Rangeland Oasis

SHEILA BARRY

Vernal pools provide habitat for an unusual diversity of plants and animals.

They have been called "pot holes in the rangeland." During the summer they are dry depressions in the ground. In the winter months they fill with rain water. Vernal pools hold water long enough to allow some specialized aquatic organisms to grow and reproduce, but not long enough for a pond or marsh ecosystem to develop. The plants and animals that inhabit a vernal pool are well adapted to withstand extreme conditions - drought and sun-baking summer heat, floods and freezing winter weather.

Vernal pools are found in California and just a few other places in the world. Seasonal wet depressions or temporary pools are not particularly unique to California. A temporary pool can form anywhere there is a depression with a water-restricting surface or "hardpan" and variable rainfall. In fact, every state in the U.S. probably has temporary pools. California's temporary pools are "vernal" pools because of its mediterranean climate. Similar temporary pools occur in regions of the world that have similar climates such as Australia and South Africa. Vernal means "of or in spring". These "rangeland potholes" are so named because as their winter water levels recede, many plants in the vernal pool habitat welcome the spring with beautiful blooms.

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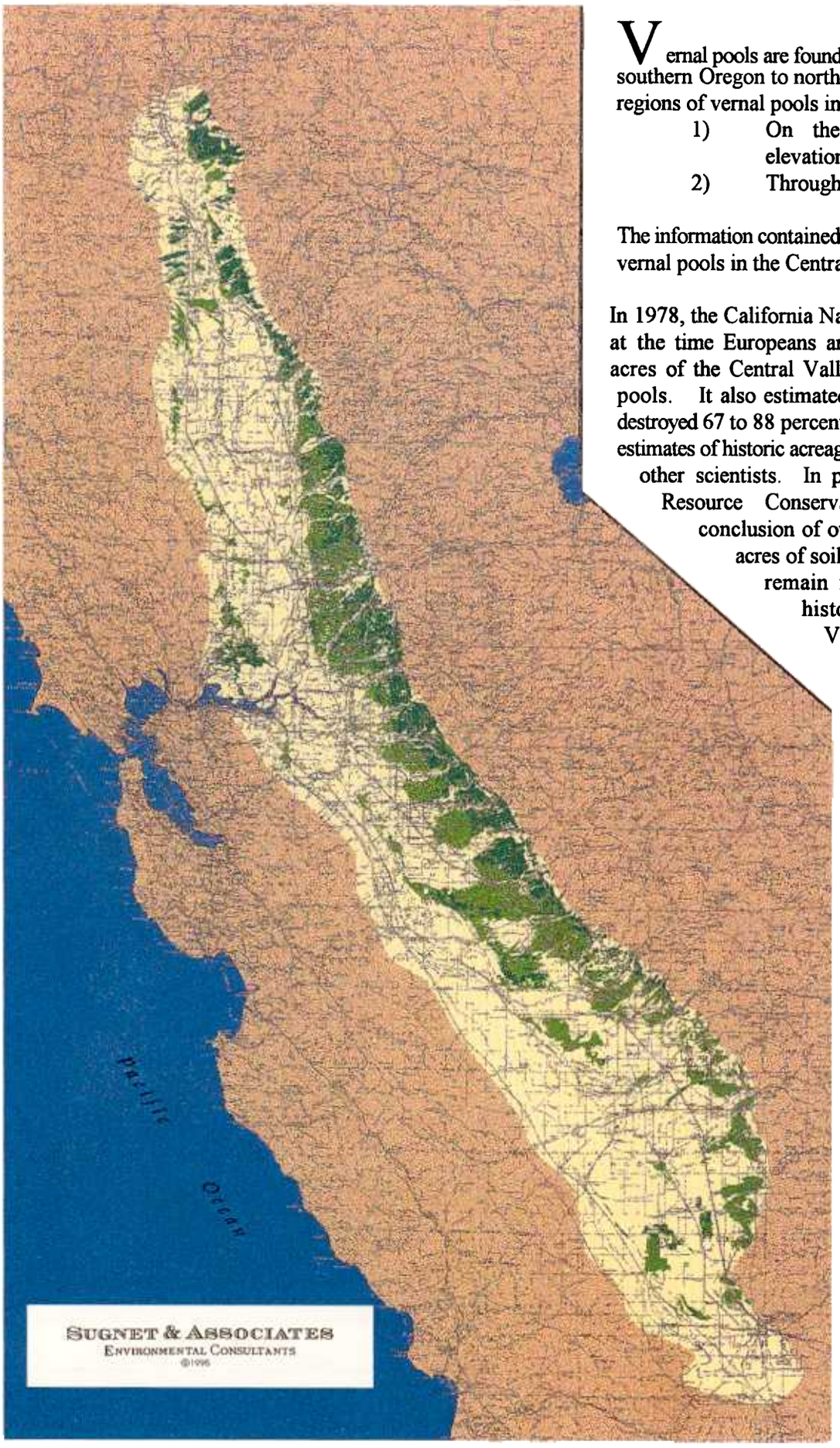
Vernal Pool Landscapes in the Central Valley



