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NRS Transect

Title

The NRS Transect 10:2 (fall 1992)

Permalink

<https://escholarship.org/uc/item/7125k0cc>

Journal

UC Natural Reserve System, 10(2)

Author

UC Natural Reserve System

Publication Date

1992-09-21

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Systemwide Salutations

New Initiatives for Study at NRS Coastal Reserves

In a typical year, more than 300 scientists carry out research on NRS reserves. In addition to conducting descriptive inventories of species and habitats, these reserve users are working increasingly to collect precise quantitative and instrumental data on community and ecosystem structure and function.

In order to support these mechanistic studies, however, we need accurate, descriptive information on reserve biota and the abiotic environments in which they exist. With such data in hand, we can better understand the mechanisms and processes that control ecosystems and lead to their persistence. This knowledge—paired with an awareness that our environment is complex, dynamic, and susceptible to rapid change—is crucial to our long-term management of NRS reserves. It will also aid managers of other natural areas across the state.

One of California's most dynamic regions is the coastal zone. Its dynamics are both natural and human in origin, both short-term and long-term in nature. Whether the cause is diurnal tidal fluctuation, tectonic subsidence, or elevated nutrients from adjacent land-use activities, the coastal environments are continually disturbed across various temporal and spatial scales. Study of these environments is thus complex, but increasingly relevant. Growing population in the coastal zone, changing availability of water, harvest of marine resources, and climate change are topics that become more critical

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Newest Serpentine Reserve Is Real Gold Mine



The Davis campus has added a new jewel to its collection of natural areas along the Putah Creek drainage. The Donald and Sylvia McLaughlin Natural Reserve, located at the headwaters of Putah Creek

two hours by car northwest of Davis, adds extensive serpentine habitats to the NRS treasure chest of natural features. It offers unparalleled opportunities for environmental research and the potential for a new environmental research center at the site of one of the nation's most innovative gold mines.

The new reserve will join the NRS in stages over the next 20 years. In July, the UC Regents approved the first stage: a reserve of approximately 300 acres owned by Homestake Mining Company that will be available for research and teaching through a

use agreement. Eventually, the reserve could encompass nearly 10,000 acres.

Serpentine deposits cover a third of the reserve, creating islands of endemic plants adapted to the chemically induced stress of serpentine soils. The diverse serpentine landscape at the McLaughlin Reserve includes woodlands of Sargent and McNab cypress, along with chaparral dominated by whiteleaf manzanita, *Ceanothus jepsonii*, and leather oak. The serpentine grassland includes rare Morrison's jewelflower and short-podded thelypody, as well as a host of insects associated with serpentine communities. The reserve's nonserpentine soils support examples of more typical Coast Range habitats, including blue oak woodland and savannah, riparian woodland, grassland, and chaparral.

Serpentine is found in unusual geologic settings around the world, always with

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Davis Creek is part of the watershed in the new Donald and Sylvia McLaughlin Natural Reserve, which is located at the headwaters of Putah Creek in Napa and Lake counties. (Photo courtesy of Raymond E. Krauss, Homestake Mining Company)

Instruction and Research Highlights

Focus on Urban Reserves

Students Pursue Studies at Coastal Wetland Sites

Editor's note: Last spring Transect introduced a column that focuses on the importance and management needs of reserves surrounded by urban or agricultural development. Of all NRS sites, those with coastal wetlands have suffered most from the impacts of human activities. As land managers, it is our long-term goal to reduce the negative effects of such impacts and restore degraded habitats. But before we can diagnose and cure our wetland ills, we must first take the pulse of these sites by monitoring them and conducting basic ecological research. In this issue, we highlight several studies that do just that.

The projects described here have something in common besides habitat: all are being conducted by UC students. With their abundant natural values, our coastal wetlands may serve as the most important classroom many students will ever have.

Urban coastal wetlands are highly productive—but very fragile—ecosystems that often serve as a microcosm of our environmental problems. Water diversion, stream and groundwater pollution, habitat fragmentation, sedimentation, air pollution, ocean pollution, and extirpation of endangered species are just few of the impacts degrading these vital links between land and sea.

Transitions occur rapidly within wetlands, yielding numerous habitats and environmental zones within their small areas. Such diverse ecosystems offer excellent opportunities to study environmental impacts and response systems. Because of their proximity to human endeavors, the coastal wetlands protected in six NRS urban reserves are fairly accessible, and nearby UC campuses offer research and teaching support. Numerous professors instruct classes at these sites, and several UC students are using them to explore a wide array of scientific questions. A sampling of such projects at three reserves follows.

At the southern end of the California coast, the *Kendall-Frost Mission Bay Marsh Reserve* protects 16 acres of salt marsh contiguous with the mudflats and open water of the Mission Bay Northern Wildlife Preserve. The marsh communities follow a classic vertical zonation from submerged shoreline to high marsh.

Eric Vetter, a doctoral student at nearby UC San Diego, is studying the effect of cur-



Habitat restoration requires hands-on work at the Kendall-Frost Mission Bay Marsh Reserve, where undergraduate Victoria Seidman designed the restoration of a one-acre parcel for her senior thesis at UC San Diego. (Photo courtesy of Isabelle S. Kay)

rent speed and sediment size on benthic invertebrates in the mudflat and salt marsh habitats. Sand imported for recreational beaches in other parts of Mission Bay alters sediment size ratio and the abundance of nutrients in the marsh. Vetter has been assisted by Ami Groce, a senior at UCSD, who conducted much of the field work as a project for her community ecology course.

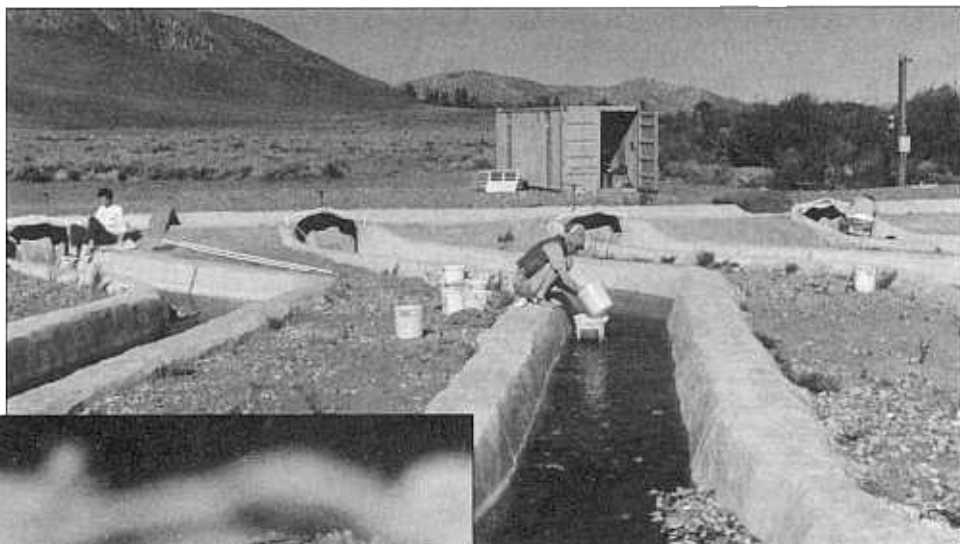
Victoria Seidman, also a UCSD undergraduate, planned and designed the restoration of a one-acre parcel of the reserve for her senior thesis in restoration and conservation biology (a self-directed degree program). She recently received a Mathias Student Research Grant for this project (see page 4). The restoration and monitoring will continue, with student assistance encouraged.

