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Report of the Director:**Departing director leaves legacy of long-range vision**

After nearly five years as director of the Natural Reserve System (NRS), Deborah Elliott-Fisk left that position in July to resume her full-time faculty position at UC Davis. Her accomplishments as director include strengthening the ability of NRS sites to support the kinds of long-term inventory, research, and monitoring projects that are the focus of this issue of *Transect*.

Elliott-Fisk announced her resignation in an April 10 letter to her NRS colleagues in which she cited her "long desire to get back to campus so I could teach (which I have missed dearly) and interact more closely with my graduate students and research colleagues."

Elliott-Fisk brought to the job of NRS director prodigious energy, interdisciplinary expertise, and a systems perspective based on years of research and teaching in geography and ecology. As a long-time user of NRS reserves for both teaching and research, she was committed to developing the NRS as an ecological and educational resource.

Under her leadership, three new reserves were added to the NRS: Stunt Ranch Santa Monica Mountains Reserve, Fort Ord Natural Reserve, and Sedgwick Reserve. She presided over the NRS's entry onto the information superhighway, with the development of our World Wide Web site (<http://nrs.ucop.edu>), and she spearheaded the development of computer-based geographic information systems (GISs) for several reserves.

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Photo by Peter G. Connors

Banding of shorebirds, such as this immature sanderling at Bodega Marine Reserve, helps researchers gather long-term demographic data (see story on page 11).

Long-term research, monitoring call for long-range planning

By design and management, the Natural Reserve System (NRS) protects and conserves its wildland areas as examples of California's environmental heritage. Does protection mean these sites are unchanging snapshots of our biological, physical, and cultural landscape? No, today's dynamic landscapes were molded by events as long past as glacial action in the Sierra Nevada and as recent as the 1993 Malibu/Topanga fire in the Santa Monica Mountains.

Current biological systems also reflect interactions between species and with the physical environment. Although humans have influenced North American landscapes for perhaps only ten thousand years, their effects have been tremendous. Native Americans routinely used fire as a tool in chaparral and pine forest to in-

crease a variety of food crops. Modern urban, industrial, and agricultural development have degraded and destroyed habitats on a massive scale, resulted in widespread introduction of chemicals, and may threaten to change our global climate.

Teasing apart these complex interactions creates grist for the intellectual mill of NRS researchers investigating population, community, and landscape dynamics. Instructors at NRS sites use field examples to teach natural history, ecological principles, and management issues. Reserve managers design management programs that may reintroduce fire to a chaparral system, restore sites destroyed by past land uses, or reestablish flow through a marsh — all examples of efforts toward restoring and maintaining healthy ecosystems.

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The goals and objectives of long-term monitoring

- Provide a periodic inventory of resources (biological, physical, or cultural) present on the reserve.
- Determine the condition of resources present on the reserve.
- Identify natural long-term trends, cycles, or limits of variation (local, regional, or global).
- Develop a better understanding of the controlling physical and biotic factors.
- Diagnose abnormal conditions (local, regional, or global) so effective management and mitigation strategies can be implemented in a timely manner.
- Identify agents of abnormal change (local, regional, or global).
- Provide a reference point against which less pristine areas can be compared.
- Provide baseline data for future comparisons.
- Provide a "canary in the mine" early-warning signal of the effects of human activities.
- Provide background information needed by researchers.
- Provide resource material for the development of instructional curricula.
- Determine the effects of land-use management decisions on or off the reserve.
- Determine the efficacy of restoration activities.
- Enable managers to make better informed management decisions.
- Convince others to make decisions beneficial to management of the reserves.
- Serve as a baseline for the preparation of environmental impact analyses.
- Fulfill a legal or policy mandate.
- Determine compliance with regulatory requirements.

Long-term planning

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However, NRS reserve users often must operate in what has been called the "invisible present," limited by their awareness of the events and processes that shaped the current landscape. Such inadequate understanding can cause the researchers to reach incorrect conclusions, the teachers to pass along false information, and the managers to embark upon management courses that yield unintended results.

Long-term research and monitoring help us to extend our ecological horizons and to see beyond the "invisible present" by providing data on past conditions. Comparing records made at various times, researchers can find trends that hint at the underlying relationships and can begin to understand the mechanisms responsible. Ecological research focuses increasingly on hypothesis testing and experimental manipulation. Yet as one past president of the Ecological Society of America, Gene Likens, explained:

Qualitative and quantitative observations over long periods are vital to formulate meaningful, testable hypotheses in

ecology. Routine observations or analyses provide a base of information and the necessary experience to develop meaningful hypotheses.

It is not possible to ask a question or model a system to what is a "typical response" or what is a "typical pattern" in ecology without an understanding of the system based on a long record of observation and analysis. (Likens, G. E. 1983. A priority for ecological research. Bull. Ecol. Soc. Am. 64:234-243.)

The founders of the NRS understood, from the start, the need for long-term and baseline data on the conditions and trends of ecological systems on the reserves. In the late 1960s and early 1970s, Bill Mayhew, now professor emeritus at UC Riverside, established photomonitoring points and vertebrate transects at four southern California sites: Philip L. Boyd Deep Canyon Desert Research Center, James San Jacinto Mountains Reserve, Burns Piñon Ridge Reserve, and Motte Rimrock Reserve. In some cases, Mayhew collected data before the properties entered the NRS. Over the years that followed, reserve users have resampled many

of Mayhew's original points and transects, thus creating a data set that covers nearly a quarter of a century.

Researchers on NRS reserves request long-term meteorological data more frequently than any other information. Weather stations operate on approximately one-half of the NRS's 33 reserves. A few sites, such as Bodega Marine Reserve in Sonoma County, have been collecting onsite data for over 25 years. Hastings Natural History Reservation in Monterey County has kept weather records since 1937.

A number of monitoring programs on NRS reserves are site-specific and have grown from investigations by individual faculty, students, and reserve managers. Two examples will serve to illustrate:

At the Donald and Sylvia McLaughlin Reserve, located in Napa, Lake, and Yolo counties on the watershed divide between Putah and Cache creeks, Darrell Slotten and John Reuter (now post-doctoral researchers at UC Davis) and Charles Goldman, professor of limnology at UC Davis, studied the dynamics of mercury in Davis Creek Reservoir. Their investigations, initiated with the closure of the reservoir by the Homestake Mining Company in 1985, now are used worldwide as a model for understanding the movement of mercury in aquatic systems.

At the Hastings Natural History Reservation, research ecologist James Griffin and reserve manager Mark Stromberg demonstrated that California's old fields, unlike those in the Midwest, remain dominated by European barnyard weeds and show no tendency, even after 60 years, for native grasses to return. Pocket gophers "farm" nonnative grasses and have become so abundant on their "new" European foods that they effectively plow all deep, level soils, assuring that native grasses do not reestablish. In refugia that are not plowed, native grasses persist, often living to 200 years, and probably at presettlement densities.

The techniques used for long-term monitoring need not be complex. Routine aerial photography can be an excellent archive of past land-use practices and ecosystem conditions. Repeated ground-level photographs at fixed points can be used to monitor change at a smaller scale. At Bodega Marine Reserve, on the Sonoma County coast, the site manager and site steward, Peter Connors and John Maron, initiated a ground-based photomonitoring program in 1986. Analysis of these photos revealed interesting changes over a 3- to 5-year time scale in the establishment and mortality of the dominant local shrub, bush lupine (*Lupinus arboreus*). These observations prompted them to compile

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A case in point:

Carpinteria plans long-term ecosystem monitoring

The Carpinteria Salt Marsh is one of California's most intensively studied and best understood marshes, an observation that is both gratifying and disturbing to those who work there. It is gratifying because years of conducting surveys and research in the marsh have established a broad base of information about the marsh ecosystem. The disturbing aspect comes from the recognition that a great deal more remains to be learned about this relatively small coastal wetland.

The NRS acquired 120 acres of the 230-acre Carpinteria Salt Marsh in 1977. Since then, researchers have inventoried the biological resources of the marsh and have steadily deepened their understanding of the marsh ecosystem. This knowledge base has enabled University personnel to draw up a comprehensive management plan, currently in draft form, for the Carpinteria Salt Marsh Reserve.

