HEALING

In the reserve at low tide, Theresa (left) and Drew Talley wade into a channel to collect marine animals living within the sediments.

the Marsh

Basic Research Supports Wetlands Restoration

BY PAIGE JENNINGS

Travel brochures tempt visitors to San Diego with glossy color photos of Mission Bay, a vacation paradise complete with sailing, fishing, water skiing, and resorts. It is also an important research site for Scripps scientists and students.

Within a 30-acre patch of protected land fringing the bay's northern shore lies the Kendall-Frost Mission Bay Marsh Reserve. This refuge, established in 1965 as a wildlife preserve and research area, is a small remnant of a once healthy natural wetlands network.

It is here that Scripps researchers, including Lisa Levin and Paul Dayton, and their students have undertaken a variety of projects aimed at understanding, protecting, and eventually rebuilding southern California wetlands.

Located on city-owned land and managed by the University of California Natural Reserve System, Kendall-Frost serves as an invaluable research and teaching site for scientists at Scripps, UC San Diego, San Diego State University, and others studying such topics as wetland biology, marsh plant productivity, and urban wetland management.

Under a project funded by the California Sea Grant College Program, Levin—an ecologist studying benthic organisms—and

Lisa Levin (right) introduces Scripps graduate students to coastal ecology at the Kendall-Frost Mission Bay Marsh Reserve, which consists of land donated to the University of California by Lena Kendall and the A. H. Frost estate.

her research team are conducting basic research related to the biological structure of southern California marshes. Her first task is to describe comprehensively the existing infaunal community.

"There is not a single published paper describing the animals [infauna] that live in the vegetated sediments of California salt marshes," explains Levin. "We need this information if we want to create new systems and evaluate the success of restoration projects."

In the 1940s, the city's vision for a coastal recreation park became reality at Mission Bay with the onset of extensive construction and land development. This benefitted the local economy but decimated much of the natural wetlands, including an extensive network of eelgrass beds, mudflats, and salt marshes. In their natural states, these habitats are abundant in plant and animal life, serving as vital nesting areas for shorebirds and refuges for mammals, invertebrates, and plants.

To make way for parking lots and residential housing, freshwater tributaries were diverted into controlled flood channels, thus removing the vital sources of water and sediments that create and sustain wetland habitats.

Historically, wetlands along the Pacific and Atlantic coasts have declined in scope and health because of human encroachment; 75 percent of southern California natural wetlands have disappeared.

Restoration efforts are being made by governments, industry, and environmental organizations. For these efforts to succeed, fundamental research such as Levin's is necessary.

Levin is also analyzing older southern California restoration projects to determine whether infauna in manmade marshes recover to a natural state, and if so, how long that process takes. In December 1995 the city of San Diego established several acres of restored wetlands adjacent to Kendall-Frost. This new research area, devoid of life before being opened to tidal flow, provides a unique laboratory in which to study the birth of a marsh.

Theresa Talley, a staff research assistant with Levin and Dayton, explains the importance of their research in the restored marsh. "We are trying to tease out the patterns of the fauna that live in the various salt marshes of southern California. The restoration implications of this are that for a certain sediment type, hydrology, and vegetation, we will have a better idea of what animals we should expect in a fully recovered system versus a more disturbed or degraded one.

"It also yields clues as to what sorts of manipulations or amendments might encourage natural fauna to come in and thrive. This kind of information is critical for California's wetland managers."

Talley and her husband, graduate student Drew Talley, traveled with Levin to nine southern California salt marshes to collect specimens and sediment, and now are engrossed with the project's laboratory component. For this they are studying the role of oligochaetes—microscopic, marine earthworms—in salt marsh communities.

"For most southern California marshes, oligochaetes comprise more than three-fourths of the animals present," explains Levin, "but

nobody really knows what they do." She thinks their minute size and the fact that they live within the sediment might have contributed to their past neglect.