Two UCSD doctoral students are studying the Mission Bay Marsh long-jawed mudsucker (*Gillichthys mirabilis*) and its close relative in the Gulf of California. Prior to the present interglacial period, these fish belonged to the same population. When the oceans warmed, they moved up the coast of meso-America, were separated by the Baja peninsula, and exposed to different water temperatures. With the possibility of global climatic warming in the future, Peter Fields is trying to determine how the fish cope with temperature change. In addition, Jen-Jen Lin is comparing the mudsuckers at a molecular level to see if subspeciation has occurred.

One of the few remaining freshwater marshes in coastal Southern California, the *San Joaquin Freshwater Marsh Reserve* provides crucial resources to migratory birds and a year-round haven for a myriad of native plants and animals. Although surrounded by development, including that of the Irvine campus, the marsh itself remains relatively wild.

UC Irvine undergraduate Lola Fong is studying the importance of wild artichoke, an exotic species, to California ground squirrels. In addition to supporting ground squirrels, the wild artichoke feeds such birds as morning dove, savannah sparrow, and California quail. This study raises a key issue in restoration biology because if the wild artichoke is eradicated as part of an effort to restore habitat, the birds, ground squirrels, and other native fauna may be left without an adequate food source.

UCI offers an excellent opportunity for social ecology majors to fulfill their internship requirement at the San Joaquin Marsh. Teri Miley chose to do so after taking a course that got her interested in environmental education. She plans to teach elementary school students the value of California's natural habitats. Chris Hatt, another recent intern, worked on developing a photo-monitoring system to record vegetation changes over time. Miley and Hatt are among more than 50 social ecology majors who have worked at the reserve



Above: A researcher sorts through a sample of drifting insects in one of SNARL's new stream channels. (Photo by Kim Kratz)



Left: The insect's-eye view of a stonefly larva, the primary invertebrate predator in the SNARL channels. (Photo by Will Swalling)

since the internship program was established in 1983.

Twenty miles southeast of the UC Santa Barbara campus, the *Carpinteria Salt Marsh Reserve* offers a range of estuarine habitats, including southern coastal salt marsh, tidal channels, tidal mud flats, sand flats, salt flats, upland transitional areas, and subtidal deepwater habitats. There, UCSB doctoral student Theresa Stevens, a Mathias Grant recipient, is studying the larval form of a parasitic flatworm as it moves from snails to crabs and fish to see how it spreads between host populations. The parasite she is working with is similar to one that penetrates the skin of humans, causing schistosomiasis, a severe disease widespread in the Third World.

Dan Meade, a UCSB doctoral student, is assisting biologist Mark Page with an assessment of the impacts on water quality of nutrients entering the marsh from adjacent urban and agricultural areas (see *Transect* 10(1):4). He is also conducting the first inventory of the terrestrial insects of the reserve. Doctoral student Kris Burnell is studying the genetic and cultural diversity of the Belding's savannah sparrow (*Passerculus sandwichensis ssp. beldingi*), an endangered species.

In addition to providing research sites for many student projects, the reserve system's urban wetlands serve as classrooms for a

wide range of educational levels and subjects. UC and California State University professors bring students to NRS wetland reserves for courses in aquatic ecology, limnology, freshwater biology, restoration ecology, geography, and environmental ethics, among others. Secondary school students, adult education classes, community organizations, and groups from herbaria and natural history museums also visit the reserves on a regular basis.

Because they are so easily degraded, urban wetlands are ideal sites for examining the impacts of human activity on the environment. These fragile habitats will continue to provide valuable instructional and research opportunities—not to mention crucial resources for their floral and faunal inhabitants—if we can learn enough about them to reduce the negative effects of human impacts and focus on their preservation and restoration.

—Molly Pohl
NRS Environmental Analyst/
Cartographer

Scale Theory Tested in New SNARL Channels

Picture a small stretch of stream. The overall form persists, even as the individual drops

of water that give it shape move constantly across your field of vision.

Now consider the insects in a patch of stream. Though individuals drift through, the population in the patch endures. But what influence does the movement of those insects in and out of the patch have on the overall dynamics of the population? What role do the predators of this mobile feast play? And how does the effect of both migration and predators change as you look at increasingly larger sections of stream?

These are questions Scott Cooper attempts to answer in the research he recently undertook using SNARL's new stream channels (see page 6). "Ecologists now realize that most answers to our questions depend on scale," says Cooper, a professor of biology at UC Santa Barbara. "The answers change as the scale you examine changes."

Using nets, Cooper will control the downstream movement—called "drift"—of mayfly and midge larvae, the primary insect prey in high Sierra Nevada streams. He will also manipulate the numbers of stonefly larvae, the major invertebrate predator, which live on the stream bottom. His 132 research arenas vary in size from mesh containers less than half a foot square to sections of Convict Creek almost 12,000 square feet in area. He'll be using all nine new channels, which he helped design with this project in mind.

By fiddling with the numbers of organisms in each arena, Cooper hopes to determine how scale affects the relative importance of birth and death rates versus immigration and emigration. Ecological theory holds that the smaller the scale, the more important are the latter. In a small spot on the bottom of a stream, for instance, the prey population is turning over at a rapid rate because animals are constantly drifting in and out of the area. Furthermore, prey eaten are constantly being replaced by the drift.

Over the course of the whole stream, on the other hand, there is comparatively little immigration and emigration. At such a large scale, migration processes play a much smaller role; birth and death become more important to the population dynamics. And since predation is a major cause of death, the interaction between predators and prey may have a greater effect at the larger scale.

SNARL's new facilities hold the key to testing this theory in streams. Says Cooper, "We'll be able to manipulate drift input and predator populations at scales that have never been examined before." The results could have implications for conservation biology as well as basic ecology. "It's important to know," says Cooper, "how much the

Instruction and Research Highlights *continued*

rate of immigration and emigration affect the persistence and dynamics of populations."

Because SNARL's channels are brand-new, Cooper will have the unique opportunity to manipulate and study predator-prey interactions as his team stocks the facility with non-drifting animals such as stonefly larvae. "As we bring it up to natural conditions, we can look at how component parts affect the whole system," he says. Once the field work on stonefly larvae is complete, they will even out the distribution of this insect among all channels. Then Cooper will begin introducing and studying the role of stone-cased caddisfly larvae, algae-eaters that are too heavy to have entered the channels via drift.

Next spring Cooper will begin adding and studying another stream predator to the channels: local brown trout, which eat mainly drifting invertebrates. In collaboration with Tom Jenkins, a fisheries biologist with UCSB, he will examine how the feeding behavior of the trout changes as their food supply is manipulated.

Cooper received a \$200,000 grant for this project, which began in July and will run for two years, from the National Science Foundation. The work involves a number of UCSB undergraduate and graduate students, including Kim Kratz, a doctoral student who serves as field manager. Kratz received Mathias Student Research Grants from the Natural Reserve System in 1989 and 1990 to conduct pilot work for this project. Staff Research Associate Sheila Wiseman directs the processing of samples in the lab. But the star of the project will undoubtedly be the stream channels themselves. As Cooper explains, "There is no other facility like this in the world where we could do such comprehensive experiments at a variety of scales."