Staff reserve manager and associate NRS director Wayne Ferren has been working on the management plan with UC Santa Barbara biologist Mark Page. One of their goals is to use the management plan to integrate the activities of the various agencies that have an interest in the marsh. A key feature of the draft management plan is a proposal to extend NRS management of the reserve to include the entire marsh ecosystem.

An integrated ecosystem-monitoring program is one of 20 cooperative interagency programs proposed in the plan. Long-term environmental monitoring and research can yield valuable insights into the dynamics of the marsh ecosystem. It can help guide management decisions and provide a useful database for researchers.

Ferren hopes to establish a system for organizing the different types of environmental data that are collected on an ongoing basis by researchers and by various agencies involved in the marsh. The ecosystem-monitoring program would incorporate data from tide gauges, rain gauges, vegetation transects, bird surveys, monitoring of fish and benthic fauna, and water-quality sampling.

For example, research by graduate student Andy Brooks on some of the fish that inhabit the marsh has included monitoring of water temperature and salinity over the past three years. The reserve also has data from six years of monthly bird surveys conducted by a local volunteer, Bob Hansen. UCLA biologist Rick Vance has set up transects on the reserve for long-term vegetation monitoring as part of a project designed to compare vegetation at different sites along the coast.

Ferren conducted the first comprehensive survey of the botanical resources and physical environment of the marsh. His work, published in 1985, has served as a foundation for much of the subsequent research on the marsh ecosystem.

Much of the data gathered in the marsh is not systematically organized or readily available to researchers. The ecosystem monitoring program proposed in the draft management plan would bring together data from a variety of sources and package it in an accessible format.

"This program could serve as a clearinghouse for information from many different agencies," Ferren said.

Unfortunately, long-term funding for ongoing monitoring and research projects is difficult to obtain. Research grants tend to provide funding for only a year or two. Nevertheless, many research projects that do not have long-term funding still provide data that could be usefully incorporated into a general ecosystem-monitoring program.

Page's water-quality study is a good example of a short-term project that has provided extremely valuable data on the functioning of the marsh ecosystem. Page monitored nutrients in groundwater and in surface runoff entering the marsh from six different drainages, taking samples three times a month for one year (see *Transect* 10:1). The study demonstrated high concentrations of nutrients, particularly nitrates, in both surface and groundwater. Excess nitrates can stimulate rapid growth of algae in the marsh channels.

Page believes that illegal discharges from greenhouses or other agricultural activities in the watershed may be contributing to the problem of excess nutrients, because he observed periodic rapid increases in nutrient levels in his samples. A long-term monitoring program might enable him to pinpoint the source or sources of these periodic discharges. The water-sampling wells Page installed remain in place and can be used for ongoing studies, but continued funding for water-quality analyses (which can be expensive) is not currently available.

"Sometimes our monitoring is more like occasional sampling, but it gives you a sense of what's going on in the ecosystem," Ferren said.

Management programs designed to benefit endangered spe-

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Photo by Mark Page

Carpinteria Marsh supports sensitive plant and animal species, provides habitat for migratory water fowl, and serves as a regional nursery for halibut and other marine and estuarine fish.

NRS reserves support national butterfly counts

What were you doing July 4, 1976? If you are a long-time butterflyer, perhaps you participated in the first national Fourth of July Butterfly Count. Today these annual counts continue to grow in popularity, drawing fanciers of all levels of expertise — sometimes to NRS sites. Both the Landels-Hill Big Creek Reserve, near Big Sur, and the Quail Ridge Reserve, in Napa County, have long hosted counts.

Every year, on or around the Fourth of July, volunteers celebrate by counting and identifying as many lepidoptera as they can in a 24-hour period. The count is patterned after the highly successful National Audubon Society's Christmas Bird Count, now more than 90 years old. The butterfly counts began with 76 participants at 28 scattered sites; two decades later, more than 2,000 people gathered at over 250 locations nationwide.

Count guidelines urge that sites be selected mainly for their potential for repeated counts year after year, not just for the richness or rarity of their species. UC Berkeley Professor Jerry Powell, who has led butterfly counts for over 20 years in Berkeley and at nearby Mt. Diablo, helped start them eight years ago at the Big Creek Reserve. "I selected the Big Creek site," he said, "because it is being protected, with some promise of long-term consistent count." Powell adds that much of his en-

thusiasm for starting the Big Creek count came from the interest expressed by NRS Reserve Manager John Smiley.

Another central California count occurs at the NRS's Quail Ridge Reserve. Entomologists Greg Kareofelas and Bill Patterson have been conducting surveys at Quail Ridge throughout the year, compiling a list of species and recording the time of year each species is flying. The data they provide to the national survey is only a fraction of what they have gathered at this site. Says Kareofelas, "We got interested in Quail Ridge because it contains fairly undisturbed blue oak woodland, which in most of California is a very disturbed habitat."

Once a site is chosen for the July Fourth survey, the count boundary is established as a circle with a 15-mile diameter. Covering this large area can be tricky, so count leaders delineate specific routes through their sites to be followed year after year. At least one butterfly expert leads each group along a route, teaching volunteers how to identify the lepidoptera as they go. Sticking to predetermined pathways, without backtracking, decreases the likelihood that the same individuals will be counted twice.

The summer 1995 count revealed that butterfly figures from the Big Creek Reserve had plummeted. More than half of

the total individuals observed belonged to only three species.* Usually between 32 and 36 species are counted, with a potential for 42. Numbers of butterflies observed on a count day can be deceptively low at this coastal reserve, because frequent cold fog makes the insects inactive. However, Powell attributes this particular recent decrease to unusual weather conditions earlier in 1995. The potential for wide variations in butterfly observations from year to year underlines the need for long-term counting.

Count results are given to the North American Butterfly Association (NABA), which publishes the national findings. NABA forms require that the methods used for observing each individual (sighted, binocularized, photographed, etc.) be listed. Numbers of immature butterflies (eggs, caterpillars, pupae) are recorded separately. Butterflies must be identified using NABA-approved scientific and common names. Moths are not counted.

Three years old, the NABA is an all-volunteer organization with nearly 2,000 members. The NABA recently took over most responsibilities for the butterfly count previously held by the Xerces Society, a small conservationist organization that did not grow as quickly as the count it started. The organization is named after *Glaucopsyche xerces*, the first American butterfly species to go extinct due to human disturbance: infilling of coastal dunes near San Francisco caused this tiny blue butterfly to disappear permanently in 1943.

"Look at the big picture," says Powell. "The general value potential for the 250 counts in the country is to monitor large-scale changes and even some local change like extinction. It is not reliable for fine-grain monitoring of butterfly presence or abundance." Powell believes counts must continue for more than 20 years before general trends can be detected. "Many people start counts and drop them," says Powell. "Usually it is the contentiousness of one person in charge, like [Big Creek Reserve Manager] John Smiley, that keeps it going."

— Elaine P. Miller
NRS Senior Science Writer



Photo by Jerry A. Powell

The western tiger swallowtail (*Papilio rutulus*) is a prevalent species in butterfly counts at Big Creek Reserve and elsewhere in California.

* Names of butterfly species counted have been withheld in this article to protect them from overzealous collectors.

James Reserve goes "virtual" after 30 years

In recognition of the thirtieth anniversary of the James San Jacinto Mountains Reserve, located in Riverside County, resident reserve director Michael Hamilton is inaugurating the James "Virtual Reserve."

Incorporating species inventories based on nearly 100 years of biological investigations, augmented by concentrated data collection over the past 12 years, the James Reserve homepage will emulate on the Internet's World Wide Web the actual physical reserve and surrounding natural and human environments. Utilizing a database comprised of nearly seven gigabytes of computerized information, the electronic reserve will provide scientists, students, and agencies — such as the California Department of Forestry — fingertip-access to text, multimedia, and data files that translate the San Jacinto Mountains, the town of Idyllwild, and nearby mountain communities, into high-resolution detail, literally to the level of individual plants.

The site, which Hamilton expects to go online in September, will be more than an informational brochure documenting 30 years of activities; it will include access to the complete geographic information system (GIS), remote-sensing imagery, biodiversity accounts, reserve user profiles, and reserve research publication bibliography that currently reside at the James Reserve. It will also include an electronic reservation calendar, e-mail post office, and topical discussion area.

