long-term projects were also not possible. And with no back-up plans for bad weather conditions, teaching was often cancelled at the slightest hint of inclement weather.” Located at an elevation of 8,000 to 8,500 feet, the reserve is blanketed annually by deep snow pack, and the classroom is buttoned up from November through May.

Each year since 1995, the Outdoor Science Education Program has benefited 2,000 students from more than ten schools in six different districts. Many students take class field trips to Valentine Camp, some piling onto buses to head there from communities located up to two hours away. After the opening of the new classroom on July 15, 2000, several hundred children, ages seven through twelve (second through seventh grades) have taken classes and fieldtrips there.

Reserve Manager Dawson says, “Working with children is a high-profile activity with tremendous community support. This outreach program is our direct connection to the

community.” And in the future, the new facility will also be used for teacher-training workshops. The Outdoor Science Education Program is coordinated and designed by widely respected teacher and specialist in outdoor education, Leslie Dawson. — *EMB*

For more information, contact:

Leslie Dawson
Education Coordinator
Sierra Nevada Aquatic Research Laboratory (SNARL)
Route 1, Box 198
1016 Mt. Morrison Road
Mammoth Lakes, CA 93546
Phone: 760-935-4334
Email: Ldawson@msi.ucsb.edu



The new science education center at Valentine Camp. Photo by Dan Dawson



Education Coordinator Leslie Dawson (center) and well-wishers of all ages celebrated the 90th birthday of reserve matriarch Carol Valentine (right) at Valentine Camp's newly constructed education center. Photo by Paul Page

SNARL-based researcher receives U.S. Forest Service award

This year the U.S. Forest Service conferred a prestigious award — the “Rise to the Future: Individual or Group Research Achievement Award” — on Roland Knapp, a research scientist from UC Santa Barbara’s Marine Science Institute, who is stationed at the NRS’s Sierra Nevada Aquatic Research Laboratory (SNARL) near Mammoth Lakes in Mono County.

Knapp is the first non-Forest Service scientist ever to receive this high honor. He shared the award with Kathleen Matthews, a research scientist from the U.S. Department of Agriculture’s Pacific Southwest Research Station.

Knapp uses SNARL as a base for studying the rapidly declining mountain yellow-legged frog (*Rana muscosa*) in the high country of the Sierra Nevada. Since 1996, Knapp and his research team have completed the most extensive, most physically challenging survey of frog habitat ever undertaken — currently totaling a remarkable 3,700 lakes and ponds at high elevations of 9,500 to 12,000 feet.

In the process, Knapp has discovered and documented the devastating effect that stocking lakes with trout has had on the frogs, which evolved in the absence of fish and are therefore particularly vulnerable to these new predators.

To help restore mountain yellow-legged frogs, Knapp is working to establish frog refuges in backcountry areas. He has already removed fish from a handful of lakes, and in just three years, adult frogs have increased fivefold, while tadpoles have rebounded by more than

5,000 percent. Knapp also hopes to restore frogs in additional fishless lakes that are too far from existing frog populations to be recolonized naturally.

In this time of global amphibian decline, Knapp’s invaluable work is contributing greatly to the body of knowledge of a native species that will likely be listed as federally endangered within a year. — *EMB*



Award-winning scientist Rol and Knapp at work. Knapp’s critical research on California’s dwindling population of native mountain yellow-legged frogs was highlighted in “Native frogs are ‘sitting ducks’ for introduced predators,” *Transect* 17:2 (Autumn/Winter 1999), pages 9-10. Photo by Eric Knapp



Rol and Knapp (left) received his award from Chief of the U.S. Forest Service Mike Dombeck in Washington, D.C. last April. Photo courtesy of Rol and Knapp

Changing NRS guard at UCSB

The NRS offers thanks and bids farewell to Scott Cooper, the professor of biology who served six years as campus NRS director at UC Santa Barbara before stepping down from that demanding post.

Filling in for Cooper will be Henry Offen, professor emeritus in UCSB’s Department of Chemistry and a longtime supporter of the reserve system, who is in fact a former campus NRS director at Santa Barbara.

Under Cooper’s leadership, the NRS reserves administered by UC Santa Barbara made huge strides, individually and as a group. The NRS budget at UC Santa Barbara nearly doubled during the period Cooper was NRS campus director, and facilities were built at several UCSB-administered reserves, including computer centers at Santa Cruz Island Reserve and Sierra Nevada Aquatic Research Laboratory (SNARL).

Moreover, during Cooper’s administration, two reserves were brought into the system: the Sedgwick Reserve, in Santa Barbara County, and an emerging new NRS site near San Luis Obispo called the Kenneth S. Norris Rancho Marino Reserve.

Cooper helped to develop plans for environmental protection and restoration. He assisted the expansion of reserve-based outreach programs, and he supported the formation of partnerships with several community organizations, such as the Santa Barbara Museum of Natural History, The Nature Conservancy, and the Land Trust for Santa Barbara County.

Cooper has taken the position of director of the Education Abroad program at UCSB. He also continues to chair UCSB’s Department of Ecology,

NRS mourns Charlie Motte

Evolution, and Marine Biology, as well as maintain an active program of research (some of which he conducts at SNARL in the Eastern Sierra), teach a teaching-assistant training course, and serve on a variety of advisory and planning committees for the chancellor.