—Sarah Steinberg Gustafson
NRS Publications Consultant

NSF Funds Workshops at Bodega Marine Reserve 1991-92 Mathias Winners at Work around State

The National Science Foundation, together with the U.S. departments of Agriculture and Energy, has funded a workshop series to be held at the Bodega Marine Reserve during the next five years. Research teams studying plant and animal interactions centered on the California bush lupine at the reserve will meet twice annually, in October and March. Principal Investigator Barbara Bentley and other program organizers intend to foster terrestrial plant research at the reserve, especially that which combines field work with sophisticated laboratory work.

October workshops will focus on emerging issues in plant ecology and give researchers a chance to discuss recent findings and plan research directions. At the March series, graduate students and senior researchers will learn, through "hands-on" instruction, analytical techniques and instrumentation for field applications.

According to program organizers, the training ecologists receive in analytical methods and instrumentation is often deficient. March workshops will cover such topics as use of open-top chambers for CO₂ enrichment studies, chemical analysis for field biologists, and instrumentation for physiological plant ecology. To capitalize on participants' newly acquired knowledge, the grant provides funds for graduate student projects following the workshops, usually for pilot projects or feasibility studies.

Bush lupine is critical to the central and northern California coastal prairie community. It serves as a food source for both vertebrates and invertebrates, and is a major competitor with other plant species. A nitrogen-fixing legume, the species is, in fact, the most important source of new nitrogen into the local system. Scientists from several universities with interests that vary from chemical ecology to the role of vertebrate herbivores are now studying bush lupine at Bodega. Professor Bentley, a long-time reserve researcher from the State University of New York at Stony Brook, has done important work on the role of nitrogen fixation in the chemistry and plant-herbivore interactions of the lupine.

—Ethan Michaels
NRS Assistant Editor

Thirteen became a lucky number earlier this spring when the NRS awarded a baker's dozen of Mildred Mathias Student Research Grants for 1991-92. The 13 grants ranged from \$1,000 to \$2,000 and totalled \$21,691—the largest overall award yet made in this four-year-old systemwide program. The grant recipients, who represent six UC campuses, developed plans to conduct research at 12 NRS sites.

And the winners are...

From UC Berkeley:

- Jane Claire Marks, "Population genetic structure of *Cladophora glomerata*: A reductionist approach to understanding genetic diversity of a freshwater alga" (research site: Landels-Hill Big Creek Reserve).
- Elizabeth A. Ross, "The California scrub jay: Why float?" (Hastings Natural History Reservation).

From UC Davis:

- Andrew R. Dyer, "Genetic diversity and gene flow in *Stipa pulchra* [purple needlegrass]" (Jepson Prairie Reserve).
- Jamie Lynn King, "Population genetic structure and the effects of spatial and temporal variability in the California vernal pool tadpole shrimp, *Lepidurus packardii*: Application to conservation management (Jepson Prairie Reserve).
- Katherine L. Muller, "The role of conspecifics in habitat selection and territory establishment in the desert clicker, *Ligurotettix coquilletti*" (Boyd Deep Canyon Desert Research Center).

From UC Irvine:

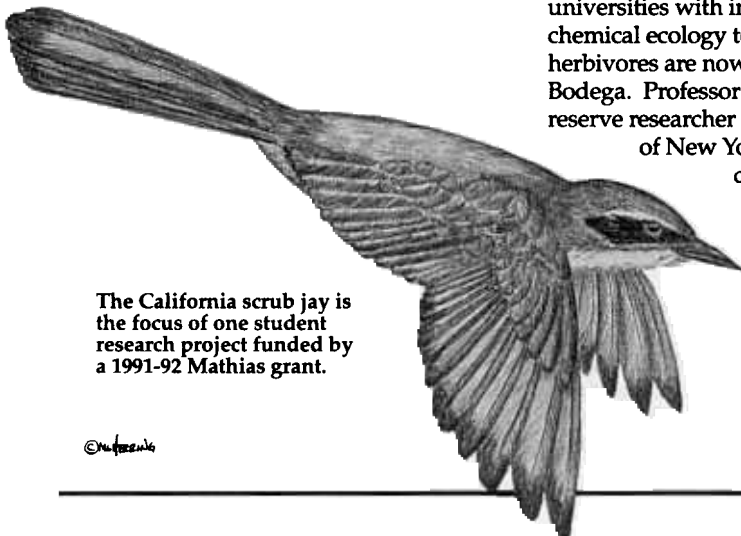
- Gary A. Krupnick, "The effect of herbivorous insects on the reproductive success of *Isomeris arborea* [bladderpod]" (Burns Piñon Ridge Reserve).

From UC Riverside:

- Pamela J. MacKay, "The influence of introduced species on a native ephemeral in a coastal sage scrub community" (Motte Rimrock Reserve).
- Ernest W. Taylor, "Interference competition in heteromyid rodents: Effect of exclusion of a dominant species on the activity of a subordinate species" (Granite Mountains Reserve).

From UC San Diego:

- Jesus Pineda, "Coarse and meso-scale patterns of settlement in the barnacle *Chtamalus* spp." (Scripps Coastal Reserve).



The California scrub jay is the focus of one student research project funded by a 1991-92 Mathias grant.

- Victoria Seidman, "High marsh and transition zone initial restoration at Kendall-Frost Mission Bay Marsh Reserve: A senior thesis."

From UC Santa Barbara:

- Cheryl J. Briggs, "The effect of multiple parasitoid species on the gall-forming midge, *Rhopalomyia californica*" (Coal Oil Point Natural Reserve).
- Laura Furlong, "The biogeography and ecology of streams on Santa Cruz Island Reserve."
- Theresa Stevens, "Shedding patterns of tramatode cercariae: Ecological significance in transmission to second intermediate hosts" (Carpinteria Salt Marsh Reserve).

For information on next year's competition, contact your campus NRS representative.

Salamander Survey Gives Scientists Some Surprises

California tiger salamanders surprised scientists at the Hastings Natural History Reservation this year with their fecundity, their use of terrestrial habitat, and the timing of their dispersal. The salamander, which is a state-designated species of special concern and a candidate for federal listing, also yielded data that may change current vernal pool mitigation practices.

More than a decade ago, zoologists began to document a decline in populations of *Ambystoma californiense*, a once-widespread denizen of ephemeral ponds in California's central valley and inner coast range. But attempts at mitigation and recovery were limited by the lack of basic knowledge of the salamander's habits. "If you don't plan your mitigation around the animals' natural history, you might as well just kill them," says Brad Shaffer, a professor of biology at UC Davis and author of the federal proposal to list the species as endangered. "A big part of this project is to find out how the animal uses its habitat."

In the spring of 1990, Shaffer undertook a survey of the species across its range to produce a status report for the California Department of Fish and Game. Out of the 350 ponds he sampled, Shaffer located salamanders in 70. In an effort to reconstruct the salamander's history of population movement and speciation, Shaffer is analyzing the genetics of animals from around the state. He has also chosen two seasonal ponds near Hastings in Upper Carmel Valley and two at

the Jepson Prairie Reserve in Solano County for more detailed demographic and natural history research.