Contingent upon funding from FEMA, the Federal Emergency Management Agency, additional amenities will be added to offer near real-time information: for example, environmental sensor data, live-video camera grabs, local clips from a NOAA (National Oceanic and Atmospheric Administration) weather satellite, and even a live microphone feed. Such features will establish this web site as the first generation of a true "virtual reserve."

This Internet-accessible reserve will aid scientists as they tackle complex land-management issues and biotic species investigations, and will assist educators with environmental education applications.

— Jana Shaker
UC Riverside Science Writer
College of Natural & Agricultural Sciences



Photo by Don Usner

The Rat Creek Fire of 1985 burned a total of 57,000 acres, including the entire 7,648-acre Big Creek Reserve. Post-fire research conducted in its aftermath focused on the natural heterogeneity of fire and its effects on the landscape.

Fire research guides reserve management plans

Fire plays an important role in shaping and maintaining many of California's natural plant communities. The management of fire on NRS lands is a complex issue, however, requiring careful research and planning.

Valentine Camp, part of the Valentine Eastern Sierra Reserve located in Mono County, provides a classic example of the problem of fire management at the interface between wildlands and urban development. A fire at Valentine Camp would threaten not only reserve facilities, but also the town of Mammoth Lakes, which borders the reserve on two sides. While timber harvesting has reduced the fuel load on adjacent National Forest lands, no timber harvests have been allowed on the reserve. As a result, the fuel load in some of the Valentine Camp forests is relatively high for the eastern Sierra Nevada, says reserve manager Dan Dawson.

A fire history project was initiated two years ago at Valentine Camp as the first step toward developing a fire management plan. Scott Stephens, a post-doctoral researcher with the U.S. Forest Service, analyzed wedges cut from fire-scarred trees and reconstructed a fire chronology extending back in time hundreds of years. The last fire at Valentine Camp occurred more than 100 years ago, around 1888-89, but before then the average interval between fires was 10 to 11 years for the Jeffrey pine forest and about 37 years for the wetter montane forest, says Stephens.

This information, along with data on fuel loading and burn potential at different sites, will be used to guide management decisions regarding the need for tree thinning or controlled burns.

At the James San Jacinto Mountains Reserve, vegetation and fire-history data have been integrated into the reserve's geographic information system (GIS). This enables resident reserve director Mike Hamilton to use the GIS to assess the fire risk at different sites and plan fire management strategies (see *Transect* 12:1). Property owners in the neighboring town of Idyllwild can also use the GIS to assess their own fire risk and take appropriate fire prevention and safety measures.

The use of prescribed burns as a management tool remains largely an experimental approach at NRS reserves. It has been used most often in efforts to restore native perennial grasslands. Last year, at Santa Cruz Island Reserve, located on one of California's Channel Islands, a prescribed burn of Bishop pine habitat was conducted to stimulate regeneration of this fire-adapted, closed-cone pine.

At the Angelo Coast Range Reserve in Mendocino County, resident steward Peter Steel has considered both controlled burns and cutting fuel breaks to avert a potentially catastrophic fire. The absence of fire for about 75 years has allowed a heavy fuel load to accumulate. In discussions with the Bureau of Land Management and the California Department of Forestry,

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Fire research

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reserve staff have requested use of modified suppression techniques in the event of a major fire, with no heavy equipment on reserve lands and aerial drops of water only, not fire retardant.

"Whether that would actually occur in the heat of the moment, though, is not clear," says Steel.

A major fire at one of the reserves often spurs a flurry of post-fire research. Larry Ford, currently a visiting lecturer in Environmental Science, Policy, and Management at UC Berkeley, began post-fire studies after the devastating Rat Creek Fire of 1985, which burned the entire Landels-Hill Big Creek Reserve on the Big Sur coast. (More recently, in October 1995, a fire started on Highlands peak in the Big Creek Reserve and threatened nearby homes, but was successfully contained [see *Transect* 13:1].)

Ford's research focused on the heterogeneity of fire and its effects on the landscape. The intensity of a fire as it passes through an area can vary considerably from one small patch of ground to the next. This is due both to the heterogeneous nature of the vegetation and to the unique, almost fluidlike properties of fire itself, says Ford. For many plant species, fire intensity may determine whether adult plants survive and whether seeds in the soil are stimulated to germinate. Thus, the natural heterogeneity of fire is partly responsible for the shifting mosaic of vegetation within certain plant communities.

"It is a story of great complexity," says Ford. "How fire works on the landscape is not well understood in most cases."

The Malibu/Topanga Fire of November 1993 burned most of the vegetation and all of the facilities at the Stunt Ranch Santa Monica Mountains Reserve (see *Transect* 14:1). In its aftermath, researchers are studying seed germination in fire-adapted annual plants, postfire succession in chaparral plant and animal communities, and the nature and magnitude of postfire erosion.

In July 1994, a major fire burned 300 acres of the Boyd Deep Canyon Desert Research Center near Palm Desert, including a pristine stand of pinyon-juniper woodland. The staff at Deep Canyon immediately began planning a long-term ecological monitoring project to see how the ecosystem responds to the fire. They established permanent transects in burned and unburned areas, which they plan to monitor for decades to come.

— Tim Stephens
NRS Senior Science Writer



Photo by R. Cole

Biotic surveys indicate there are no introduced species of fish or invertebrates in Eagle Lake, a situation that is most unusual in California.

Fish research thrives across UC sites

The Sierra Nevada Aquatic Research Laboratory (SNARL), located in Mono County, has been the site of fisheries research since the 1930s, when federal biologists began studying survival of fingerling trout in Convict Creek. Current projects include research on the effects of livestock grazing on stream ecosystems. SNARL is critical to this study because it provides the only ungrazed stream site in the area, says Roland Knapp, a UC Santa Barbara research biologist based at SNARL.

Monitoring of fish populations is one of three techniques Knapp and his colleagues are using to assess the impact of grazing on stream ecosystems. The brown and rainbow trout in Convict Creek and other Long Valley streams are not native, but they are very sensitive to environmental modifications caused by livestock, such as collapsed stream banks, removal of riparian vegetation, and increased erosion. The researchers are also monitoring aquatic invertebrates and measuring physical stream characteristics to evaluate the health of the ecosystem at each site.

Another long history of fisheries research has been compiled from UC Berkeley's Sagehen Creek Field Station in Nevada County. Data on the abundance and distribution of different fish species in Sagehen Creek have been collected regularly since 1952. In addition, long-term records of stream flow and weather conditions are available. An underwater observatory built in the early sixties offers researchers a 24-foot plate-glass window for observing fish in their natural habitat.

Fisheries research at Sagehen has demonstrated major changes in fish populations resulting from the construction in 1969 of a reservoir downstream from the site, says Don Erman, former director of the field station and now director of the UC Centers for Water and Wildlands Resources in Davis.

Finally, Eagle Lake Field Station, located in Lassen County, is another valuable NRS site for fisheries research. Eagle Lake supports thriving populations of five native fish species, including an endemic subspecies of rainbow trout that has adapted to the lake's high alkalinity (pH 9). Student research projects under UC Davis fisheries biologist Peter Moyle have found that the Tui chubs in the lake can live longer than 30 years. Biotic surveys also indicate that there are no introduced species of fish or invertebrates in the lake, a highly unusual situation for California.

— Tim Stephens
NRS Senior Science Writer

Big Creek manager reels in data from anglers using sustainable fishery

The common phrase, "There are always more fish in the sea," was obviously coined before heavy modern demands were placed on the world's fish stocks. Nowadays, increased pressure from the commercial fishing industry — aggravated by high-seas driftnets, which can stretch thirty to forty miles in length — is seriously depleting global fish populations. In some locations, these declines in fish and shellfish stocks are caused by habitat loss. But along a protected stretch of California's Big Sur Coast, a sustainable fishery has been maintained for seven years, thanks to John Smiley, reserve manager of the NRS's Big Creek Marine Ecological Reserve.

Smiley's unique cooperative program, called the Big Creek Hook and Line Kelpfish Survey, involves swapping fish for data. Smiley allows low-to-moderate fishing in the marine reserve — so long as the anglers give him information (except for red herrings) about their catches. He inputs this information, such as fish type and size, into a computer database.

"Since 1989, local fishermen have helped us to see if fish sizes and diversity are declining due to fishing pressure," says Smiley. "And there is good news: so far, fish diversity and sizes are holding steady."