"In North Carolina restored marshes, which I've studied more extensively, oligochaetes are slow to recover. After three or four years, they often remain rare and other things have taken their place. Without knowing whether or not they were in the man-made marshes here, I decided we really needed to find out what their role is in the marsh."

This process requires the exacting task of collecting sediments; bringing them to the laboratory; extracting the microscopic, nearly transparent organisms; identifying and separating them; and placing them in prepared microcosms. These enclosures simulate aspects of the marsh environment, such as tidal inundation or nutrient composition.

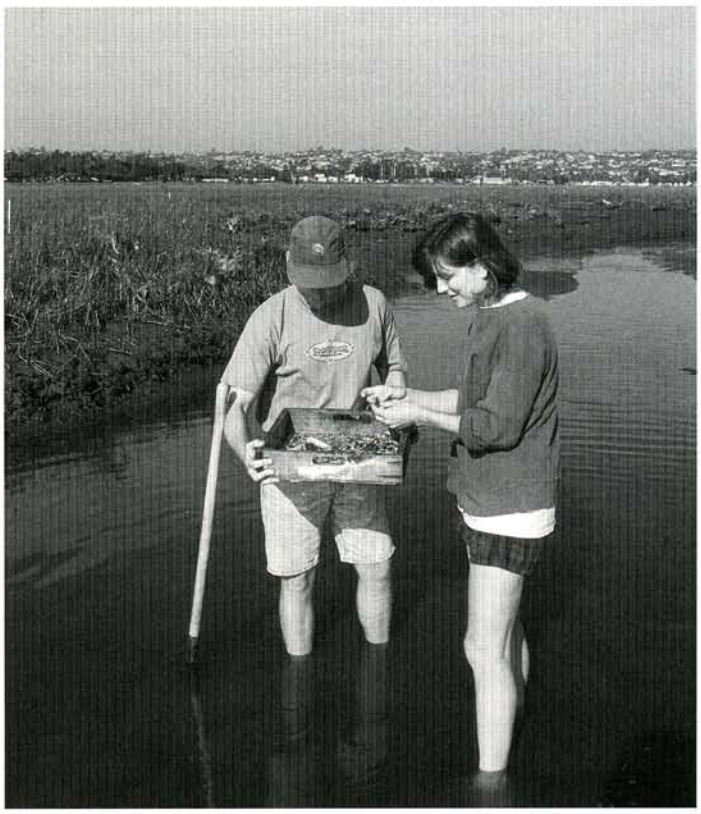
Drew is attempting to culture oligochaetes to provide a working population in the laboratory. "Culturing specific families can be a challenge because they are similar in appearance," says Drew, "but we need pure cultures so we can test for functional differences among families."

Although no solid data have been compiled yet, Levin and the Talleys are working on some strong assumptions.

Levin explains, "We think they [oligochaetes] break down marsh plants, help degrade and contribute to the organic material in the sediment, and help recycle minerals. We also think they change sediment properties as they burrow and aerate the sediments, potentially helping the marsh plants."

Drew adds, "Oligochaetes also play important roles in the food web, and probably have other functions that are not known because they have been so understudied."

Graduate student Arja McCray (left) and her advisor Paul Dayton measure cordgrass in the marsh reserve.



The simplest tools, such as a shovel and a sieve, are often the most effective in field research.

Regular visits to the newly restored marsh are providing insight into which animals are getting into the habitat, how they get there, and how they disperse and thrive. Most marine organisms in marshes enter as planktonic larvae. This might be the reason oligochaetes are slow to recover in some restored marshes. With the exception of one species, oligochaetes are born, live, reproduce, and die within the sediment.

"There is one species [*Paranais littoralis*] that swims as an adult," explains Levin. "This species reproduces asexually. They explode in numbers, and when the densities get high, individuals go up into the water and move around. This species is common in restored areas. The catch is that it is not always common in natural marshes. The most common species don't have this swimming stage. In North

CONTINUED ON PAGE 15

University of California Preserves Threatened Habitats

The University of California Natural Reserve System was established by the regents in 1965 to protect the state's diverse natural habitats and make them accessible for educational and scientific study. Population growth and land development in all regions of California threatened to damage or completely destroy many habitats. Today, researchers and students from the nine University of California campuses, and other institutions, have access to 33 reserves.