Vernal pools are found west of the Sierra Nevada, from southern Oregon to northern Mexico. There are two main regions of vernal pools in California:

1) On the coastal terraces and lower elevations of the coastal mountains
2) Throughout the Central Valley

The information contained in this pamphlet emphasizes the vernal pools in the Central Valley of California.

In 1978, the California Native Plant Society estimated that at the time Europeans arrived in California, 4.2 million acres of the Central Valley could have supported vernal pools. It also estimated that by 1973 human activities destroyed 67 to 88 percent of this acreage. Recently, these estimates of historic acreage and loss have been disputed by other scientists. In particular, the U.S.D.A. Natural Resource Conservation Service supported the conclusion of other soil scientists that 1 million acres of soils suitable for vernal pool habitat remain from 2 million acres that were historically present in the Central Valley. This implies that historic losses are closer to 50 percent. The loss of vernal pool habitat due to development and intensive agriculture is one of the reasons that prompted the listing of some vernal pool plants and animals under the federal and state Endangered Species Acts.

EXTANT VERNAL POOL
HISTORIC VERNAL LANDSCAPE
CENTRAL VALLEY

Endangered Vernal Pool Species

Vernal Animals		
Species	**Federal Status**	**County Locations**
Vernal Pool Fairy Shrimp	Threatened	Wide range of Counties througout Central Valley
[illegible]	[illegible]	[illegible]
Conservancy Fairy Shrimp	Endangered	Butte, Solano, Ventura, Tehama, Merced
Longhorn Fairy Shrimp	Endangered	Contra Costa, San Luis Obispo
Vernal Pool Tadpole Shrimp	Endangered	Wide range of Counties throughout Central Valley

Vernal Plants		
Species	**Federal Status**	**County Locations**
Butte County Meadowfoam	Endangered	Tehama, Glenn, Butte
Green's Tuctoria	Proposed Endangered	Tehama, Shasta, Butte, Madera, Merced, Tulare, San Joaquin, Stanislaus
Sacramento Orcutt Grass	Proposed Endangered	Sacramento
Hairy Orcutt Grass	Proposed Endangered	Tehama, Glenn, Butte, Merced, Madera, Stanislaus
Hoover's Spurge	Proposed Threatened	Tehama, Glenn, Butte
Slender Orcutt Grass	Proposed Threatened	Tehama, Shasta, Plumas, Sacramento

California's Natural Landscapes - At Odds With a Growing Population

With over 2,000 people immigrating to California every day, it is not only vernal pool landscapes that are threatened. Woodlands along streams and rivers, old-growth conifer forests, oak woodlands, coastal wetlands, native grasslands and sage rangelands have all been impacted and/or lost. California's natural landscapes are shrinking while demand for their resources grows.