The kelp-forest fishes that make up this sustainable fishery include several species

of rockfish (genus *Sebastes*) — kelp rockfish (*S. atrovirens*), gopher rockfish (*S. carnatus*), copper rockfish (*S. caurinus*), black and yellow rockfish (*S. chrysomelas*), vermilion rockfish (*S. miniatus*), olive rockfish (*S. serranoides*), and black rockfish (*S. melanops*) — plus lingcod (*Ophiodon elongatus*) and cabezon (*Scorpaenichthys marmoratus*).

Smiley believes the program keeps everyone happy: the anglers get their fish, the reserve gets its data, and the fish, although individuals are harvested, get to maintain stable populations.

Data netted from anglers at Big Creek were helpful to UC Santa Cruz graduate student Michelle Paddack as she analyzed the usefulness of marine reserves in sustaining nearshore fish populations. Her work involves establishing long-term kelp-forest monitoring programs, not only at the Big Creek Marine Reserve, but also at two other marine reserves within the Monterey Bay National Marine Sanctuary: the Hopkins Marine Life Refuge, in Monterey Bay, and the Point Lobos Marine Reserve, in Carmel Bay. Paddack's study was funded in part by a Mildred E. Mathias Graduate Student Research Grant from the NRS.

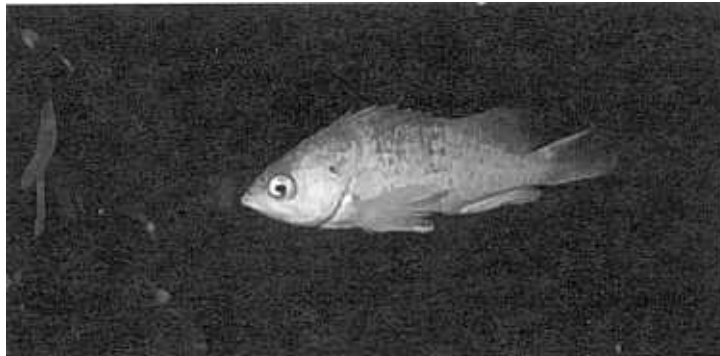
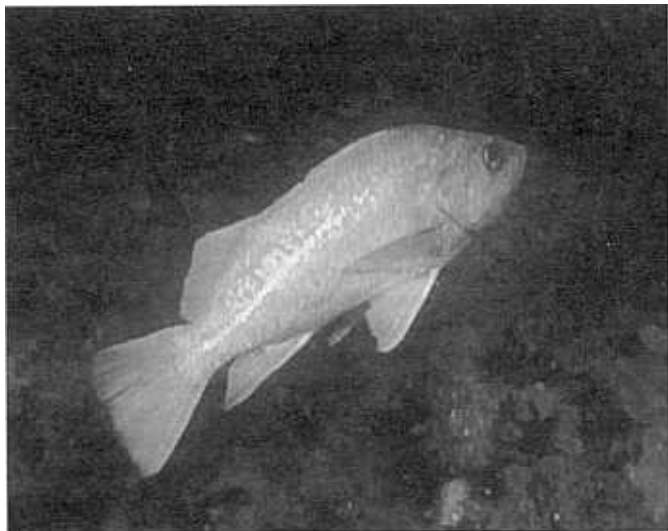
To maintain the Big Creek fishery, Smiley has not yet needed to limit the anglers' catches. However, he does control where and when fishing occurs by work-

ing out agreements with the anglers in advance. They must agree to stay clear of the mouth of Big Creek. Smiley also warns them that the beach might close at any time — for instance, during seal whelping (birthing). The anglers, usually numbering between six and ten (one per boat), also agree to fish at the reserve only from September to early November. Each angler holds a license and typically catches between 60 and 100 fish per day, using hook and line.

Though some anglers may be tempted to sneak onto the marine reserve, bypassing Smiley's requirements, this seldom happens. Their fishing boats are small and poorly equipped to travel far on the rough waters of the Big Sur coast. They must therefore launch near the fishery. The Big Creek Reserve is the area's favored launch spot — and if you enter the Big Creek Reserve with a boat, you have to talk to Smiley.

Smiley says that, at the beginning of the Big Creek Hook and Line Kelpfish Survey, he had to turn away several anglers who refused to cooperate. Over the years, however, most local anglers have come to understand and accept the cooperative program.

— Elaine P. Miller
NRS Senior Science Writer



Photos by Nicole Crane

The Big Creek Hook and Line Kelpfish Survey targets several species of rockfish (genus *Sebastes*), which are also commonly called rockcod. Some of the deep-water species are red and are often sold as red snapper. The species pictured here are vermilion rockfish (above), kelp rockfish (top right), and an immature fish tentatively identified as a black and yellow rockfish (bottom right).

Golden state grassland restorationists seek the return of the natives

Efforts to restore and enhance native perennial grasslands face some daunting obstacles. Most California grasslands are now dominated by exotic species — annual grasses and forbs native to southern Europe that arrived with European settlers in the eighteenth century. Long-term studies have shown that the seedlings of native bunchgrasses stand little chance of out-competing those of the introduced annuals.

Small, relict stands of native perennial bunchgrasses, which once carpeted California's valleys and foothills, can still be found at many sites, including Hastings Natural History Reservation and the Jepson Prairie, Sedgwick, and Bodega Marine reserves. Researchers at these sites are conducting long-term studies of grassland ecology, and their results are guiding management strategies aimed at promoting a comeback of the native bunchgrasses.

Numerous studies indicate grasslands dominated by introduced annuals are not likely to revert to native perennials under a "preservationist" approach that simply protects the land from such disturbances as grazing. In most cases, an active management strategy is needed to promote the growth of native bunchgrasses. Experiments indicate the most effective restoration tools are prescribed burning and short-duration, controlled grazing.

At the Hastings Reserve, in Monterey County, data on the species composition of abandoned agricultural fields are available as far back as the 1940s. Although the land has been protected from grazing since the University acquired it in 1937, the old fields are still dominated by the same introduced annuals recorded fifty years ago.

Relict perennial grasslands at Hastings also show remarkable stability. Clumps of purple needlegrass (*Nassella pulchra*) mapped and monitored since 1964 have not changed much and may be 200 years old or older, says Mark Stromberg, the resident reserve manager at Hastings.

A 20-year study of the Hastings grasslands has shown that cultivation of the land was the decisive factor in the loss of perennial bunchgrasses (Stromberg and Griffin, *Ecological Applications*, in press). The only sites where these bunchgrasses survive are steep hillsides and heavy clay soils that couldn't be plowed. Grazing by cattle and sheep appears to have had surprisingly little effect on established perennials at Hastings, even in areas with a history of massive overgrazing. But plowing destroyed the mature bunchgrasses, and when the fields were abandoned, introduced annuals had a competitive edge on the disturbed ground.

For thousands of years in southern Europe, the weedy species evolved in the presence of agriculture, heavy grazing, and periodic drought. They produce massive quantities of seeds that disperse widely. Their seedlings grow rapidly and compete fiercely for water and sunlight, maturing and producing seeds even under highly unfavorable conditions.

At Jepson Prairie in Solano County, however, researchers are learning how to turn the tables on the introduced annuals.



Three California native grasses: purple needlegrass (*Nassella pulchra*) [top], blue wildrye (*Elymus glaucus*) [middle], and barley (*Hordeum brachyantherum*) [bottom].

Eight years ago, with a 10-year funding commitment from The Nature Conservancy, researchers led by John Menke from UC Davis set up 18 fenced paddocks on the prairie to compare the effects of different treatments, including protection from disturbance, prescribed burning, and sheep grazing in spring or summer.

Burning is far and away the most useful tool for fostering the growth of native perennials, says Menke. Burning in the spring, when the seeds of the annuals are still in the seed heads, reduces the seed load and subsequent competition from annual seedlings. Managers of the Jepson Reserve are now beginning to apply this treatment on a larger scale.

Livestock grazing can also be used to control annual grasses and promote native perennials, but it must be carefully regulated. Short-duration, high-intensity grazing by cattle or sheep for several days in early spring reduces the seed load from annual grasses, similar to spring burning. Short-duration summer grazing appears to stimulate growth of perennial grasses by reducing shading from dead stems and litter.

