Using environmental DNA to detect fairy shrimp in vernal pools at MCAS Miramar

Though they may be dry most of the year, the temporary wetlands known as vernal pools come to life when the pools fill with water during the rainy season. Plants and animals associated with vernal pools in coastal California are adapted to grow and reproduce quickly when the pools hold water in the winter and spring and go dormant during the long dry months of summer and fall. Some of the most well-known vernal pool animals are the many species of fairy shrimp – small, often translucent crustaceans – that must mature and breed in the space of a few weeks when water has ponded. Toward the end of the pool's wet period, female fairy shrimp lay thick-walled eggs known as cysts. These cysts survive the dry season buried in the dried bottom mud of the pool, hatching when the rains again begin to pond.

Field surveys for fairy shrimp are conducted in the wet season by dipnetting pools to find maturing fairy shrimp, and in the dry season by collecting soil from the dry pond and searching through the soil samples for cysts. There are a number of difficulties with these methods. If rainy periods are short or variable, pools might not hold water long enough for fairy shrimp to mature to a size that can be visually detected by surveyors, leading to uncertainty about whether fairy shrimp have been present in the pool. In the dry season, cysts of some different fairy shrimp species can't be distinguished from each other without hatching the cysts and growing the individuals to mature adults that can be identified.

Department of Defense installations contain some of the most extensive and best examples of vernal pools remaining in California, particularly in the southern part of the state where the majority of these pools occur on land actively used for military training. As a result, DoD assumes a large burden for managing fairy shrimp and other vernal pool species. Current U.S. Fish and Wildlife Service (USFWS) survey protocols for federally listed fairy shrimp require intensive efforts that can span up to five years. Because of the time frames involved, surveys can be very costly, and may delay implementation of new training activities and military construction projects by years. The difficulties of distinguishing between species can result in misidentifications, potentially leading to unnecessary restrictions on military training if a non-listed species is mistaken for a listed species.

Enter environmental DNA. The sensitivity and accuracy of eDNA methods offer an attractive alternative to field surveys by improving efficiency, reducing the likelihood of missing fairy shrimp when they're present, and eliminating species misidentification. With eDNA, the survey timeline for establishing presence or absence could be shortened from years to a few visits during a single season.

Like other DoD sites in southern California, managers at Marine Corps Air Station (MCAS) Miramar need to know whether threatened or endangered fairy shrimp species occur in vernal pools on the installation. Two fairy shrimp species at Miramar -- Riverside (*Streptocephalos woottoni*) and San Diego

fairy shrimp (*Branchinecta sandiegonensis*) -- are listed as federally endangered and can be difficult to distinguish from the non-listed versatile fairy shrimp (*Branchinecta lindahli*) based on physical characters.

A new project will use eDNA sampling concurrently with current field survey protocols and compare detection probabilities and costs through the season for each approach. The effort, funded by the Legacy Resource Management Program, is a collaboration of researchers and managers at Washington State University, SPAWAR's Environmental Sciences and Applied Systems Branch, and MCAS Miramar. If this project demonstrates that eDNA is an effective tool for detecting fairy shrimp during wet and dry seasons, eDNA sampling can be incorporated into fairy shrimp survey protocols to increase the cost effectiveness and reliability of fairy shrimp detection and monitoring.

For further information about eDNA sampling at MCAS Miramar, please contact Katherine Strickler at k.strickler@wsu.edu.