California's natural landscapes are not only known worldwide for their natural beauty but also for their diversity and wealth of resources. California is one of the most biologically diverse areas in the world. Many of its plants and animals are not found anywhere else. Over the past two decades extraordinary efforts have been made to save individual species like the California Condor, the Spotted Owl and the Vernal Pool Fairy Shrimp. As of April 1995, 291 species of plants and animals were listed by the State and/or Federal government as endangered or threatened species. Some scientists estimate that over 600 more species meet the same definitions.

These efforts to save individual species are not only highly intensive and expensive, but have not ended with stories of success. Many "preserves" are now considered too small to support large, wide-ranging species, or manage as a functioning habitat. These "preserves" are often severely impacted by surrounding land uses. Species live in ecosystems -- interrelated habitats that provide the food, shelter and living conditions they need to survive.

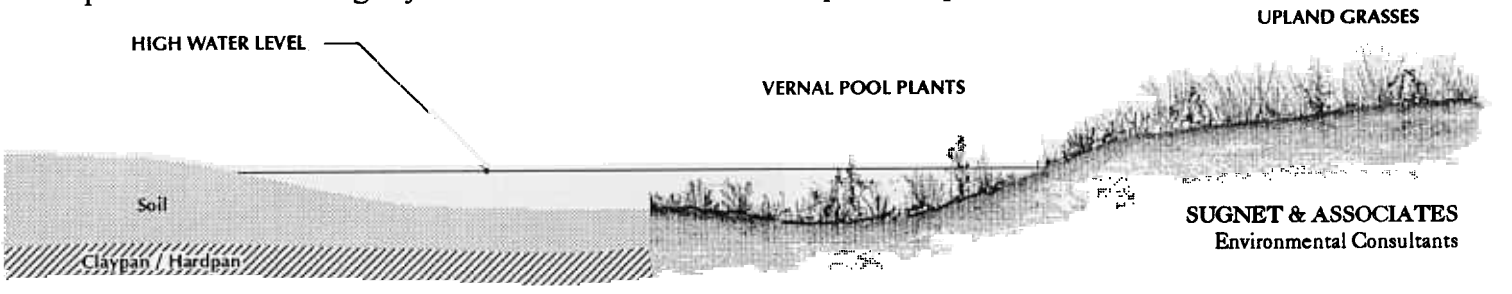
Contemporary planners face an enormous challenge and opportunity. On one hand, there is tremendous public support for preserving natural landscapes or open spaces. Many people value the scenic beauty, recreational opportunities, wildlife preservation and natural hazard reduction provided by natural landscapes. On the other hand, California's population continues to soar. This growing population needs space and resources. Today's conservation plans will require planners to conserve natural landscape resources that provide for the habitat needs of numerous plant and animal species while providing for the needs of a growing human population - a formidable task.

A Different Scene

Vernal Pools: Size and Scope

The poorly drained depressions that create a vernal pool are usually small and shallow; however, they can range widely in depth and size. Pool depth can range from several inches to a foot or more. Pool size can range from several feet to several acres. Table Mountain Lake in northern Tehama County covers nearly 180 acres and is the second largest vernal pool in northern California.

Vernal pools may occur as isolated, individual pools or as groups of depressions within a drainage system. Groups of vernal pools within a drainage system are referred to as a vernal pool complex.



Vernal Pools: Formation

Vernal pools fill with water because a hard subsurface layer or "hardpan" prevents downward drainage. The pools lose water predominantly through evaporation or overflow.

Vernal pools typically form on terraced soils that are formed from uplifted sedimentary material. They are also found on soils formed by ancient mud and lava flows. In the Sacramento Valley, it is believed that many pools were carved out by the wind about 4,000 years ago. More recently, some vernal pool habitat may have been unintentionally created as a result of human or animal activity - for example, ditches created by road construction or wallows created by livestock.

Constructing and Restoring Vernal Pools

by Dr. Kenneth Whitney, Sugnet & Assoc.