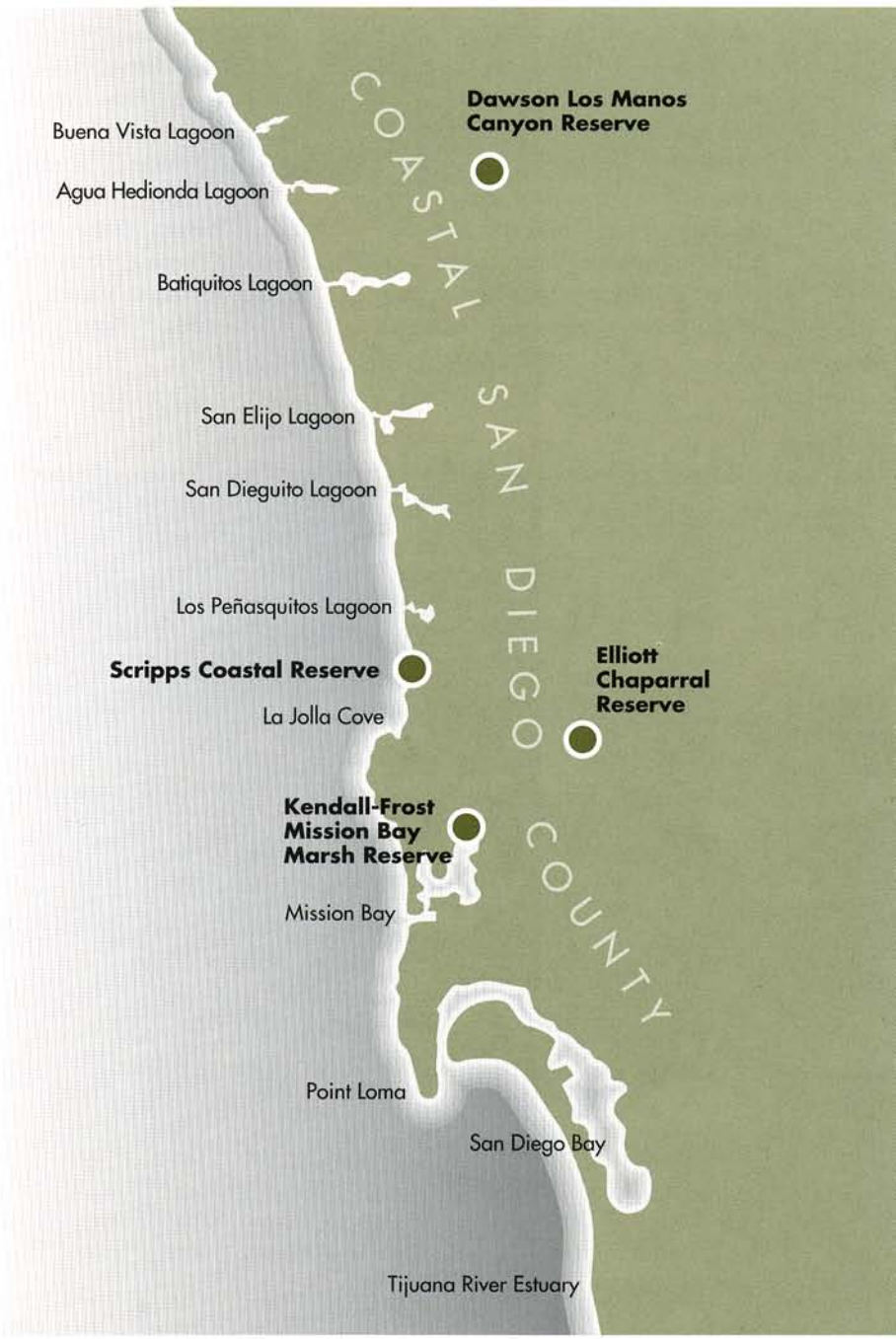
UC San Diego manages four reserves within San Diego County under the supervision of academic coordinator Isabelle Kay and a faculty advisory committee from UC San Diego and Scripps.