Late last year Shaffer's group constructed drift fences along sections of two large vernal pools at Jepson Prairie, while Hastings staff—including site manager Mark Stromberg, zoologist Walt Koenig, and research assistant Connie Adams—built one around Blomquist Pond, an artificial cattle pond on a ranch adjacent to Hastings.

With help from Koenig and his assistants, Adams and Valerie Stack, Shaffer trapped and released salamanders from December (when adults began entering the newly filled pools to breed) through the mid-August (when the last babies leave their now-dessicated nursery). UCD undergraduate Stephanie Rollman also attempted to determine where adults go when they leave the water by fitting six with radio harnesses; unfortunately, all slithered out of the harnesses before yielding much data on dispersal.

Shaffer and colleagues were surprised by many of their findings, especially those from Blomquist Pond. The researchers identified more than 250 adults and at least 500 young of the year in the pond, about ten times more than anticipated. Instead of retreating to rodent burrows (where they spend the dry season) right after breeding, the adults spent several weeks going in and out of the water repeatedly, perhaps to feed on land. In addition, the young left the pond continuously over a period of several months, rather than just during one or two big rainstorms.

Furthermore, Shaffer's preliminary results on the species's genetics from across its range indicate populations undergo a great deal of local extinction and recolonization and that salamanders commonly migrate between ponds. "What this says for recovery is that if we continue with what is becoming standard mitigation practice of saving a single pond, the population may not survive," says Shaffer. "This argues for protecting relatively large tracts with a series of interconnected ponds so that some can serve as sources for recolonization of others."

Shaffer's group hopes to expand their work at Hastings this coming season by fencing and trapping at Laguna Conejo, a vernal pool near Blomquist Pond, to see how much individual salamanders move between the two. They will also continue their efforts to radiotrack these very slippery subjects. A future issue of *Transect* will highlight the results.

—Sarah Steinberg Gustafson
NRS Publications Consultant



Haven't I Seen Your Abdomen Somewhere Before?

How do you tell one tiger salamander from hundreds of others? Walt Koenig, research zoologist at Hastings, may have solved this riddle. He found that by making photocopies of the salamanders, he could record their apparently individual patterns of belly splotches.

Koenig and colleagues xeroxed about 100 individuals over the course of the field season. The researchers hope to be able to use the copies to identify individuals when they re-emerge with the winter rains. If the technique works, Reserve Manager Mark Stromberg will search for funds to buy a dedicated copier. "Sometimes the salamanders get loose and slime the machine," says Stromberg, who doesn't know whether his warranty covers this.

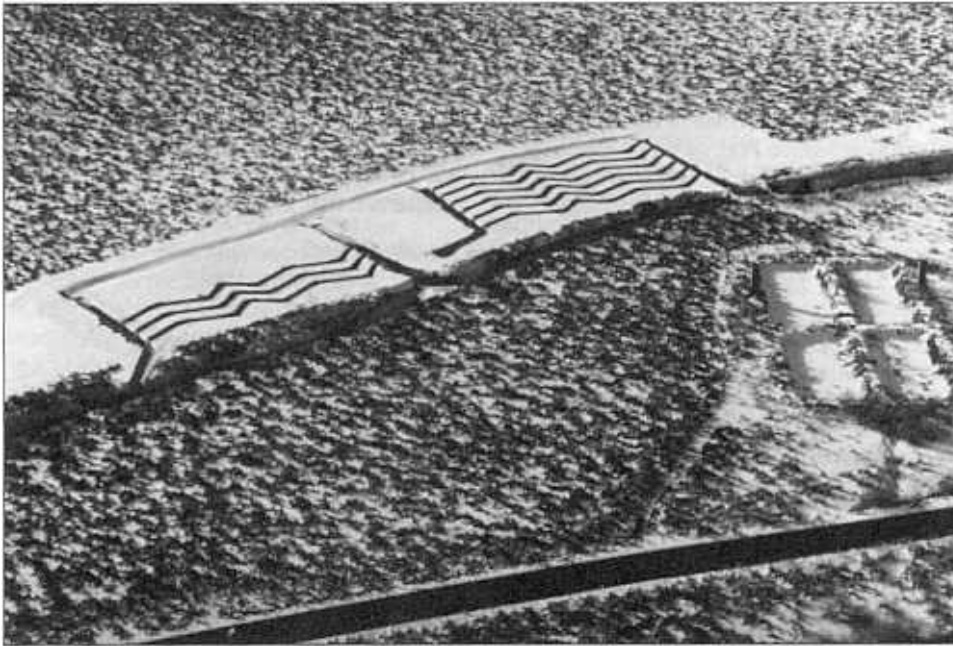
In addition to making photocopies of some, the scientists also marked each salamander they trapped by clipping a unique combination of toes. Because salamanders can regenerate toes over the course of several months, the researchers don't yet know if the patterns will be readable over the decade of the animal's life. UCD's Brad Shaffer plans to evaluate the success of this dual-identification method during the coming breeding season.

Thanks to Oak Ridge Ranch and AVM Instruments

The Hastings salamander studies are made possible by the cooperation of Jim Kirk, owner of the adjacent Oak Ridge Ranch. Kirk allowed the reserve to fence the ponds for research in exchange for filling a livestock watering trough from the Hastings well. Hastings Manager Mark Stromberg explains: "We provide clear water for Oak Ridge cattle and Oak Ridge provides muddy water for our salamander studies."

Biophysicist Barbara Kermeen, President of AVM Instrument Co. of Livermore, CA, is donating radiotracking equipment to the project as part of her ongoing work to develop telemetry equipment for amphibian field studies.

Reserve Highlights



An aerial view of the nine channels that make up SNARL's new experimental stream system. The channels create a cryptic pattern which is dramatically visible against the snowfall—and scientists on earth hope the message being signaled to approaching Martians and other aliens is a friendly one. (Photo by Dan Dawson)

SNARL Stream System Is Proving Successful

Nestled at the base of Mt. Morrison in the eastern Sierra Nevada is a research facility unlike any other in the world: an experimental stream system that allows scientists to simulate natural conditions while conducting complex experiments. Located along Convict Creek at the Sierra Nevada Aquatic Research Laboratory (SNARL), the newest and most sophisticated part of the stream system opened for experimental work this summer. It already supports a wide variety of stream algae and invertebrates, not to mention a project on predator-prey relations (see page 3) funded by the National Science Foundation (NSF).

SNARL has been the site of fisheries research since 1935. Previously available stream facilities consist of small laboratory channels and large stream sections formed by dividing Convict Creek. SNARL also provides researchers access to the stretches of Convict Creek above and below the reserve, as well as to the network of streams draining the eastern Sierra Nevada.

According to Dan Dawson, reserve manager and *majordomo* of the stream system, the new experimental channels fill an important niche in SNARL's stream ecology facilities. "Because the channels are the size and shape

of small natural streams," he says, "this system allows us to replicate experiments at a real-world scale. It also gives us the opportunity to conduct research over a complete range of scales."

Designed by a team that included specialists in fish behavior, invertebrate community structure, and stream geomorphology, the new system consists of nine concrete-lined channels, each about 3 feet wide and 180 feet long. They mimic the meandering structure of natural streams, with a series of shallow, fast-moving riffles alternating with pools of deep, slow-moving water.