To accomplish the goal of "no-net loss" of wetlands under Section 404 of the Clean Water Act, construction of vernal pools to compensate for vernal pool fills has been a common practice in the Central Valley. Although still a somewhat controversial technique, advances in methodology have led to reliable construction of functional vernal pools, providing high-quality replacement habitat for vernal pool plants and animals.

Construction of vernal pools requires careful analysis of soils on the proposed construction site to ensure that a water-restricting soil layer is present in areas of vernal pool construction. Once a suitable site has been identified, shallow basins are excavated using standard earth-moving equipment. The upper three to four inches of topsoil is collected from the vernal pools to be impacted, and this material -- containing vernal pool plant seeds and the eggs and cysts of vernal pool invertebrates -- is spread within the newly constructed vernal pools.

Constructed Vernal Pool, Roseville Area, Placer County
Sugnet & Assoc.

Winter rains activate plant seeds and invertebrate eggs, and typical vernal pool plants and animals occupy the newly constructed vernal pools the first year following construction. Within two to three years following construction, the vernal pool plant community in constructed pools develops the characteristic structure of a "natural" vernal pool plant community.

Recently, emphasis has shifted from constructing vernal pools on undisturbed soils to reconstructing vernal pools on sites that formerly supported vernal pools but have been leveled for agriculture, or that have suffered some other kind of surface disturbance.

A Different Season

A vernal pool is by no means a single static ecosystem, but rather a **sequence** of ecosystems. The pool itself represents only one phase of the sequence. Important ecological events happen before and after the pool fills with water.

Vernal pool ecosystems can be divided into four seasonal phases.

During the **wetting phase,** the first fall rains provide for the germination of dormant seeds and growth of the perennial plants. A turf of seedlings may develop in the pool before it holds water for an extended time.

*The **aquatic phase** begins during the winter once the soil is saturated and the pool holds water. This normally requires several days of rainfall. Aquatic plants and animals come to life. Egrets, ducks, hawks and frogs may be attracted to the pool.*

*The **drying phase** begins as water from the pool evaporates and the water level recedes. Seeds, eggs and cysts settle into the mud. Wildflowers in and around the pool bloom. Bees emerge from their underground nests, mate and collect pollen from the vernal pool flowers.*

*During the **drought phase** the pool is dry. Seeds, eggs and cysts lie dormant. Some plants able to tap deeper moisture may continue to grow and flower. Drying cracks might appear. Orcutt grass and Tuctoria appear in the bottom of some dried pools.*

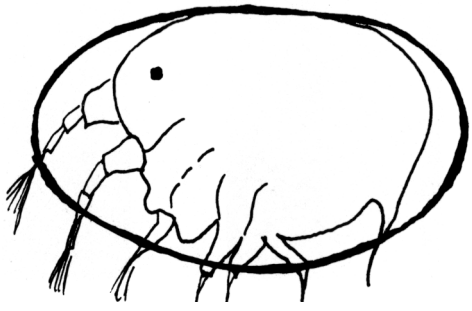
SHEILA BARRY

Vernal Pool: Fauna

A large number of invertebrates inhabit vernal pools and other shallow water-filled depressions in the Central Valley. The aquatic invertebrates grow and reproduce when the pools are flooded in the fall or winter. They spend the summer dormant as eggs or cysts (hard-shelled eggs) in the sun-baked soils of the pool bottoms.

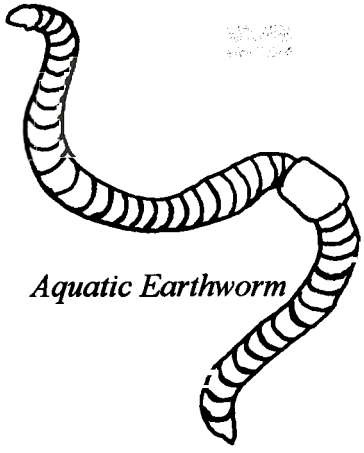
Although fairy shrimp and tadpole shrimp are the most commonly discussed vernal pool invertebrates, there are numerous invertebrates that may live in a vernal pool. Most are very small or even microscopic.

