Izzy Becchetti

California Pacific Section

Vernal Pools-An Often Overlooked Goldmine of California Diversity

Introduction

Driving up to Yosemite from California's Central Valley, enthusiastic to view the spectacular waterfalls in the spring during the thaw, you might notice the beauty of the rangelands in the foothills, the green of the newly germinated grass providing a stark contrast to the clusters of white and yellow flowers ringing small pools which reflect the image of the cattle grazing around them. While you might only reflect briefly on the landscape outside the National Park before focusing on the centerpiece of the trip, the majestic falls, towering evergreens and lush valleys of preserved Yosemite, these small, seemingly insignificant pools of water are just as important a habitat as the valley of Yosemite, the only difference being that Yosemite caught the eyes of nature writers such as John Muir, while the ecosystems outside the valley went unnoticed, and therefore unprotected for far longer. It is truly a marvel how such significant parts of the rangeland ecosystem could go overlooked for so long, until most of the historic coverage of these tiny ecosystems have been destroyed. It is of dire necessity to educate the public on these habitats, in order to accomplish the preservation of them before the remainder has vanished into the dust of the Anthropocene.

Definition

So what are these small, flower ringed pools, and how did they come to be? Called vernal pools, for their appearance in the spring, they are defined by the Environmental Protection

Agency (EPA) as seasonal depressional wetlands that occur under the Mediterranean climate conditions of the west coast (EPA 2024). To put this definition into more simple terms, vernal pools are simply when water collects in small holes in the ground. When precipitation occurs, water attempts to join the collection of aquifers, but runs into the aquitard, a layer of soil commonly known as the hardpan layer, which water can not penetrate (Utah Geological Survey). The water instead runs along the aquitard until it reaches a stream, or in the case of a vernal pool, a small depression in the rangeland, where it provides habitat for a variety of flora and fauna. When present in an ecosystem, vernal pools enhance not only the amount of species present, but the biodiversity of the ecosystem as well (Michaels et al 2021) However, the fragility of vernal pools depend on not only the essential aquitard, but also the Mediterranean climate conditions of the area. Often considered its own biome, the Mediterranean climate comprises dry areas that receive most of its rain in the winter, before temperatures rise enough to permit plant growth (Petruzzello 2022). This critical precipitation pattern is what drives the cyclical habitat, forming the four seasonal phases of the vernal pool:

- The wetting phase, in which the early precipitation of the Mediterranean climate provides for germination of seeds and growth of perennial plants. This stage occurs before the pool holds water for an extended period.
- The aquatic phase, in which the continued precipitation during the winter season fills the pool with water, providing habitat for aquatic flora and fauna. Facultative species may access the pool for water.
- The drying phase, in which the precipitation from the winter months evaporates, causing the water level to recede. Seeds, eggs, and cysts become lodged in the mud. Flora blooms around the pool, which attracts pollinators.

- The drought phase, in which the pool has dried up. Seeds, eggs, and cysts are dormant (Barry 1995).

The establishment of these tiny but vital ecosystems rely on both the Mediterranean climate and the aquitard to provide the optimal conditions for both federally endangered and threatened flora and fauna, many of which are endemic to California.

Dependents of Vernal Pools

Vernal pools on the west coast contain thirty three endemic species of flora and fauna recognized by the US Department of Fish and Wildlife, including 10 endangered flora, 3 endangered fauna, 5 threatened flora, and 2 threatened fauna, a list that includes Limnanthes floccosa ssp. californica (Butte County meadowfoam) and Branchinecta longiantenna (longhorn fairy shrimp) (USDFW 2022). Additional dependent species include several species of Orcuttia (Orcutt grass), Lepidurus packardi (vernal pool tadpole shrimp), Ambystoma californiense (California tiger salamander), Astragalus tener var. tener (alkali milkvetch), Spea hammondii (western spadefoot toad), Actinemys marmorata (western pond turtle), and several species of Anisoptera (dragonfly) (Barry,). Facultative species include Buteo lineatus (red shouldered hawk), Thamnophis hammondii (two-striped garter snake), and Ardea alba (great egret) (EPA 2024). This diverse cast relies on vernal pools for varying reasons. Branchinecta longiantenna, for example, live their whole lives in vernal pools, hatching soon after the pool fills and laying their cysts in the soil of the pool (Barry 1995). Ambystoma californiense, on the other hand, hatch and remain in the pool until they metamorphose from larvae into juveniles, who leave the vernal pool when it dries up in late spring, only returning to the pool to mate and lay eggs (USDFW 2021). More facultative species, such as Buteo lineatus, access vernal pools for drinking water. Not only do vernal pools play host to a variety of species, they also support an

array of diversity, which is essential for the proper functioning of larger ecosystems (EPA 2024).