Slots for holding drift nets were built into the channel walls at the beginning and end of each riffle. Among other things, the nets will enable researchers to control the numbers of invertebrates entering and leaving each channel section, confine fish to particular sections, and subdivide channels into experimental arenas of different sizes. The system also offers lights for night work, electrical service, and a building for storing equipment.

The channels were constructed during the summer of 1991. After adding a substrate of cobbles and coarse sand, the reserve began diverting water to them from Convict Creek that September.

UC Santa Barbara researchers Kim Kratz, Scott Cooper, and colleagues then spent several weeks verifying that water chemistry

was the same in the channels as in the natural stream, as well as confirming that water discharge and depth could be manipulated precisely within individual channels. As algae and invertebrates colonized the system, the researchers documented their numbers, redistributing the invertebrates equally among channels as needed. By the time the channels opened for experimental manipulation in July, the variety and abundance of most drifting algae and invertebrates was comparable to adjacent sections of Convict Creek.

Although experimental stream systems exist at other research stations, most do not have enough separate channels to perform experiments that involve several factors with replicates of each factor. Furthermore, most other systems consist only of straight canals; SNARL's design of meandering pools and riffles better mimics natural streambeds.

This \$370,000 experimental facility was funded by a \$175,000 grant from the NSF to Dawson, Cooper, and UCSB Professor John Melack, matched by funds from UCSB (which administers SNARL), the Natural Reserve System, Inyo and Mono Counties, and in-kind services from Dempsey Construction Company.

—Sarah Steinberg Gustafson
NRS Publications Consultant

Reserve System Initiates Computer Mapping

The Natural Reserve System is engaged in a long-term project of vast scope and extreme benefit—the first phase in the implementation of a geographic information system (GIS) consisting of computerized maps of all the reserves. Maintaining accurate maps of the system's 32 sites has always been daunting because reserve boundaries change frequently. Furthermore, new information affecting map features—the location of sensitive species, for instance—flows constantly from on-site research. As difficult as they are to keep current, such maps are essential to effective management.

Geographic information software lets cartographers store layers of information about an area in computerized maps of great precision and detail, and to revise the information at will. Managers and researchers can view multiple layers of information at once to see the relationship between various features, such as an area's topography, soil types, and cultural features, to name but a few. Scientists can also conduct complex spatial analyses of digital data stored within the GIS.

Coastal Reserves *continued from page 1*

After much consideration, we chose a Macintosh-based GIS software package called Geo/Navigator. This newly developed program is remarkable for its simplicity of use, its utility as an environmental management tool, and its compatibility with varied computer systems.

The NRS intends to make a GIS available at major reserves and campus NRS offices, with detailed layers on flora and fauna linked to additional database files. Eventually, the system could become fully networked and allow for data exchange between reserves. In any case, the system will be invaluable to researchers and students seeking information about reserve study sites; their findings, in turn, can be integrated back into the reserve's GIS. Managers will benefit from detailed, spatially referenced biological inventories showing reserve dynamics through the years. Customized maps can be generated and printed at various scales for specific class and research use.

The main obstacle we face in implementing the GIS is the lack of high-quality digital data. Limited United States Geological Survey (USGS) data is available in digitized form for many reserves, providing some accurate registration points with which to start. We will enter additional data on topography, hydrology, cultural features, etc., from USGS paper maps, engineering drawings, and any other accurate maps we can find. We hope to procure funding to create digital terrain models and orthophotos for every site.

The project is proceeding extremely well to date. Any questions or suggestions are very welcome.

—Andre Zerger
NRS Cartographer/
Environmental Analyst

Editor's note: NRS staff member Steve Greco (see page 8) will teach a UC Davis Extension course on Geo/Navigator for the Macintosh on December 14, 1992 and again on June 25, 1993. The class will meet at the D&G Computer Center in Sacramento from 8:30 to 4:00. A fee of \$225 covers instructional materials and lunch. For more information, contact UC Extension at (800) 752-0881. To register, refer to section #922-U430 for the December course and section #924-U430 for the June course.

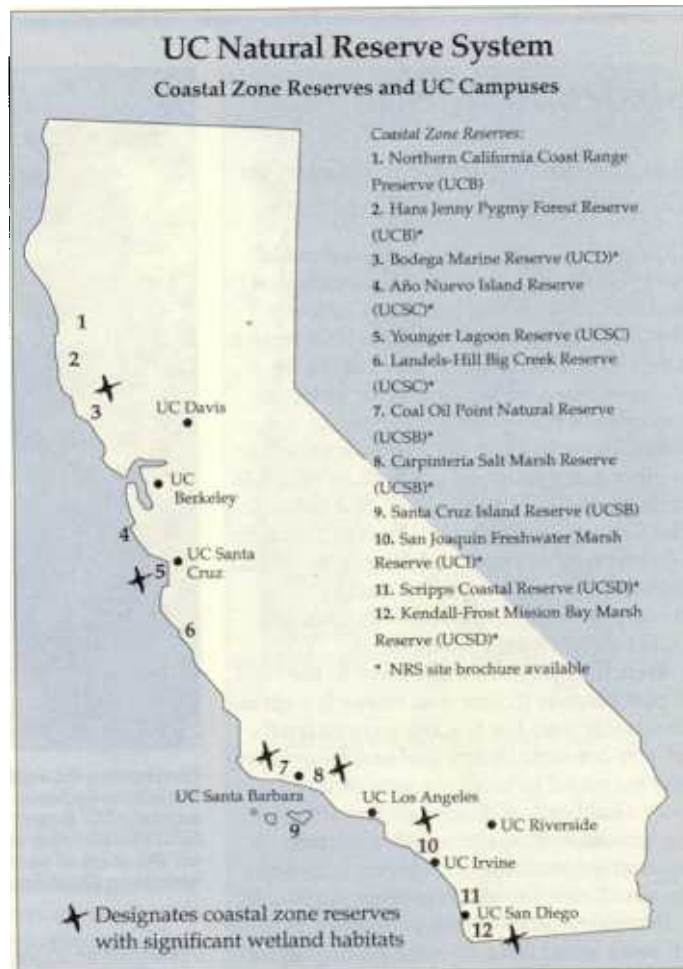
every year as the demand for limited resources increases.

The NRS contains 12 sites in the coastal zone, 6 of which protect significant areas of coastal wetlands. Such sites grow more precious with every passing year. In California, approximately 90 percent of our coastal wetlands have already been lost; most of the surviving sites, such as our Kendall-Frost Reserve, are but small remnants of once more regionally extensive ecosystems. The urban onslaught of hydrologic, chemical, and sediment inputs to our coastal wetlands continues largely uncontrolled. Yet it can be monitored and, hopefully, mitigated through research efforts on NRS sites. Several of our coastal reserves are on or near a UC campus and thus receive significant campus study (see page 2).

Recognizing the ecological importance of these wetlands and the exciting potential for integrating research and instruction across many disciplines in the study of them, we have initiated a systemwide program focusing on NRS coastal wetland reserves. We are currently pursuing extramural funding to inventory these sites through intensive survey and monitoring of the physical environment and its biota across all trophic levels.

This important work will bring together faculty, students, and staff from UC Davis, Irvine, San Diego, Santa Barbara, and Santa Cruz. Their data will form the foundation of a geographic information system (GIS) for reserve research, instruction, and management (see page 6). The systemwide NRS office has funded software and hardware purchases to make our GIS available at major reserves and campus NRS offices.