Clam Shrimp

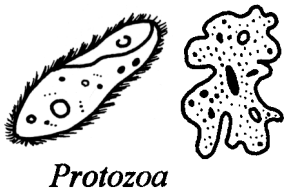


Seed Shrimp

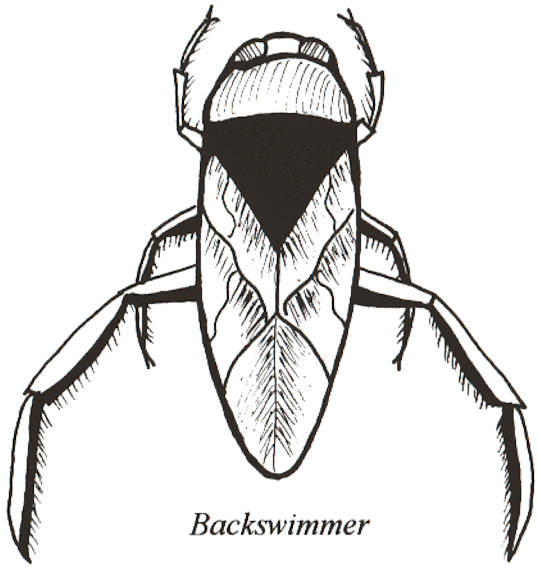
Flatworm



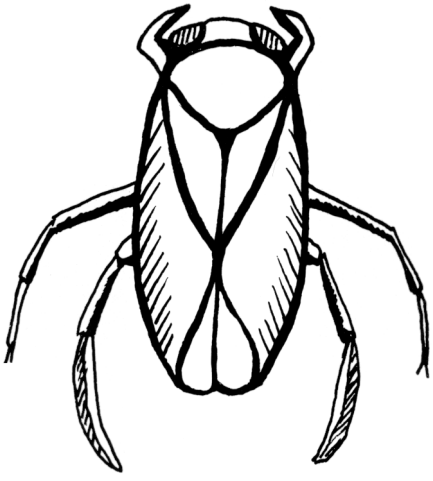
Aquatic Earthworm



Protozoa

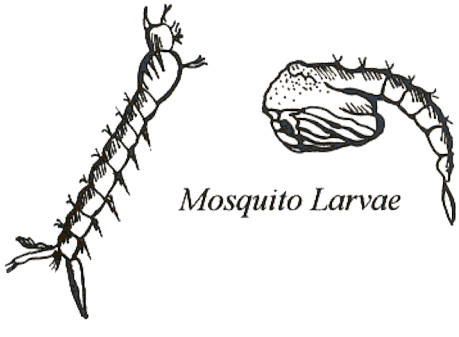


Backswimmer



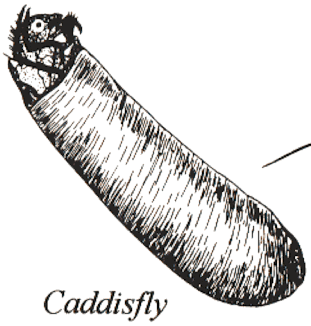
Water Boatman

Moss Animal



Mosquito Larvae

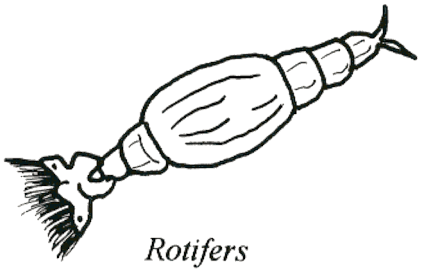
Illustrations by Sharleen Gaertner



Caddisfly
Larvae Case

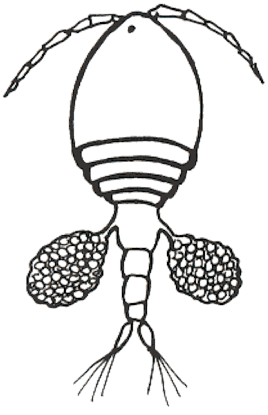
Caddisfly

Snail

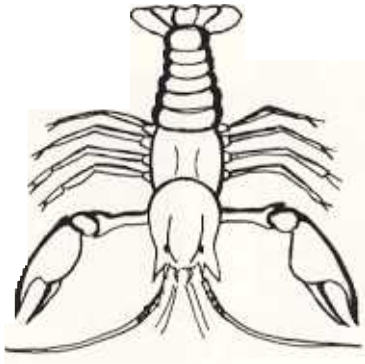


Rotifers

Aquatic Beetle



Copepods

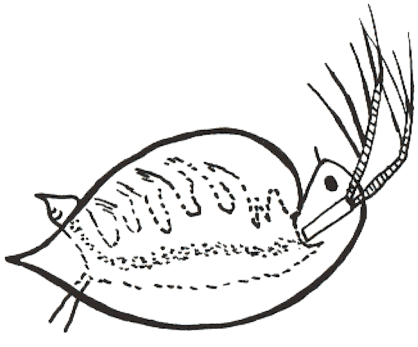


Crayfish

Watermite

Round Worm

May Fly

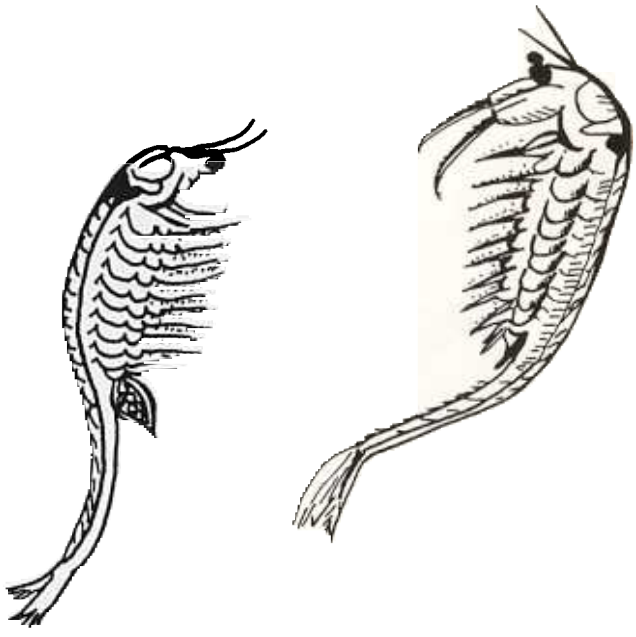


Water Flea

Mayfly Nymph

Vernal Pool: Fauna

Fairy Shrimp *(Order Anostraca)*