Meanwhile, at Sedgwick Reserve near Santa Barbara, researchers are just beginning a long-term study designed to test and extend Menke's ideas about the use of grazing as a tool for restoring native grasslands. The study will also look at the impact of different grazing treatments on oak regeneration. Mark Reynolds, who co-manages the reserve with Virginia ("Shorty") Boucher, hopes this study, planned to continue for at least 10 years, will yield results that can be applied to stewardship on the rest of the property.

At Bodega Marine Reserve on the Sonoma County coast, recent surveys of the coastal prairie indicate significant recovery of native perennials in some locations. Reserve manager Peter Connors attributes this to the elimination of grazing since the early 1960s. At inland sites, protection from grazing has not led to recovery of the native bunchgrasses, which underscores the point that not all grasslands will react the same way to the same management strategies, says Connors.

At these and other NRS sites, researchers have made tremendous progress in their understanding of California's native perennial grasslands. Although California grasslands remain one of the biggest challenges in the field of habitat restoration, NRS research is helping restorationists to meet that challenge.

— Tim Stephens
NRS Senior Science Writer

Santa Cruz Island archaeologist unearths new clues to Chumash culture

Discovery of a deeply buried redwood-post structure on Santa Cruz Island has led to a new research project, funded by a grant from the National Science Foundation (NSF), for UC Los Angeles archaeologist Jeanne Arnold.

The redwood structure, which dates to around the period of contact between the Chumash people and Spanish colonists in the mid- to late-eighteenth century, was probably a house belonging to a family or a lineage of very high status within Chumash society. Its discovery in 1991 inspired Arnold to undertake detailed comparative studies of individual households at several archaeological sites on this largest of the California Channel Islands.

Arnold has been studying the prehistoric culture of the Island Chumash since 1981, when she was a graduate student at UC Santa Barbara. Her doctoral dissertation and subsequent research (funded by another NSF grant from 1988 to 1991) focused on the intensive craft specializations of the Chumash during a critical period about 900 years ago (see *Transect* 7:2). Having broadly characterized the activities of different Chumash communities on the island, Arnold has begun looking at individual households within those communities.

"To be able to go back to the same sites where I had worked in the early eighties and do a different sort of study is extremely valuable," Arnold says.

The Santa Cruz Island Reserve has helped preserve the island's archaeological resources for such long-term research projects as Arnold's. Compared to the mainland of southern California, the preservation of archaeological sites on Santa Cruz Island is outstanding. Due to the absence of burrowing animals and the limited amount of road construction and other development, most sites on the island are relatively undisturbed. Arnold's main concern is the growing population of feral pigs, whose digging in search of food can destroy the archaeological value of a site overnight.

The excellent condition of archaeological sites on the island would be of limited interest, however, were it not for the extraordinary society that once lived there.

"The Chumash were hunter-gatherers who never adopted agriculture, yet they developed a fairly sophisticated level of sociopolitical integration, with a hierarchical society and a complex system of specialized manufacturing and trade," Arnold says.

On the mainland, Chumash territory extended along the coast from San Luis Obispo south to Topanga Canyon. The Island Chumash played a key role in the trade network that extended throughout this territory, making the shell beads that served as a form of currency, or "money."

As a result of these findings, Arnold became interested in learning more about the nature and activities of different households within the Island Chumash communities. The NSF grant provides funding for this project from 1995 through 1998.

Last year, Arnold and her students began collecting samples from individual houses at several sites dating to the same period as the redwood structure (the late prehistoric and early Mission period, about 1700 to 1810). Undisturbed depressions on the surface of the ground at these sites indicate the locations of houses. Although analysis of the samples has just begun, it is already clear that there was considerable variability among the houses within a community. Some of the differ-

ences are related to occupational specialization — such as fishing or bead-making — while others appear to be related to social status and wealth.

A large number of graduate and undergraduate students have participated in Arnold's research projects. She has always integrated the summer field school with her research. In the past, she says, her research projects shaped the activities of the field school, but with the discovery of the redwood posts, the field school ended up driving her research in a new direction.

Arnold's field research on the Chumash has provided the foundation

for theoretical advances regarding the emergence of social complexity among hunter-gatherers. Her recent publications include cross-cultural studies comparing complex societies in California with those in other areas, such as the Northwest coast. Arnold's interactions with scholars studying complex hunter-gatherers in other parts of the world is bringing increased attention to the Chumash and to the Santa Cruz Island Reserve.

— Tim Stephens
NRS Senior Science Writer



Photo by J. E. Arnold

Students in the archaeology summer field school on Santa Cruz Island have made significant contributions to research on the Island Chumash.

The redwood-post structure was found during the summer field school in archaeology that Arnold has taught nearly every year since 1988. She and her students have spent four summers slowly excavating it. The perfectly preserved redwood poles, each about two to three inches in diameter, form a circle, of which about one-third of the circumference has been uncovered. Associated with this structure are numerous artifacts that indicate the high status of its owner.

"Although it could be a ritual structure of some sort, I'm pretty sure it's a house belonging to an elite family with unusual access to high-status, exotic goods coming in from other cultures in southern California," Arnold says.

Pygmy forest field trip marks end of an era

One Saturday morning in late April, a caravan of buses, carry-alls, and cars pulled up on the Mendocino headlands and unloaded some 120 UC Berkeley undergraduate students, several teaching assistants, and one professor emeritus: Arnold M. Schultz.

Since his retirement in 1991, Schultz has continued to teach his favorite course, Ecosystemology (ESPM 164), and bring his students to the marine terraces of Mendocino County for a lesson on landscape evolution. To the regret of many, however, this was perhaps the last ecosystemology field trip Schultz would lead.

"There's no one else who could teach this material the way Arnold does," commented Debora Hammond, one of the class's teaching assistants.

With a cane in one hand and his notes in the other, Schultz launched into a lecture on soil formation and vegetation development. Beyond the gathered students stretched a lush meadow dotted with wildflowers, the first step of an "ecological staircase" found on the series of uplifted, wave-cut terraces that extends back from the Mendocino coastline. Each of the five terraces is about 30 meters (100 feet) higher and roughly 100,000 years older than the one below it. Thus, the staircase provides snapshots of roughly one-half million years of ecosystem evolution.

As the day progressed, the class would observe dense forests of Bishop pine, Douglas fir, and coast redwood on the second and third terraces, and finally, on the highest and oldest terraces, the pygmy forest. There, on highly weathered soils leached of nutrients and underlain by an impenetrable hardpan, century-old trees stand less than six feet tall, their trunks only an inch thick.

Schultz began doing research in the pygmy forest in 1963, working closely with the late Hans Jenny, an eminent researcher and professor of soil science at UC Berkeley. Schultz and Jenny were instrumental in the creation of the NRS's Hans Jenny Pygmy Forest Reserve, and also helped establish a pygmy forest reserve

within the nearby Jackson State Forest. In the course of their research, Schultz and Jenny elucidated the origins and implications of the ecological staircase that culminates in the pygmy forest and developed a model of ecosystem formation.

Schultz has been teaching his ecosystemology course since 1975. Now, however, he wants to focus on writing a monograph that will present his and Jenny's findings from years of research, a project that was delayed by Jenny's death in 1993. Their first major publication on the pygmy forest appeared in 1969 (*Madroño* 20:60-74), but much of their subsequent work has not been published.

"We rejected the idea of publishing a lot of fragments, because with ecosystem research you want to put all of the pieces together," Schultz said.

Although Schultz's presence in the classroom will be missed, ecologists will surely benefit from the publication of a comprehensive monograph on the concepts of ecosystem formation that were inspired by the pygmy forest. Schultz also plans to continue his research and to remain the reserve manager for the Pygmy Forest Reserve.

"I have imagined at least one hundred juicy [research] problems there that are waiting to be investigated," he said.

— Tim Stephens
NRS Senior Science Writer



Photo by Tim Stephens

Professor Emeritus Schultz delivers a lecture to his ecosystemology students on his final field trip to the Mendocino coast.

Oak research branching out at Sedgwick site

Over the next decade, an oak restoration project at Sedgwick Reserve — a new NRS site located in Santa Barbara County — will provide a tree of knowledge for land managers. Two UC Santa Barbara professors, Frank Davis and Bruce Mahall, are working to restore oak woodlands and to disseminate their findings, with the help of \$750,000 from Santa Barbara County.