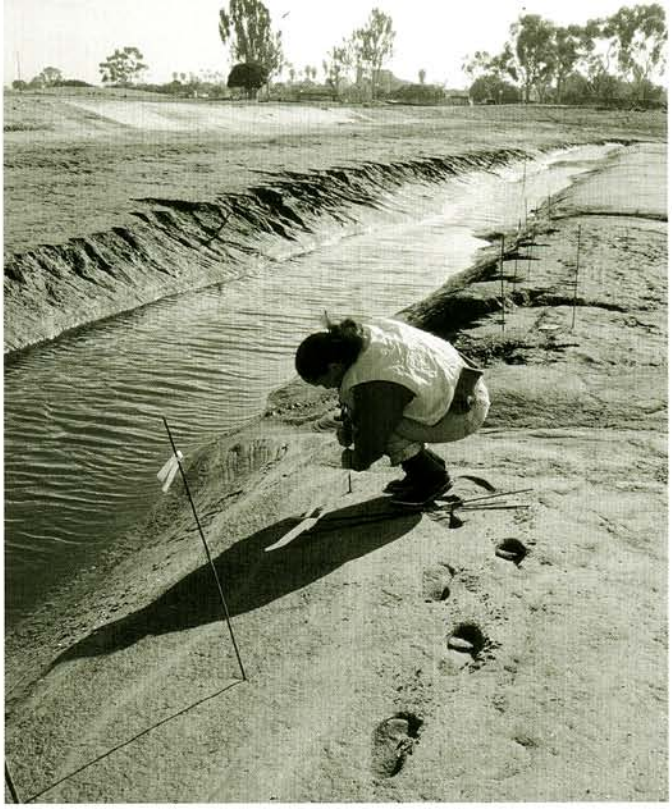
The Dawson Los Manos Canyon Reserve—163 acres consisting of a young, stream-cut valley through a coastal terrace/foothill valley—contains springs and a perennial stream, southern coastal oak woodland, coastal sage scrub, and chaparral.

The Elliott Chaparral Reserve—107 acres located on a flat narrow ridge southeast of UC San Diego—is bounded to the north and south by broad valleys and arroyos, and supports chamise chaparral intermixed with coastal sage scrub.

The Kendall-Frost Mission Bay Marsh Reserve—16 acres of protected salt marshlands—encompasses open water, subtidal mudflats, and low silty salt marsh cut by well-developed tidal channels. This reserve, and several adjacent acres of city-managed marshland, supports a variety of coastal plants and animals, including 107 species of birds.

The Scripps Coastal Reserve—943 acres bordering Scripps Institution of Oceanography—includes a coastal mesa and canyon, sea cliffs, exposed sandy beach, open water, intertidal zone, nearshore continental shelf, and tributary slopes of two submarine canyons. It is home to myriad species of terrestrial flora and fauna, intertidal and benthic invertebrates, and 90 fish species.





Arja McCray establishes experimental plots in the restored marsh area to test the effect of different soil amendments on future cordgrass growth.

Carolina they are slow to recover. We don't know if it's because they do not readily colonize the restored area due to their lack of a swimming stage, or if the conditions in the restored marsh aren't right to support them.

"Usually a man-made marsh has very low soil organic matter, whereas a natural marsh that has been growing for hundreds to thousands of years is full of root mat, peat, and other dead plant material."

In later stages of the experiment, Levin hopes to conduct seeding experiments in the new marsh to see if they can encourage oligochaete representation.