The proximity of the coastal reserves to university campuses facilitates interdisciplinary research and student training. Specific courses can readily take on field projects and, at the same time, take advantage of easy access to state-of-the-science analytical laboratories and research collections on campus.



(Design concept by Molly Pohl, Andre Zerger)

Comparing the six NRS sites that include coastal wetlands may reveal processes and mechanisms not obvious at a single site, as these reserves may contain different ecosystem states. Study of the coastal wetland complex, therefore, will not only involve investigation of physical gradients inland for a single reserve, but also changes in climate, tectonics, and ocean currents across a larger geographical region.

The NRS reserves encompass a sample of the diversity and quality of California's natural coastal wetlands. With their protected status, they form excellent natural laboratories for study of the species, mechanisms, and processes that lead to the persistence of coastal wetlands and the maintenance of biodiversity.

—Deborah L. Elliott-Fisk
NRS Interim Director

Editor's note: Brochures describing the natural features, facilities, and use of most NRS coastal reserves are available at no charge from the systemwide NRS office in Oakland. Call (510) 987-0150 for a list of NRS publications or a free subscription to Transect (two issues per year).

News and Notes

Systemwide Staff

Education Expert Leads Team to Develop NRS Grant Proposals

This July the NRS systemwide staff in Oakland welcomed Joan Brenchley-Jackson as senior environmental analyst. Currently, Brenchley-Jackson is leading an NRS team as it develops a major grant proposal to the National Science Foundation for biotic inventories of NRS coastal reserves. In the future she will apply her scientific expertise to other grant proposals, as well as efforts to promote use of NRS reserves. She holds a Ph.D. in ecology from UC Davis (1992), with a focus on ecosystem modeling and wetland ecology. A highly regarded teacher, Brenchley-Jackson has been a lecturer at UCD for eight years.

Brenchley-Jackson was drawn to the NRS in part because it combines research with instructional use. For her, bringing to life the relation between theory and real natural process is crucial in teaching, one of its most exciting aspects. On campus and at the systemwide office, she searches for new ways to get students of all levels "out into the world to make what they learn applicable."

Brenchley-Jackson's attraction to ecological work arises from its essential importance. She says, "I'm engaged in the effort to understand ways to preserve natural areas and to get the public involved."

—Ethan Michaels
NRS Assistant Editor

Outstanding UC Davis Graduate Plots on Behalf of NRS Reserves

In land management, skilled cartographers are important to understanding and maintaining the areas under administration. This June the systemwide NRS office gained a talented environmental analyst and cartographer in the person of Molly Pohl, who will work on various projects including the new NRS geographic information system (see page 6) and the development of grant proposals. Pohl recently graduated with honors from UC Davis in geography, receiving the Susan F. Regan award as the outstanding graduating woman.

Pohl first became acquainted with the NRS when she worked as a research assistant for UCD professor Deborah Elliott-Fisk. She brings to her work a background in soils geomorphology and enthusiasm for studying natural systems. Pohl will remain in the



Environmental analysts Molly Pohl and Dr. Joan Brenchley-Jackson, as they appeared at the ninth annual NRS Reserve Management Workshop held this October on Santa Cruz Island Reserve off the coast of Santa Barbara. (Photo by Sarah Steinberg Gustafson)

systemwide office until next fall when she intends to pursue her Ph.D. in physical geography.

—Ethan Michaels
NRS Assistant Editor

New Computer Cartographer Helps Map Reserve System

"I was computerphobic until I saw a map on a computer one day," Steve Greco explains. "The idea just struck me—it made sense." Greco, a Ph.D. candidate in ecology at UC Davis, has served as a computer mapping consultant for the NRS's geographic information system since July (see page 6). In addition, he works at the UCD Arboretum.

Greco graduated from Davis in landscape architecture. His training in that field, especially as it relates to spatial information systems, enabled him to work on projects for UCD's Center of Design Research, the National Park Service, and the California Department of Parks and Recreation.

At these jobs Greco learned just how important spatial information is to land management. Yet, as he points out, the NRS has had no formal mapping system—until now. Once its new GIS is in place, the NRS will

have maps with spatially referenced data, meaning that information can be linked to a given point on a map. "These maps are not static," he says. "The data can easily be changed to reflect changing conditions."

Greco plans to continue with the NRS through next summer, when the first phase of its GIS will be functioning and can be distributed to the reserves.

—Ethan Michaels
NRS Assistant Editor

Editor's Note: Ethan D. Michaels joined the NRS systemwide staff as assistant editor in August. He brings to the NRS publications program editorial skills honed at UC Press and Berkeley Child Art Studio. Michaels earned a degree in English from UC Santa Cruz and taught English language courses in Mexico. Outside of the office, he pursues his interests in writing and drawing.

NRS People

Big Creek Teacher's Project Wins Environmental Science Award

Big Sur science teacher Kim Smiley recently received an award of \$500 from the Rancho San Carlos Foundation for an environmental education project she developed at the Landels-Hill Big Creek Reserve. Dubbed Project REAL (for Rural Ecology Action Lab), Smiley's program brings students in grades six through nine at Pacific Valley School to the reserve to learn firsthand about its natural and cultural history. In its initial year, Project REAL focused on oak woodlands; this year it concentrates on oceanography; next year it will cover archaeology. Smiley won her award in a competition for environmental science education at the high school level.

NRS Family Gladly Receives Trio of Babes in the Wilderness

The NRS family added three new members over the past several months. "Our house has grown by two feet!" announced Cindy Stead and Philippe Cohen, resident managers of the Granite Mountains Reserve, following the arrival of Benjamin Walter Cohen-Stead. Born April 27 weighing eight pounds, Ben currently believes that everything in the world can fit into his mouth.

Brenda Anne Fisher was born August 5 to Tracy Fisher and Mark Fisher, steward at the Boyd Deep Canyon Desert Research Center.



Granite Mountains Reserve Manager Philippe Cohen had his hands full at this year's NRS Reserve Management Workshop. (Photo by Sarah Steinberg Gustafson)

A true reserve child, Brenda loves being outdoors, staring at the sky and trees.

Next to arrive on-site was Kendall Ho Soon Dawson. Born March 3 in Seoul, Korea, Kendall was adopted by Leslie Dawson and Dan Dawson, resident manager of the Sierra Nevada Aquatic Research Laboratory (SNARL) and Valentine Camp Reserve. She arrived August 20 in America and came home to SNARL the following week.

The NRS welcomes all three junior reserve staffers!

In Memoriam

Gerald L. Hassler died May 11, 1992, while vacationing in Mexico with his wife of 52 years, Mildred E. Mathias. Hassler was a retired physicist and a former lecturer in the School of Engineering at UC Los Angeles. He is survived by Mathias, an internationally renowned botanist and "grandmother" of the Natural Reserve System, along with three children and eight grandchildren.

Donations in memory of Hassler may be made to the Mathias Student Research Grant Program. Checks should be made to "The Regents of the University of California" and mailed to the Natural Reserve System, University of California, 300 Lakeside Drive, 6th floor, Oakland, CA 94612-3560.

NRS Regrets Retirement of Invaluable UCSB Colleague

The Natural Reserve System said good-bye to an esteemed employee and faithful friend when Shirley Clarke retired on October 30, 1992. For 12 years, Clarke provided all administrative support for UC Santa Barbara's four reserves, which include two of the most academically productive sites in the NRS. Because of its smooth and efficient operation, Santa Barbara's NRS office has long been considered a model for other campuses, and Clarke was largely responsible for its success.