This oak-regeneration project, which first took root in late 1994, focuses on three species: valley oak (*Quercus lobata*), blue oak (*Q. douglasii*), and coast live oak (*Q. agrifolia*). Davis and Mahall will restore several hundred acres of the Sedgwick Reserve's oak woodland and savanna using multiple techniques, including experimental sowing and the protection of acorns along with self-established seedlings and saplings. In addition, they will plant seedlings grown from acorns in a greenhouse.

The two researchers are also developing methods to reduce impacts of livestock on oaks. For nearly 200 years, cattle have grazed ranch property. Davis and Mahall are working cooperatively with livestock researchers from California Polytechnic University, San Luis Obispo, to manipulate the timing and intensity of cattle grazing in fenced portions of the site. Additionally, Davis and Mahall are working to decrease the number of acorns and seedlings lost to deer and introduced wild pigs.

Davis and Mahall will turn their research findings into recommendations for local land managers. They plan to make their prescriptions for oak regeneration available by publishing literature and giving on-site demonstrations.

An oak-restoration database and geographic information system will be maintained at the UC Santa Barbara campus, where they will be made available to researchers, managers, and other interested parties. The database will contain both baseline data and information on Davis and Mahall's long-term monitoring and oak-restoration experiments.

The use of computer technology will also enable Davis and Mahall to branch out into other areas of oak research. Once the sprouting database contains enough information, it will be applied to the modeling of oak sites in other regions of the country.

— Elaine P. Miller
NRS Senior Science Writer



At-sea monitoring tracks elephant seals in transit between Big Creek and Año Nuevo

Researchers at Año Nuevo Island Reserve attach a satellite transmitter and time-depth recorder to a male elephant seal (above) as part of an at-sea monitoring program. UC Santa Cruz biologist Daniel Costa heads the project, which involves transporting elephant seals from the Año Nuevo rookery to the waters off the Big Creek Reserve. After their release at Big Creek (right), most of the seals return to Año Nuevo in about four days. Instruments attached to the animals' backs enable researchers to track their movements and collect data on diving behavior and other aspects of the elephant seal's life at sea, where it spends the vast majority of its time (below). Data from Costa's studies will be used to assess the potential effects of low frequency sound on marine mammals as part of the Acoustic Thermometry of the Ocean Climate (ATOC) project, an international effort to use low frequency sound waves to measure ocean temperatures (see *Transect* 13:2).



Photos provided by Daniel Costa



Bird studies rely on long-term observation

Some of the most fascinating and valuable long-term studies at NRS reserves focus on bird populations.

Researchers at Hastings Natural History Reservation, for example, have been studying cooperative breeding in acorn woodpeckers (*Melanerpes formicivorus*) since the early 1970s. Ongoing studies at this Carmel Valley site continue to yield new insights into the social behavior of this unusual species, the only cooperatively breeding bird native to California.

Hastings research zoologist Walt Koenig, who began studying the acorn woodpeckers in 1974, says the birds continue to surprise him. In communal breeding groups, more than one breeding pair and several nonbreeding helpers work together to raise and feed young birds at a single nest. Koenig and his coworkers have found that the individuals within communal breeding groups are very closely related, yet there is intense competition among the individuals in a group. Co-breeding females, for example, may destroy each other's eggs by tossing them out of the nest.

Koenig is now looking at patterns of incest avoidance within groups. The woodpeckers' breeding behavior appears to be limited by strong incest-avoidance taboos that cause them to lose considerable reproductive potential. "That's the kind of thing that we would never have been able to figure out without long-term studies of marked individuals," Koenig says.

At several reserves, bird monitoring programs enable researchers to track fluctuations and identify long-term trends in local populations. For example, counts of wintering shorebirds have been conducted since the 1970s at Bodega Marine Reserve, 50 miles north of San Francisco. About 20 years of population data are available for some species, such as sanderlings and marbled godwits. Regular monitoring of all shorebirds began about 12 years ago.

Sanderlings declined somewhat alarmingly for several years in the 1980s, but the population has since recovered, says Reserve Manager Peter Connors. In recent years, sanderlings have been as numerous as they were in the late 1970s. The population of black-bellied plovers, in contrast, remains considerably smaller than it was in the 1970s. While the sanderling recovery is encouraging, it raises the question of when scientists should become alarmed about population declines, Connors says.

A related concern is whether a population decline observed in one location is a local phenomenon, caused by local condi-

Continued on page 12

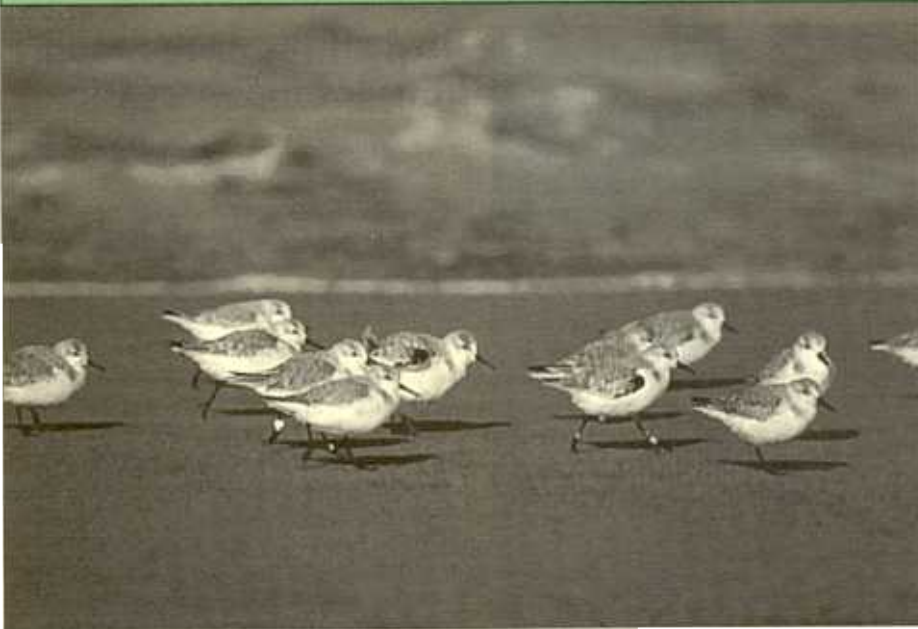


Photo by Peter G. Connors

Ecosystem monitoring

Continued from page 3

cies in the marsh can also be valuable sources of information about the entire ecosystem. For example, an animal-trapping program, which was initiated by the U. S. Fish and Wildlife Service to protect the light-footed clapper rail from predation by racoons, cats, and other animals, has the secondary function of providing information about the numbers and species of mammals that occur in the marsh.

Monitoring programs are essential for effective management of sensitive habitats, such as the Carpinteria Salt Marsh. The reserve has accumulated a wealth of information about the marsh ecosystem and is now in a position to propose extending its management responsibilities to the entire marsh. The marsh as a whole encompasses lands owned by Santa Barbara County, the City of Carpinteria, a land trust, homeowners' associations, and private individuals. Building on the management experience and community support it has gained over the years, the reserve hopes to establish cooperative agreements with the various agencies so that the whole ecosystem will be preserved and managed under a single plan.

— Tim Stephens

NRS Senior Science Writer

Bird monitoring

Continued from page 11

tions, or more widespread, indicating changes in the worldwide population of the species. To address this question, Connors is working with researchers from the W. Alton Jones Foundation and the Manomet Bird Observatory to monitor sanderling populations at additional sites in California and South America.

Changes in bird populations can sometimes be linked to changes in the local ecosystem. One such case involved a heavy settlement of Dungeness crab juveniles in Bodega Bay several years ago, causing a decline in the invertebrates on which they feed, which in turn led to lower populations of the shorebirds that also feed on those invertebrates. A similar phenomenon may be occurring now due to an invasion of the European green crab (see *Transect 12:1*).

"It was partly because of the availability of long-term data on shorebird populations that we were able to get NSF (National Science Foundation) funding to look at the long-term effects of the green crabs," Connors says.