The findings of this project should help regulatory agencies, such as the U. S. Army Corps of Engineers, establish restoration permit requirements and determine if federal and state requirements have been met. Data should also help organizations in the design and implementation of future wetland restoration projects.

In addition to conducting infauna research, Theresa is helping Dayton and his graduate student Arja McCray monitor the health of cordgrass, *Spartina alterniflora*, in the marsh. Cordgrass is a rugged flowering plant common in most salt marshes. Over the last several years, Dayton has noticed a decline in the health and quantity of cordgrass in Kendall-Frost. In 1988 he placed permanent markers within the reserve to measure the plants' die-off rate. He suspects that lack of freshwater and nutrients supplied in the past by upland tributaries, encroachment of other plants, and erosion on the bay-side of the marsh are contributing to cordgrass decline.

He has installed a freshwater sprinkler system and—with Theresa, McCray, and several undergraduate assistants—is experimenting with a variety of fertilization techniques to encourage plant growth. Dayton has been dissatisfied with past experiment results and in the summer plans to install a new sprinkler system to completely flood the area. With the extent of surrounding development, there is likely not to be a natural freshwater source feeding the marsh in the near future.

Loss of this habitat would be disastrous for many reasons. It is the only habitat in the area for an endangered species of clapper rail—a small, brown marsh bird.

"If we lose cordgrass, the marsh will erode from the sides, meaning we could lose the clapper rail. We don't know what else will happen. Functionally, the cordgrass could be gone in three or four more years, and I'm not sure we can turn it around. It needs a river system feeding into it, and that's not possible."

For more than 20 years, Dayton has helped oversee research projects conducted in Kendall-Frost and is dedicated to protecting it not only as a research site, but also as natural habitat.

Kendall-Frost and the other 32 sites in the University of California Natural Reserve System represent the state's rich ecological diversity, providing an unsurpassed network of education and research sites.

EXPLORATIONS
SUMMER 1996

HOBBYIST

Flying High for Science

Mark Lipsky double-checks the camera mounting on his plane before sending it on a mission over the marsh reserve.

The pursuit of scientific data sometimes creates interesting collaborations. Such is the case between Scripps marine ecologist Paul Dayton and Mark Lipsky, a local entrepreneur and radio-controlled plane enthusiast.

In the fall of 1995 Dayton was in search of an aircraft from which to take aerial photographs of the Kendall-Frost Mission Bay Reserve at low altitudes and for the cost of a camera and film. Dayton placed a notice in the Palomar RC Flyers club newsletter and enlisted Lipsky and his radio-controlled airplane. The perfect aircraft for this operation, Dayton decided, was not much bigger than many of the birds commonly found in the reserve.

Lipsky equipped his plane, one of four he flies each weekend, with a homemade camera mount and rigged an auxiliary channel on his hand-held transmitter to activate the camera shutter. Dayton provided the camera, film, and research site, and Lipsky used expert skill—acquired during 20 years of flying radio-controlled planes—to maneuver the 4.5-pound aircraft over specific areas of the reserve. Not a simple task considering the plane's engine had to be stalled so that pictures could be taken without the camera mount shaking and vibrating.

Paul Dayton, an expert on coastal ecology, stands by while Mark Lipsky, the expert on radio-controlled planes, prepares his aircraft for flight.

"I would get the plane as high as possible, but where I could still see it well enough to control it," explains Lipsky, "then I would stall the engine and glide the plane down over the reserve and Paul would tell me when to snap each photo. The big challenge was trying to land the plane exactly where I wanted without the use of the engine." During the first flight, he accidentally landed the plane in an inch of water. The camera required some repair, but the pictures turned out perfectly.

When asked why he volunteers his time on this project, Lipsky explained, "I answered Paul's ad because this seemed like a good chance to use my radio-control skills, while at the same time helping out science and having fun."

Lipsky—who owns the San Diego company Effective Engineering—is having fun, but he is also providing access to invaluable information regarding the current and future health of an endangered habitat.