In becoming Santa Barbara's new campus NRS director, Henry Offen, returns to a post in which he had already acquired more than 20 years of experience. Offen joined the campus administration in 1972, two years after UCSB's first reserve, Coal Oil Point Reserve, was added to the system. He remained in administrative charge of reserves from 1972 until 1994 — first in the Graduate Division, then in Research Development (now, the Office of Research), then in the Marine Science Institute. (The title of campus NRS director was created between 1977 and 1981, during Offen's tenure as director of the Marine Science Institute, back when the NRS was still known as the Natural Lands and Water Reserves System.)

Although Offen was a professor of chemistry, traditionally a lab-based subject, he was instrumental in increasing scientific use of reserves for field-based research. And he was strongly supported by faculty and students.

With Offen having created a strong foundation for the NRS at UC Santa Barbara and Cooper having enhanced and energized system administration at a campus level, it's no wonder the exceptional organizational cohesion of the NRS at UC Santa Barbara is so well respected and admired.

The NRS looks forward to maintaining grateful close ties with Cooper and to welcoming back Offen, who, despite his recent years in retirement, never truly left us.

Long-time NRS friend and donor Charlie Motte died on September 26, 2000, at age 86. If it had not been for this forward-thinking man, whose full given name was Charles Louis Alphonse Motte, rapid suburban development throughout Perris Valley might well have engulfed one of the most important and interesting natural landscapes in the Riverside County region.

A prominent land developer in the latter part of his career, Motte balanced industrial growth with environmental preservation. In 1976, he and his wife, Oattie Motte, established the NRS's Motte Rimrock Reserve just outside the City of Perris — and, in the years that followed, they continued to add to it. The site's boundaries now encompass 644 acres.

A boulder-strewn landscape covered with rare coastal sage scrub, the Motte Rimrock Reserve contains some of the best-preserved pictographs in Southern California and is home to a variety of rare, threatened, and endangered animals. The rocky rim above the reserve was also home to the Mottes, enabling Charlie Motte to keep a close eye on the land he loved and wanted to preserve.

Motte moved with his family to Perris in 1925 and became deeply involved in the community. One of his early interests was potato farming. So talented he was in working the earth that he served as a role-model and mentor

to other farmers in the region. His intimate knowledge of the land carried over to his desire to protect it for research and education.

Barbara Carlson, who has managed the Motte Rimrock Reserve since 1986, recalled the first time she met Charlie Motte:

It was back when I was still a graduate student at UC Riverside. I was out at Motte doing field research on breeding birds of coastal sage scrub for my master's thesis.

I had been instructed repeatedly to not allow anyone to trespass or bring dogs onto the reserve, and one day I saw a man walking a dog along the fence. I walked over to him, and he came over to me. Before I had a chance to say anything, he sternly asked me, "Who are you, and what are you doing here?" I replied, then asked him the same question. His response hit me by surprise.

So that's how we met: we were each going to kick the other one off the reserve. We worked together ever since then, trying to protect the Motte Rimrock Reserve. I really miss him.

Although the Mottes had no children of their own, Charlie Motte was widely known in the community as "Uncle Charlie." He is survived by Oattie, his wife of 63 years, and by numerous nieces and nephews, many of whom reside in Perris Valley. — *EMB*



Motte Rimrock Reserve landscape. Art by Kendal Morris

A few words

Continued from page 1

colleague Kathleen Matthews showed that introduced fish were the major factor leading to the decline of the mountain yellow-legged frog in Sierra Nevada lakes (see article on page 14 of this issue of *Transect* and, also, *Conservation Biology* (2000) 14:428-438).

At the Elliott Chaparral Reserve, research by Andrew Suarez traced the rapid decline of coast horned lizards to indirect impacts of invasion by Argentine ants (see article on page 6). Further studies (*Proceedings of the National Academy of Sciences of the United States of America* [2000] 97:5948-5953) demonstrated that, in the U.S., the introduced populations of Argentine ants have a much-reduced genetic diversity as compared to Argentine ants in their native ranges. This loss is associated with reduced intraspecific aggression among the ants and allows the formation of supercolonies in which workers and queens mix freely among physically separate nests. The invaders wipe out indigenous ants by sheer superiority in numbers. This finding challenges widely held beliefs. The researchers write: "The ecological success of this species is surprising, given that reduc-

tions in genetic diversity are generally believed to be harmful."

In an elegant study performed at Angelo Coast Range Reserve, exploiting mini-ecosystems within the tussocks of a sedge (*Carex nudata*), UC Berkeley graduate student Jonathan Levine tested the classic hypothesis that species diversity enhances community resistance to biological invasions (*Science* [2000] 288:852-854). He concluded that the most important factor influencing invasion abundance in this system was the number of seeds of the invasive plants per tussock, as opposed to either diversity or resource conditions. He concludes that the most effective way to stem invasions is not just to try to maintain the natural species diversity, but to stop nonnative seeds or organisms from getting into an ecosystem in the first place — a difficult prescription to follow.

In 1983, Lewis Thomas, renowned physician and essayist, observed wryly that "the principal discoveries in this century, taking all in all, are the glimpses of the depth of our ignorance about nature." The surprising outcomes of the studies described here support his perspective.

— Alexander N. Glazer
Director, Natural Reserve System



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Managing Editor: Susan Gee Rumsey
Senior Science Writer: Elaine Miller Bond
Circulation: Kara Gall
Web Mistress: Cyndi Lukk



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Natural Reserve System

University of California
1111 Franklin Street, 6th Floor
Oakland, CA 94607-5200



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