Bird populations are also monitored at the Motte Rimrock Reserve in Riverside County. Instituted in 1990 by staff reserve manager Barbara Carlson, the monitoring program is part of a continentwide project called MAPS (Monitoring Avian Productivity and Survival) that is gathering long-term demographic data on landbirds (see *Transect 11:1*). Most of the birds monitored at Motte are resident species, so the data are likely to reflect environmental conditions in the local area, Carlson says.

— Tim Stephens

NRS Senior Science Writer

(Photo above) Researchers have been monitoring the population of sanderlings at Bodega Marine Reserve since the 1970s. The population declined markedly in the 1980s, but has since recovered. Researchers are now monitoring sanderlings at additional sites in an effort to measure global population trends.

(Illustration below) In April of 1995, the endangered light-footed clapper rail was spotted in the Carpinteria Salt Marsh for the first time since 1988. Three birds have been sighted. The control of predators through an animal-trapping program may have encouraged the birds to return to the marsh.

Art by M. L. Herring



Long-term planning

Continued from page 2

older aerial photos dating back to the 1950s, which confirmed the rapidly changing demographics of this plant. Today, approximately 10 researchers are involved in ongoing projects and have produced many publications on the ecology of this species. Many of the interesting and testable hypotheses formulated by these researchers were aided by an understanding of the shrub's natural history established through photomonitoring.

The value of long-term research is confirmed by the findings of these and other NRS researchers, as well as investigators at numerous sites throughout the world. Their discoveries would not have been possible if only short-term data sets had been available to them.

On the other hand, monitoring efforts can potentially deteriorate into mindless data collection with no clear objective in mind. As Ecological Society of America past-president Gene Likens noted:

*Vast amounts of routine data have been collected, stored, and then unused. This deficiency occurs largely because there was no initial objective or experimental design for use of these data. The challenge is to be creative and to set up studies today with clear objectives (i.e., identify questions) that will be informative five, ten, or fifty years from now in terms of important ecological issues (or environmental problems). (Likens, *ibid.*)*

Establishing a long-term, monitoring plan for the reserve system, therefore, requires developing a clear understanding of the program's goals — a challenging task.

Fortunately, many of the elements required for success are already in place. NRS reserves are spectacular examples of California ecosystems that span the wide breadth of the state's diversity. NRS staff, well trained in a variety of fields, are focused on and committed to achieving an understanding of the dynamics of their sites. The faculty and students at the UC campuses use the NRS reserves as outdoor laboratories to push our understanding of biological and physical systems. A range of goals and objectives are possible (see table, page 2). Developing and implementing a systemwide monitoring program is in itself a long-term commitment that the NRS is only now beginning to undertake.

— A. Sidney England
Principal Environmental Planner
UC Davis

Report of the Director:

NRS vision

Continued from page

Elliott-Fisk's vision for the NRS included establishing the system as a network of field monitoring stations to support long-term research on environmental change across the state and around the globe. The 33 reserves now in the NRS provide a broad representation of California's biological communities. From Eagle Lake in northeastern California, at the interface of the Sierra Nevada, Cascade Range, Great Basin, and Modoc Plateau ecoregions, to the coastal estuary of Mission Bay in southern California, the diversity of these communities is striking. Their near-natural condition and wide geographic distribution further enhance their value to researchers investigating California's regional ecosystem, its "health" or current state, and its susceptibility and resilience to change through natural and anthropogenic mechanisms.

This "systems perspective" is the lens that has focused all of Elliott-Fisk's efforts — as teacher, researcher, and NRS director. She described her approach as one of analyzing the earth's landscape "as an ecosystem composed of biota,

surface soils, geologic structures, and landforms that interact with the atmosphere and hydrosphere to form a functional, integrated system."

It is an approach well-served by the NRS. The number, quality, and distribution of our reserves are unmatched by any other university-owned system. The opportunities they provide for teaching and research benefit not only the University,

but also resource management professionals and the public. The NRS can play a central role in addressing concerns about global warming, loss of natural biodiversity, effects of exotic species on natives, rates of erosion and stream accretion, and other environmental phenomena.

Our challenge now is to further develop our long-term physical and biological datasets and use them to help frame and answer key questions about ecosystem change. Elliott-Fisk's leadership in establishing well-referenced digital databases, GISs, and a readily accessible Web site will help both student and professional researchers make full use of this valuable information.

This issue of *Transect* provides an overview of the numerous long-term research and monitoring activities on our reserves. By illustrating the remarkable resource base these projects have established, we hope to stimulate researchers and students to consider how we can best employ these resources to help detect and track regional environmental changes, guide resource management, and inform public policy in the decades ahead.

—Elizabeth Riddle
Acting Director
Natural Reserve System



Photo by Ethan Michaels

Former NRS Director Deborah L. Elliott-Fisk.

Mathias student research grants program names 1995-96 award winners

The NRS is pleased to announce the dozen students from seven UC campuses who won research funding from the 1995-96 Mildred E. Mathias Student Research Grants program. Mathias grants support student research at NRS reserves with awards of up to \$2,000. The 1995-96 awards, totalling \$20,000, are helping to fund research at nine NRS sites. The winners:

From UC Berkeley: *Miyoko Coco Chu* investigating the dual breeding range of the phainopepla at the Boyd Deep Canyon and Sweeney Granite Mountains desert research centers (see below); *Leonard Sklar* studying controls on channel gradients in rivers with mixed beds of bedrock and alluvial material at the Angelo Coast Range Reserve.

From UC Davis: *Peter Trenham* investigating the applicability of metapopulation theory for pond-breeding amphibians at

Hastings Natural History Reservation; *John Maron* studying the population consequences of heavy insect herbivory on bush lupine at Bodega Marine Reserve.

From UC Irvine: *Lara Ferry* analyzing the feeding kinematics of the swellshark at Santa Cruz Island Reserve.

From UC Los Angeles: *Jeannette Reich* investigating the effects of herbivory on nutrient availability and ecophysiology of bush lupine at Bodega Marine Reserve.

From UC Riverside: *Michael Wangler* studying the effects of exotic grass invasions on plant succession, frequency and severity of fires, and ecosystem stability in the East Mojave Desert at Sweeney Granite Mountains Desert Research Center.

From UC San Diego: *Anne Fetscher* examining the functional ecology of the touch-sensitive stigma in bush monkey-flower at Dawson Los Monos Canyon Reserve.

From UC Santa Barbara: *Jason Hamilton* studying interference between a native perennial grass and naturalized exotic annual grasses in a California grassland at Sedgwick Reserve.

From UC Santa Cruz: *Dorian Houser* analyzing urea turnover during suckling and fasting bouts in northern elephant seal pups at Año Nuevo Island Reserve; *Suzanne Kohin* studying development of the regulation of diving and aerobic capacity in northern elephant seal pups at Año Nuevo; and *Sanjayan Muttulingam* investigating genetics, physiology, and fitness in natural populations of pocket gophers at Hastings Natural History Reservation in an effort to assess the importance of genetic variation in animal populations, a fundamental issue in conservation biology.

— Tim Stephens

NRS Senior Science Writer

Funding renewed for phainopepla breeding studies

For the second year in a row, UC Berkeley graduate student Miyoko Chu won a Mathias Student Research Grant to support her studies of breeding in phainopeplas at two NRS desert sites, the Boyd Deep Canyon and Sweeney Granite Mountains desert research centers in Riverside and San Bernardino counties, respectively.

Chu's observations from the 1995 field season yielded new information about the breeding status of first-year males in subadult plumage. Male phainopeplas (*Phainopepla nitens*) in the mottled plumage characteristic of juveniles were observed defending territories against males in full adult plumage, courting females, building nests, and successfully raising young.

According to Chu, no published account has previously documented successful breeding by male phainopeplas in subadult plumage. Her observations indicate that subadult plumage is not associated with a decreased ability to breed, nor does it seem to play a social role, such as allowing young males to forage or trespass unchallenged on territories of adult birds.

Funding from her first Mathias grant, in the 1994-95 awards cycle, enabled Chu to purchase needed equipment and to spend four months conducting field studies on the reserves. In addition to her work on subadult plumage, Chu gathered general breeding data on the phainopepla population at Deep Canyon. For example, she recorded an estimated nest failure rate of 74.4 percent, with 94.9 percent of failures

resulting from predation of the eggs or young.