Threats

Since the existence of a vernal pool relies on specific conditions, even the smallest disturbance can offset the balance and destroy the valuable ecosystem, which has happened to ninety percent of estimated historic vernal pools, and thirteen percent of remaining vernal pool landscape in twenty years (USDFW 2022). While thirteen percent might not seem like much, that thirteen percent constitutes 135,000 acres. Depletion varied across counties, with Mariposa county's vernal pool count staying static since 1976, but counties in the western portions of the Central Valley such as Glenn, Sutter, and Yolo have seen high losses, up to 75% (Holland 2009). Without the Mediterranean climate conditions threatened by fire suppression, overgrazing, exotic and invasive species, and anthropogenic climate change, the vernal pools wouldn't be able to go through its cycle of phases, limiting habitat and biodiversity (Petruzzello 2022). Even more vulnerable, however, is the aquitard, which can easily be destroyed by development, urban or agricultural. Establishment of orchards and vineyards, for example, has contributed thirty percent of vernal pool loss (40,000 acres), followed by urban development, with nineteen percent (26,000 acres) (Holland 2009). One explanation for this is that the perturbation of the soil in preparation for planting crops results in the destruction of the aquitard, which results in the depletion of the vernal pool's water source. In order to attempt to prevent this loss, the vernal pools themselves are not plowed, but this method is ineffective, resulting in a loss of diversity, as seen by myself when assisting in a study done in 2021. Consisting of using pitfall traps and sticky traps to collect insects from several locations in rangelands, followed by several locations

located in an orchard across the street, the study was an attempt to compare biodiversity in a rangeland ecosystem containing vernal pools to what had previously been rangeland before it was planted with almond trees. While this study has not yet been published, the observed differences in biodiversity between the two locations was vast, highlighting the loss of biodiversity that occurs when vernal pool environments are destroyed by development. In order to prevent the continual loss of these valuable habitats, development on rangelands containing vernal pools is critical to regulate and carefully manage.

A Mutualistic Relationship

While one might think that large grazing animals such as cows and other ungulates might damage the delicate balance of a vernal pool, the pool and the ungulate actually enter a mutually beneficial relationship. Without the grazing habits of cattle, exotic flora such as Taeniatherum caput-medusae (Medusahead) and Lolium perenne (Perennial ryegrass) would out compete native species such as Limnanthes floccosa ssp. californica. Native species consisting of 83% of the flora observed in vernal pools, it is essential that the sanctity of the pool not be invaded by exotic flora (Stallings et al 1996). But how can we be positive that cattle contribute to the continued diversity of vernal pools? In a study done by Julia Micheals (et. al), vernal pools under three different management plans were surveyed-one grazed continuously for over one hundred years, one excluded from grazing for over forty years, and one reintroduced to grazing over the past two years. By monitoring vegetation, water level, hoofprint cover, and residual dry matter, models were designed to compare the three types of pools. Both grazing plans had significantly higher diversity than the exclusion plan, while continuously grazed pools contained high diversity than only recently grazed pools. The cover of native flora was also found to be higher in vernal pools under the two grazing plans, with one exotic forb, Leontodon saxatalis (lesser

hawkbit), reduced by over fifty percent. Even cattle hoofprints, which one might consider to be a negative effect of grazing, provided micro depressions which allowed for increased native forbs and longer retention of water. Moderate stocking of cattle on vernal pool landscapes appears to benefit the native species of vernal pools and even restore habitat invaded by exotic species (Micheals et al 2021).

Why should you care?

If the current rate of ecosystem loss is to continue, it is estimated that California's vernal pools will be completely eliminated by 2087 (Holland 2009). But why should you care? While there are various types of vernal pools around the world, California's vernal pools, bolstered by the Mediterranean climate of the area, contain species found nowhere else on Earth. With the loss of these fragile ecosystems, hundreds of species will go extinct, or be severely crippled. The loss of biodiversity from lost ecosystems can generate a ripple effect, decreasing the Earth's natural ability to control forcings, which can lead to increased carbon dioxide in the atmosphere (Legacy Landscapes Fund 2022). In a butterfly effect, the small forcing of the loss of additional vernal pool habitat becomes part of the larger positive forcing that eventually changes the entire planet.

Conclusion

A valuable component of California's rangeland ecosystem, vernal pools are often overlooked as an irreplaceable habitat for numerous endangered and threatened flora and fauna, many of which are endemic to the area. Unfortunately, because very few of the public are educated of their existence, not enough is done to preserve vernal pools, and many have been destroyed, resulting in critical habitat loss. In order to assist conservation, it is of utmost

importance to inform and educate the general public of vernal pools, in order to spread public awareness of this goldmine of diversity.

Works Cited

Barry Sheila (1995) Rangeland Oasis. University of California Division of Ag and Natural Resources. Leaflet 21531

Holland Robert (2009) California's Great Valley Vernal Pool Habitat Status and Loss:Rephotorevised 2005. Placer Land Trust.

Legacy Landscapes Fund (2022) Five Reasons to Protect Biodiversity. https://legacylandscapes.org/2022/05/five-reasons-to-protect-biodiversity/ Accessed 6 January 2025

Michaels Julia, Tate Kenneth, Eviner Valerie (2021) Vernal Pool Wetlands Respond to Livestock Grazing, Exclusion and Reintroduction.

Petruzzello Melissa (2022) Mediterranean vegetation. Encyclopedia Britannica, https://www.britannica.com/plant/Mediterranean-vegetation. Accessed 6 January 2025.

Stallings Lisa, Warren Caroline (1996) Vernal Pool Substrate and Plant Community Study. California Department of Fish and Game.

United States Environmental Protection Agency (2024) EnviroAtlas Benefit Category: Biodiversity Conservation. https://www.epa.gov/enviroatlas/enviroatlas-benefit-category-biodiversity-conservation Accessed 6 January 2025

United States Environmental Protection Agency (2023) Vernal Pools. https://www.epa.gov/wetlands/vernal-pools Accessed 6 January 2025

United States Fish and Wildlife Service (2021) California Tiger Salamander. https://www.fws.gov/species/california-tiger-salamander-ambystoma-californiense Accessed 6 January 2025