Clarke plans to spend her newly freed time traveling, playing bridge, and sleeping late. She also plans to undertake an invasive vegetation removal project at her Santa Barbara home (also known as pulling weeds).



Shirley Clarke Bids Adieu

The other day I opened the local *Santa Barbara News Press* and saw a picture that reminded me so strongly of why I had been associated with the NRS all these years and why I have such high respect for its participants. It was a picture of Wayne Ferren, manager of Carpinteria Salt Marsh Reserve, leading a group of about 50 youngsters through the reserve. It brought to mind not only the efforts made by the NRS to maintain these valuable areas and to provide access to them for research and class use, but also the efforts reflected in the picture—a reserve manager taking the time to provide youngsters with perhaps their first enlightened introduction to a natural environment.

The article that accompanied the picture said that the children were "enthralled in their discoveries" at the marsh. I'm happy to have this opportunity to tell my NRS cohorts that I've been enthralled with YOU. And darned glad to have been associated with you.

Take care,

Shirley Clarke

(Photo by Sarah Steinberg Gustafson)

Management

Eagle Lake Signs for Thirty Years

A new use agreement makes the Eagle Lake Field Station in northeastern California even more desirable for long-term research. The NRS, through the UC Davis campus, recently signed a 30-year use agreement with Cal State Chico to extend the site's affiliation with the reserve system.

The remote field station provides housing and laboratory facilities on the southeastern shore of Eagle Lake, about an hour's drive from Susanville (see *Transect* 5(1):1). Accessible from there is a rich landscape, volcanic in origin, that includes the state's fourth largest freshwater lake. Descriptive studies have been conducted on the lake's limnology, water chemistry, and vertebrate populations, and on the surrounding plant communities.

For more information, contact: Professor Peter Moyle, Wildlife and Fisheries Biology, University of California, Davis, CA 95616, (916) 752-6355.

Dawson Reserve Gains Ground and New Field Facility

Thanks to a gift of property from Ida Dawson, the Dawson Los Monos Canyon Reserve recently grew by 1.2 acres. This site

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News and Notes

Dawson *continued from page 9*

now consists of 218 acres of woodland, coastal sage scrub, chaparral, grassland, and stream habitats in the western foothills of San Diego County. The reserve has been established over the years through a series of gifts from Mrs. Dawson.

Classes and researchers at the Dawson Reserve have also gained a place to meet, sleep, and perform lab work. The reserve recently installed a 650-square-foot trailer complete with a full kitchen, bathroom with composting toilet, and bedroom that sleeps up to four. These overnight accommodations will make it much easier for researchers to study nocturnal and vespertine species. The trailer also contains a work area with basic lab benches, cabinets, microscopes, as well as shelves for library materials. Students from a local high school will paint the outside of the trailer in oak trees to match its surroundings.



The Ice Plant Cometh: New Group Attacks Pest Flora

Referred to by the State of California as "noxious weeds," exotic pest plants spread aggressively, displace native plants, and in some cases substantially alter an area's habitat. A new group is forming to combat these invaders. At their initial conference in October, participants pledged their determination to promote pest plant control as a high priority in state land management. The California group has an excellent model in a Florida organization called the Exotic Pest Plant Council (EPPC), which managed to have legislation passed that prohibits the transportation or sale of certain noxious species and has raised millions for research and control efforts.

At an earlier exploratory meeting in February 1992, the California group established four working groups it hopes will enable it to duplicate Florida's success. Facing public unawareness of the exotics problem, members formed one group to disseminate information at nurseries and another to plan a computer database. The third group will define a set of invasive species upon which to focus initial efforts and will study methods of pest plant control, including prescribed fires, herbicides, simple removal, and the introduction of species that attack exotics. The fourth group will examine strategy for influencing public policy.

The NRS itself has trouble with exotics. Bodega Marine Reserve is battling ice plant, while Santa Cruz Island has an unwelcome

population of fennel. And the Kendall-Frost Mission Bay Marsh Reserve was inundated with mangrove—a species planted there in the mid-1960s by a researcher who neglected to remove them when the study was completed. Scientists abhor the homogenizing effect these plants have on their research sites.

The California group is currently in the process of forming an organization. For information, contact: Greg Archbald, Golden Gate National Parks Association, Fort Mason Building 201, San Francisco, CA 94123.

—Ethan Michaels
NRS Assistant Editor

Coast Range Preserve Will Provide Improvements This Spring

The headquarters building at the Northern California Coast Range Preserve is undergoing improvements that will offer site users more comfortable living and working accommodations come spring. Reserve Caretaker Peter Steel has remodeled the 1915-vintage kitchen and dining room, where previously, according to Steel, "the maintenance was performed by mice." Steel has also divided the building's larger bedroom into two separate rooms to allow for more privacy; the headquarters can now sleep five in three separate bedrooms. Finally, Steel is converting the 120-square-foot pantry into a small laboratory space equipped with lab benches, cabinets, drying ovens, and a sink.

(Photo courtesy of Peter Steel)



Jean Jenny, wife of the late Hans Jenny (1899-1992), had a smile for those who attended the October 10, 1992 dedication of the Hans Jenny Pygmy Forest in Mendocino County. The ceremony was held to honor Dr. Jenny, a professor emeritus of Soil Science at UC Berkeley and world authority on soils and their formation. Jenny spent

many years studying the area, which he considered America's oldest ecosystem. He and his wife were instrumental in preserving the 240-acre forest as part of Jug Handle State Reserve.

(Photo by Susan Gee Rumsey)

Serpentine *continued from page 1*

endemic flora and often in association with mercury deposits. The McLaughlin Reserve shares these features. It lies within the Knoxville Mining District, where a half dozen mercury mines have produced quicksilver since the 1860s. The early miners did not know that these hills also contained gold. It took a new geologic model and advanced exploration techniques to discover, in 1978, that a classic epicentral thermal gold deposit lay within the old Manhattan mercury mine. In 1985, the Homestake Mining Company began extracting the estimated 3,335,000 ounces of gold contained within the site.

The new, open-pit gold mine was named after the late Homestake geologist, Donald McLaughlin, former dean of the UC Berkeley School of Mining and UC regent. His widow, Sylvia McLaughlin, is an active environmentalist in the San Francisco area and a founder of the Save the Bay Foundation. Their marriage, it is said, combined interests in resource use and preservation. The same might be said for the McLaughlin Reserve.

An environmental research field station has been part of Homestake's reclamation plan since before the mining began. Establishing the McLaughlin Reserve is the first phase of this plan. As the mining operation winds down over the next 20 years, much of Homestake's 9,000 acres and facilities may be added to the reserve. Mining development covers about 1,200 acres of the Homestake holdings, and the land has been continuously reclaimed. The balance of the property serves as a buffer.

Surrounding most of the Homestake claim is land owned by the Bureau of Land Management (BLM). The agency has designated part of these holdings an Area of Critical Environmental Concern (ACEC). Up to 2,000 acres, including the ACEC, may eventually become part of the reserve through a use agreement with the BLM. To the north of Homestake land, beyond reserve boundaries, is the Cache Creek Wilderness Study Area, where the BLM hopes to reintroduce native pronghorn antelope.