Studies planned by Chu investigate differences between the populations at Deep Canyon and Granite Mountain. These studies may shed additional light on the issue of subadult plumage, which may be a by-product of nutritional status or timing of molt rather than an indication of breeding condition. Chu's data showed differences in the proportion of males with subadult plumage between the populations at Deep Canyon and Granite Mountain. Differences in insect abundance or the timing of breeding activity between the two sites may account for the observed differences in the plumage of first-year males.



Photos by Barbara A. Carlson

— Tim Stephens
NRS Senior Science Writer

Two phainopeplas observed at the Granite Mountains Desert Research Center: (top) a watchful male and (bottom) a well-concealed female sitting on her nest in *Acacia greggi*.

The NRS welcomes two new reserves

The NRS grew by two in June, with the official designation of the new Sedgwick Reserve in Santa Barbara County and Fort Ord Natural Reserve in Monterey County.

The Sedgwick Reserve, which will be managed by the Santa Barbara campus, offers exceptional opportunities for teaching and research in the areas of biodiversity and landscape ecology. At 5,100 acres and spanning an elevational range of some 1,300 feet, the site is notable for both its large size and environmental heterogeneity. The predominant plant communities include coast live oak forest, blue oak woodland, valley oak savannah, *Ceanothus* chaparral, coastal sage scrub, grassland, and willow riparian forest. A variety of localized wetland habitats also occur, including vernal pools, and there are extensive areas of serpentine soils and associated flora.

The Sedgwick Reserve is especially suitable for replicated experimental studies due to the repeated occurrence of small drainages, complete drainage systems, and distinct geological and soil regimes. A major long-term project on oak regeneration and grassland restoration is already under way (see story, page 10).

The Fort Ord Natural Reserve, located on a former military reservation, will be managed by the Santa Cruz campus. The site contains relatively intact remnants of the endemic Monterey Bay maritime chaparral, significant stands of coast live oak woodland, and large areas of native perennial grassland. Many rare and endangered species occur on the reserve, including 11 listed plant species and seven listed animal species. Among these are the endangered sand Gilia (*Gilia tenuiflora arenaria*) and Smith's blue butterfly.

Although they joined the NRS at the same time, the histories of these two properties couldn't be more different. The Sedgwick saga began in 1967, when Alice and Francis Sedgwick began transferring portions of Sedgwick Ranch to the University, with the intent of eventually leaving the entire ranch to UC for a natural reserve and for support of the arts at the Santa Barbara campus. When Francis Sedgwick died, he left his remaining interest in the ranch to the University, but Alice Sedgwick, in her last will, left the remaining 24.5 percent of the land to her heirs in 1988.

Eventually, a court settlement was reached in which the ranch was divided into a Regents' parcel of about 5,100 acres (the current reserve) and an heirs' parcel of about 750 acres, including most of the ranch buildings. The Santa Barbara Land Trust is currently trying to raise the neces-

NRS desert center celebrates system-founding sand-master

On April 20-21, 1996, the Jack and Marilyn Sweeney Granite Mountains Desert Research Center hosted the dedication of two separate facilities: the Kenneth S. Norris Camp and Teaching Area, and the Sybil and Al A. Allanson Library and Center.

Norris Camp was named in honor of Ken Norris, the retired UC Santa Cruz ecologist, physiologist, marine biologist, and beloved mentor who helped to establish the NRS.



Photo by Mark Goudy

In the photo above, Norris (who appears second from the left) is joined in a ceremonial moment by: (from left to right) UC Riverside Vice-Chancellor for University Advancement James H. Erickson, NRS Acting Director Elizabeth Riddle, UC Riverside Chancellor Raymond L. Orbach, and Sweeney Desert Center Co-Directors Claudia Luke and Jim André. In the photo below on the left, Norris stands looking out across Kelso Dunes, located near the Sweeney Desert Center, where he has spent years teasing the sands to make them give forth with their mysterious and surprisingly loud "songs." In the photo below on the right, Norris's research colleague Evan C. Evans appears at Kelso Dunes with some of the high-tech gear he employed in his demonstration of techniques for advanced sand study. Nearly one hundred friends of Norris and the NRS gathered for this weekend event.



Photos by Elizabeth Riddle

sary funds to purchase the heirs' parcel so that it can be added to the reserve.

In contrast, Fort Ord Natural Reserve has a relatively straightforward history. In 1994, the University accepted approximately 1,100 acres of land at the Fort Ord Military Reservation that had been declared surplus by the U.S. Army. The reserve was established in part to protect the rare and endangered species found on-site.

The Santa Cruz campus is establishing the Monterey Bay Education, Science, and Technology (MBEST) Center on one portion of the Fort Ord land acquired by the

University. The Fort Ord Natural Reserve encompasses about 600 acres of pristine maritime chaparral and other habitats, as well as small disturbed areas that can be used for experimental projects in restoration ecology.

The Sedgwick and Fort Ord sites both contain rich habitat diversity not represented at other NRS reserves and offer valuable new opportunities for teaching, research, and public service.

—Tim Stephens
Senior Science Writer

It's time to plan your NRS student grant proposal

The NRS systemwide office will issue calls for proposals this fall for three student grant programs: the Elizabeth Hall Blakey Travel Grants, the Mildred E. Mathias Graduate Research Grants, and the Robert M. Norris Undergraduate Research Grants. Information about the conditions of each grant and important dates in the application process are summarized below.

Blakey Travel Grants

Blakey grants support undergraduate use of NRS reserves by covering reserve-related travel expenses of undergraduate classes and independent (and small group) studies. The maximum grant for undergraduate course travel expenses is \$1,000; for an undergraduate student's independent study travel expenses it is \$250. *A fiscal match must be provided by the department, college, or other sources* (grantees are encouraged to seek a 1:1 match). Call for proposals will be issued October 1, 1996. **Applications are due to the NRS Director by December 9.** Awards will be announced by January 10, 1997.

Mathias Graduate Research Grants

Mathias grants support graduate student research at reserves. The maximum award is \$2,000. *Research must be done on UC NRS reserves.* Call for proposals will be issued September 16. **Applications are due to the campus contact for grants by November 1, and to the NRS Director by November 15.** Awards will be announced by December 20.

Norris Undergraduate Research Grants

Norris grants support undergraduate student research at reserves. The maxi-

mum award is \$1,000, issued directly to students. *Research must be done on UC NRS reserves.* Call for proposals will be issued November 19. **Student applications are due to the campus contact for grants by January 10, and to the NRS Director by January 28.** Awards will be announced by February 10.

1996-97 Campus Contacts for Grants

UC Berkeley:

Harry W. Greene, Integrative Biology, Museum of Vertebrate Zoology; (510) 642-3567; e-mail: crotalus@uclink.berkeley.edu.

UC Davis:

A. Sidney England, Planning and Budget; (916) 752-2432; e-mail: asengland@ucdavis.edu.

UC Irvine:

Peter Bowler, NRS Academic Coordinator, Ecology and Evolutionary Biology; (714) 824-5183; e-mail: pabowler@uci.edu.

UC Los Angeles:

Philip W. Rundel, Medicine/Biology; (310) 825-8729; e-mail: rundel@lbes.medsch.ucla.edu.

UC Riverside:

John T. Rotenberry, Biology; (909) 787-3953; e-mail: rrote@citrus.ucr.edu.

UC San Diego:

Ted J. Case, Biology; (619) 534-2312; email: tcase@ucsd.edu.

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NRS opens Internet chat site

Almost 2,000 people have accessed the NRS homepage on the World Wide Web since we started keeping track in March. In addition to a wide range of information about the NRS, the Web page now features a chat site where users can have conversations in cyberspace about NRS affairs.

You can access the NRS Web page at <http://nrs.ucop.edu>. You'll find a map of reserve locations linked to descriptions of individual reserves, the latest issue of the *Transect* newsletter, and information about the NRS grants program, NRS publications, and how to contact members of the NRS family. A "Highlights" section provides updates on news and events throughout the NRS.

Webmistress Jennifer Chen, who designs and maintains the NRS home page, encourages reserve managers and users to take advantage of the site and help shape it to best serve their purposes. If you have an item you'd like to see posted in the highlights section, or if you have any changes or additions to suggest, you can contact Jennifer at: jennifer.chen@ucop.edu; phone: (510) 987-0150.

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