

CONSERVATION GENOMICS PROJECT

Spiders, slugs and seal pups: Wild things stalked for DNA



PHOTO BY ANTON SOROKIN

Emma Steigerwald, a Ph.D candidate at UC Berkeley, collects spiders from vegetation for the California Conservation Genomics Project. By gathering DNA samples from the creatures, scientists aim to genetically decode some of the state's diverse wildlife.

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In a dark, deep and wet redwood forest, Max Genetti scans a trail in search of slime.

His quarry: Banana slugs, small but significant contributors to the new California Conservation Genomics Project, an ambitious effort to find, catch and genetically decode about 250 of the state's most special species.

In the pre-dawn glow of a headlamp, "you can spot the mucus trail, because it shines," said Genetti, a bioinformatics specialist at UC Santa Cruz.

The slug's DNA, extracted from a tiny slice of its tail, will tell a story. How is this bright yellow Bay Area creature, one of the slowest animals on Earth, related to its distant cousins, who resemble bruised fruit in Eureka and green unripe fruit in the Sierra Nevada foothills?

Like California's people, the extended families of its plants and animals are wildly diverse, a mélange of different colors and customs. Some, such as slugs, are separated by distance and a changing climate. Others are fractured by urban development, or have grown estranged over the relentless march of time.

By building a dataset of nearly 20,000 different genomes — representing carefully selected species from the dry Mojave Desert to the snowcapped Sierra Nevada mountains — the \$12 million state-



A species of banana slug has dramatic black spots. The California Conservation Genomics Project will reveal slugs' genetic diversity, perhaps explaining how the spots evolved.

PHOTO COURTESY OF MAX GENETTI

funded project will create a unique map of the state, providing leaders with current scientific data and analyses to help them make decisions about land use and conservation.

At a time of rapidly accelerating species decline, the map will reveal hot spots of diversity, which could serve as reservoirs of genetic variation to help species adapt to environmental change, said director Brad Shaffer of the UC Los Angeles La Brea Center for California Conservation Science, who leads the effort's 79 scientists. It could identify special landscape corridors, where creatures need to connect.

"We protect pretty places," Shaffer

said. "We may not be protecting the most biologically important places."

It also will boost research. For instance, it could reveal which populations might be at risk due to inbreeding and low genetic diversity. It will help scientists understand how populations have changed over time.

To create this inventory, scientists from all 10 UC campuses, as well as Lawrence Berkeley and Los Alamos National Labs and UC Natural Reserves, are dispersing across the state in search of fins, feathers, fronds and other tissues.

Genetti aims to sample 150 banana slugs from 70 different places. Once dis-

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covered, a slug is stretched out on a board to be measured and photographed. Using a razor blade, Genetti clips off a rice-sized piece of tail. With tweezers, he drops the skin into an alcohol-filled vial, and carries the tissue back to UCSC for freezing and processing in the lab of Professor Russ Corbett-De-tig, a principal investigator with the project.

"The more diverse a population, the healthier the population," Genetti said. And because slugs are sensitive to moisture, "it also tells us about the health of the forest."

To capture his creatures — golden eagles — Robert Fisher of USGS must use bait.

Half carcasses of dead calves, pungent and dripping blood, are wheeled for miles along rugged trails to a remote location. When the



PHOTO COURTESY OF DAN COSTA, UCSC

Patrick Robinson, left, director of the Año Nuevo Reserve, and UC Santa Cruz student Wade Matern take a sample of tissue from the flipper of an elephant seal pup.

eagle lands to eat, a gentle "bow net" trap catches it. Fisher's team, emerging from a nearby blind, subdues the bird by covering its head and wrapping gauze around its dangerous talons. Then they draw a drop of blood from a vein in its wing, and release it.

Because genetic data can be linked to flight data, the project will help reveal the

social structures, genealogies and dispersal patterns of eagles, Fisher said.

It will also guide protection strategies, said Doug Bell, wildlife program manager of East Bay Regional Park District. Different eagle populations face different pressures, ranging from drought to development, he said.

"The project gives us a

more refined picture about what conservation actions might be needed," said Bell, who has contributed DNA from golden eagles captured at Sunol Wilderness, Crockett Hills and Mission Peak Regional Preserves.

The imperiled Crotch's bumblebee is the holy grail of entomologists. So as UC Riverside collectors Blanca Ortega and Kaleigh Fisher slowly drove through Sequoia National Park last June, they were intrigued by a cloud of black insects hovering around a blossoming tree.

The pair quickly pulled over, grabbed nets and jumped out. Clinging to the edge of the steep hillside, Fisher took a swipe — and caught one.

"We couldn't believe it. It was worth risking our lives," Ortega said. The rare bee, with a distinctive thick yellow abdomen, was placed in liquid nitrogen and driven more than 250 miles back to the lab.

Emma Steigerwald of UC Berkeley's Evolab found Tetragnatha spiders by walking the edges of Marin County's Lagunitas Creek at night, when spiders are active. Spiders are well camouflaged — but when she beat the vegetation with a stick, the arachnids fell onto a white sheet.

On beaches, Dan Costa and his team creep up on their target species: Northern elephant seals. There's a brief window of time — March through May — when pups are alone on the sand, so it's safe to approach. The team is sampling four animals from each of the state's 14 colonies, from the Channel Islands to Humboldt's Punta Gorda.

"We can sneak up to them with little pliers and get a snippet of tissue, from the flipper. It's like getting an ear pierced," said Costa, director of UCSC's Institute of Marine Science. "The animal will wake up, look at us and then go back to sleep. It's only dangerous if you

don't know what you're doing."

The data will help scientists better understand the recovery of this species, once nearly extinct due to hunting. Today's 200,000 elephant seals all descend from fewer than 25 individuals.

Back in labs, the DNA of each sample is sequenced and passed through a computational analysis pipeline that converts the raw data into a format that can be more readily analyzed.

Despite challenges, such as COVID-19 and the drought, the effort is quickly progressing. So far, about 15,000 samples have been collected. Of these, DNA has been extracted from more than 5,000. In a year or two, the project should be complete.

"I'm proud that California recognizes the need for this basic science," Costa said, "to give us the best information we can get, to make the decisions to protect what we have."