Homestake has been recognized by the Sierra Club, the Soil Conservation Society of America, and others for its rigorous environmental monitoring and innovative reclamation at the McLaughlin gold mine. In order to secure mining permits for the McLaughlin site, Homestake spent over \$3 million collecting baseline data on the site's geology and soils, hydrology, air and water quality, terrestrial and aquatic ecology, archaeology, and more. Miles of drill cores archived on-site record subsurface geochemistry to depths of 1,000 feet. The limnology and chemistry of a reservoir built to support mining operations has been monitored since its creation.



The landscape above is characteristic of the McLaughlin Reserve, with digger pines on the hillside suggesting the underlying presence of serpentine. (Photo courtesy of Raymond E. Krauss, Homestake Mining Company)

Homestake's database continues to grow. Information is collected from five meteorological stations and more than 40 ground and surface water-monitoring sites, all tied to a computer database. In conjunction with their ongoing environmental monitoring, Homestake has funded several long-term ecological studies, including research on the biotransport of heavy metals in the site's watersheds and population studies of the rare Townsend's big-eared bats.

These long-term datasets provide valuable support to many kinds of research and instruction now possible at the McLaughlin Reserve. Homestake Mining Company welcomes educational use of their database and buffer lands. Furthermore, BLM land beyond the reserve boundary contributes to a landscape-scale protected area.

The potential value of the McLaughlin Reserve glitters in the future.

—M. L. Herring
NRS Science Writer

The Serpentine Story

Serpentine. The geologic name comes from Europe before the 1500s and suggests the rock's apparent likeness to the mottled green pattern of a serpent's skin. It is found throughout the world in local outcrops and in extensive regional displays. In California, Serpentine is the state rock.

Serpentine is ultramafic, a rock with more than 70 percent ferromagnesian minerals. It forms when crust melts at great depths; the intense heat drives off lighter elements, resulting in a concentration of heavy metallic elements. Serpentine weathers to a soil rich in magnesium, poor in calcium, and often laced with heavy metals, including nickel and chromium.

Many kinds of plants cannot grow on such chemically hostile soils; others grow nowhere else. The serpentine landscape is characterized by sudden, definite shifts in vegetation types. On serpentine, oak woodland shifts to islands of specialized chaparral, cypress, and pine. According to serpentine expert Arthur Kruckeberg, a botanist at the University of Washington, serpentine grasslands are often characterized by lower biomass and higher species diversity than adjacent nonserpentine grasslands.

No single factor can explain the diverse display of adaptations to serpentine soil. Not surprisingly, serpentine habitats harbor a large number of local and regional endemic plant species. And no other serpentine deposits in the temperate zones have so rich an endemic component as the serpentines of California. Fully 215 native vascular plant taxa are known to be wholly or largely restricted to the California serpentines.

Of the 1,100 square miles of serpentine identified in the state, up to now only two sites have been protected for research and teaching. At Stanford University's Jasper Ridge Reserve, a small serpentine grassland has been the site of extensive research. The larger Frenzel Creek Research Natural Area, owned by the U.S. Forest Service, protects diverse serpentine habitats, but is remote and without facilities. The University of California's McLaughlin Reserve is large, diverse, and accessible, adding an important element not only to the NRS, but to the state's protected natural heritage.

For more information, refer to Arthur R. Kruckeberg's book, *California Serpentines: Flora, Vegetation, Geology, Soils and Management Problems*, University of California Press, 1984.

Opportunities

BLM to Fund Studies at Eagle Lake Field Station

Want to conduct research at Eagle Lake? The California State University at Chico, which owns the Eagle Lake Field Station, recently forged a cooperative agreement with the Bureau of Land Management, which owns much of the northern and northeastern lakeshore, to establish a research program. Through this agreement, \$10,000 will be available to inventory and evaluate archaeological sites and biological resources in the Eagle Lake Basin and to create a computer database of resource information.

Eagle Lake Field Station has been part of the NRS since 1986 (see page 9). Although the new research fund is administered by Chico State, UC students can participate in collaboration with Chico professors. For more information, contact: Professor Jay Bogiatto, Eagle Lake Field Station, Biological Sciences, California State University, Chico, CA 95929; (916) 898-4490 (office) or -5356 (department).

APPLY IMMEDIATELY for Reserve Travel Funds

The Natural Reserve System is pleased to announce that a travel grant fund has been established to support undergraduate education on NRS reserves. Through the new Elizabeth Hall Blakey Travel Grant Program, \$24,000 will be available for each of the next three academic years.

Blakey grants will be awarded to individual instructors for travel expenses related to reserve use, either for undergraduate courses or by undergraduate students

engaged in independent study projects. The maximum award for course travel is \$1,000; for student projects, \$250. Awards must be matched by campus or other sources, preferably in the form of money for travel and expenses.

December 10, 1992 is the deadline for proposals for the 1992-93 winter and spring terms. Awards will be announced approximately December 20.

This grant program is made possible by a bequest from Elizabeth Hall Blakey, who left nearly \$70,000 to the NRS earlier this year. Blakey's interest in the NRS dated back to 1974, when she read a newspaper article about the program that prompted her to write to The Regents for more information. Her contribution will support an important part of the NRS mission: to enhance undergraduate education in the field sciences.

Student Grant Program Funds Research on NRS Reserves

The Mildred E. Mathias Student Research Grants program provides awards of up to \$2,000 each to UC graduate students and \$1,000 each to UC undergraduates for research on NRS reserves. This year, a total of \$25,000 is earmarked for Mathias grants.

The 1991-92 winners are announced on page 4; the 1992-93 awards will be made December 15. For information on next year's competition, contact your campus NRS representative.

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Sarah Steinberg Gustafson,

Transect Editor/NRS Publications Consultant

Pam Fabry, Designer/Publications Coordinator

Susan Gee Rumsey, NRS Systemwide Senior Editor

Ethan D. Michaels, NRS Systemwide Assistant Editor



New NRS Logo Mug Boosts Undergrad Study

The NRS is pleased to announce the establishment of the Robert M. Norris Undergraduate Research Program—named in honor of UCSB Professor Emeritus of Geology Norris, long-time member of the NRS Universitywide Faculty Advisory Committee.

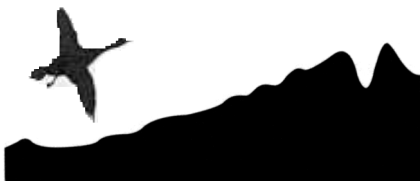
We are raising funds now to support research by undergraduate students throughout the University system on all 32 reserves. First awards will be made in fall 1993. Donors who contribute twenty-five dollars or more to this program will receive the new NRS insulated coffee mug depicted above with our logo and systemwide map. Contributions should be made payable to "The Regents of the University of California" and sent to the NRS systemwide office in Oakland.

We at the NRS appreciate your support of our efforts to promote excellence in undergraduate education.

In accordance with applicable federal laws and University policy, the University of California does not discriminate in any of its policies, procedures, or practices on the basis of race, religion, color, national origin, sex, marital status, sexual orientation, age, veteran status, medical condition, or handicap. Inquiries regarding this policy may be addressed to the Affirmative Action Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th floor, Oakland, CA 94612-3560, (510) 987-0097.

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