Species. There are at least 43 species of fairy shrimp in North America (258 species are known worldwide). In California, 23 species have been identified. Seven of these species have been discovered just since 1990.

Three species of California fairy shrimp have been listed under the Federal Endangered Species Act. They are commonly known as the Conservancy Fairy Shrimp, Longhorn Fairy Shrimp and the Vernal Pool Fairy Shrimp. All three species inhabit vernal pools in California.

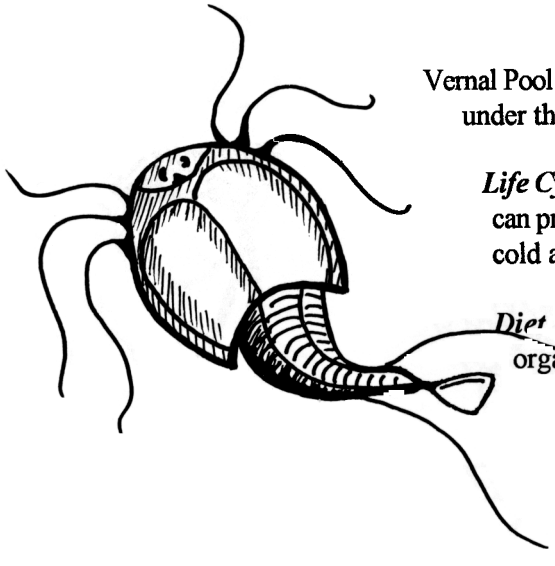
Life Cycle. The life cycles of fairy shrimp vary by species. Some can complete their life cycle within 2-3 weeks. Other species take several weeks to mature. Fairy shrimp populations often disappear early in the season, long before the vernal pool dries up.

Their cysts hatch in response to water temperature, dissolved oxygen and/or pH. Not all cysts will hatch in a given year. If the conditions aren't right for a specific species, the cysts may lay dormant for several years.

Cysts can survive passing through the digestive tract of many birds and animals. They are extremely tolerant of heat, cold and dehydration. Viable cysts have withstood temperatures of 178°F for one hour and -374°F for 24 hours.

Diet. Fairy shrimp are filter feeders. They feed on various phytoplankton, algae, bacteria, protozoa and rotifers found in the pools.

Tadpole Shrimp *(Order Notostraca)*



Vernal Pool Tadpole Shrimp exist in a habitat similar to fairy shrimp. They have been listed under the Federal Endangered Species Act.

Life Cycle. Tadpole shrimp have a longer life than many species of fairy shrimp. They can produce more than one generation per year. Their cysts are able to withstand heat, cold and dehydration. They lay dormant until pools fill with water.

Diet Tadpole shrimp are bottom feeders. They feed on organic debris and living organisms such as earthworms, frog eggs and fairy shrimp.

Illustrations by Sharleen Gaertner

Vernal Pool: Flora

Native plants have continued to thrive in and around vernal pools despite the invasion of non-native plants. In most pools, more than 70 percent of the plant species are native to California. Many of these native plants are responsible for the eye-catching rings of flowers that form around the pools as the water recedes. Since most of these native plants are commonly found in vernal pools, their presence is often used to indicate vernal pool habitat.

JEFF GLAZNER

Lasthenia fremontii
Goldfields

JEFF GLAZER

Downingia bicornuta
Downingia

DENNIS BRIGGS

Limnanthes
Meadowfoam with visiting Limnanthes specialist bee

JEFF GLAZNER

Navarretia leucocephala
Navarretia

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Sidalcea calycosa
Annual Sidalcea

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Psilocarphus
Wooley Marbles

MARK PARSON

Plagiobothrys
Popcorn Flower

JEFF GLAZNER

Layia fremontii
Tidy Tips

Vernal Pool Bees

Pollenation of many vernal pool plants involve specialist solitary bees. These bees collect pollen from a specific flowering vernal pool species. Goldfields, Meadowfoam, Downingia and Yellow Carpet each have specialist bees. These bees construct nests in the soil of upland areas near vernal pools. Their pollenation activities help the flowering vernal pool plants reproduce to their fullest potential.

Most of the vernal pool plants are annuals; however, one of the more common vernal pool plants, coyote thistle, is a native perennial.

SHEILA BARRY

Eryngium vaseyi
Mature Coyote Thistle

MARK PARSON

Eryngium vaseyi
Young Coyote Thistle

Threats to Vernal Pool Habitats

SHEILA BARRY

Vernal pool ungrazed for the past 10 years
Vina Plains, Tehama County, April 1993
Gray patch is formed by accumulating dead medusahead.

ADRIENNE MALEY

Vernal Pool Ungrazed for past 7 years
Chico, Butte County, April 1995
Vernal pool surrounded by Medusahead and other foreign annual grasses

Vernal pools are threatened by a variety of human activities that change the pools' water holding capabilities. These include urban development, water supply/flood control activities and conversion to intensive agriculture. Vernal pools may also be affected by modifications to the surrounding uplands. Many pools depend on water runoff from the surrounding uplands to maintain their wet period. The unique plants and animals that inhabit a vernal pool require an adequate wet period.

Beyond changes to a vernal pool's water holding capabilities, the invasion of non-native plants is a major threat to vernal pool habitats. In some large, deep pools, competition from non-native plants threatens native vernal pool plant populations. For example, two endangered plants, Hairy Orcutt Grass and Hoover's Spurge are threatened by competition from Cocklebur, Field Bindweed and Devil's Claw. In some smaller, swale-like pools, a non-native perennial Ryegrass has threatened the habitat of the endangered Greene's Tuctoria.

Vernal pool plants such as Meadowfoam and Tidy Tips are adapted to the edges of vernal pools and swales. They can be significantly impacted by non-native plants. For example, Medusahead and Mediterranean Barley are highly aggressive and competitive. They can crowd out native vernal pool flora. These weeds or plants evolved over thousands of years of heavy grazing and periodic drought. Fortunately, they can be controlled with managed livestock grazing.

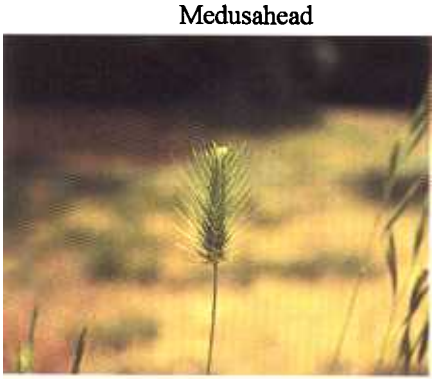
Competitive Foreign Plants

JEFF GLAZNER

Lolium perenne
Perennial Ryegrass

RON KNIGHT

Taeniatherum caput-medusae
Medusahead



JEFF GLAZNER

Hordeum marinum
Mediterranean Barley

Grazing to Prevent Invasion of Weedy Plants

The variety of plant species in a vernal pool landscape is determined largely by rainfall, temperature, soil characteristics and plant litter (dead plant material). A land manager may not be able to influence rainfall, temperature or soil characteristics, but he/she can control the quantity of plant litter. In the absence of grazing animals, plant litter can accumulate and the landscape surrounding the vernal pools is often dominated by tall stands of non-native grasses such as Medusahead, wild oats or ripgut brome. Non-native annual grasses are better at growing through thatch than most native species. A managed grazing system that leaves low to moderate levels of plant litter in the fall opens up the plant canopy and admits light. An open canopy favors a diversity of plants, including flowering vernal pool plants.

SHEILA BARRY

Vernal Pool Edge
Ungrazed for the past 10 years
Vina Plains, Tehama County, April 1993

Grass surrounding pool is predominantly Medusahead

SHEILA BARRY

Vernal Pool Edge
Grazed
Vina Plains, Tehama County, April 1993

Pool surrounded by Goldfield, Tidy Tips and Meadowfoam

Cattle grazing vernal pool landscape
Vina Plains, Tehama County, April 1995

Livestock Impact to Promote Vernal Pool Diversity

Newcomers to a vernal pool landscape in the late spring or summer see the bare ground in the bottom of a pool and the deep hoof prints left by a grazing animal. The bare ground is often found in deeper parts of a vernal pool where the wetting period is longer. The type and variety of plants in a vernal pool is largely determined by the length of the wet period. In shallow pools hoof prints might actually increase the diversity of the vernal pool habitat. For example, Dowingia Bella, a vernal pool flowering plant, is typically found in deeper vernal pools. It has also been found within hoof prints in smaller vernal pools. Similarly, a hoof print might provide a place of refuge for a fairy shrimp to complete its life cycle in a drought year.

SHEILA BARRY

Livestock Impact and Meadowfoam

SHEILA BARRY

Livestock Impact and Vernal Pool Flora

Vernal Pool Landscape
Vina Plains, Tehama County, April 1995

Additional Resources

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