Measuring Hydrological and Ecological Functioning of Vernal Pool Wetlands

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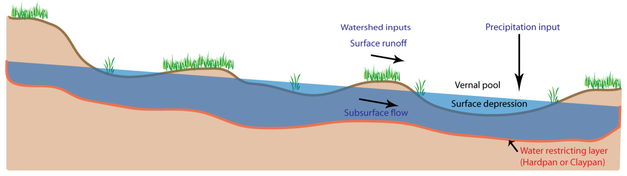
Background

Vernal pool wetlands are seasonal wetlands with complex hydrological processes related to geology, soils, and regional climate. Vernal pools provide habitat for a diverse set of native species of plants, invertebrates, and vertebrates, some of which are threatened or endangered.

Water inputs to vernal pools include direct precipitation and watershed inputs, including surface runoff and subsurface flow. Thus, changes to a vernal pool landscape beyond direct pool impacts can alter hydrologic functioning.

Below is a cross section through a vernal pool landscape. A water restricting layer (hardpan or claypan) below the soil surface leads to formation of a perched water table. Vernal pools form where surface depressions in the landscape allow the water table to rise above the soil surface.

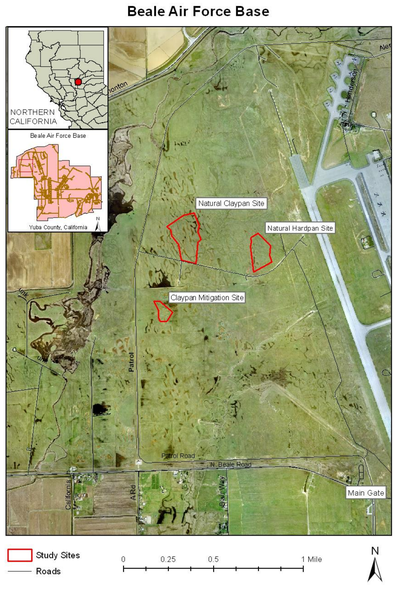
A vernal pool during the wet (top) and dry (bottom) season, showing the surface exposure of the water table in the vernal pool depressions and locations of piezometers (Leveloggers).

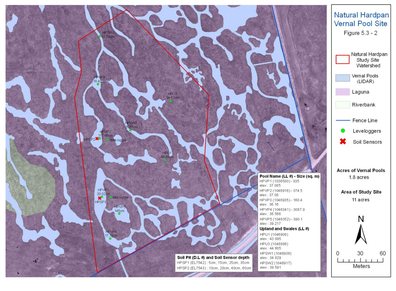


Our project demonstrates the use of four key technologies and methods to provide more precise and accurate field data on the hydrology of vernal pools and their watersheds. Combining these technologies with invertebrate and vegetation sampling allow for identification of relationships between vernal pool hydrologic functioning and biological communities. This information can be used to better design and implement pools which are created for mitigation purposes.

Demonstration sites

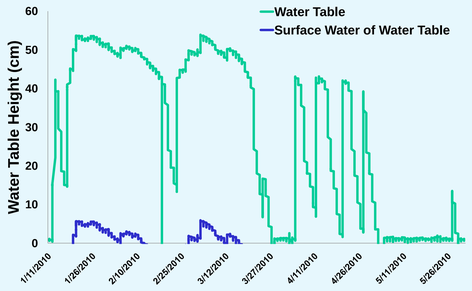
The demonstration began at Beale Air Force Base, Marysville, CA in north central California in 2010 and is being expanded to Travis AFB in 2011 and Camp Pendleton in 2012.





Four key technologies in the demonstration:

1) Water level pressure transducers (Leveloggers)



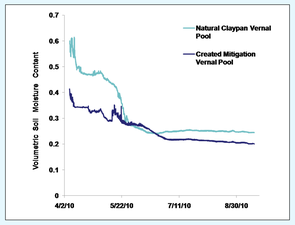
Above: A hydrograph showing water table height and depth of surface water in a created mitigation vernal pool at Beale AFB.

Leveloggers provide frequent, accurate measurement of saturated soil or surface ponding to create detailed hydrographs of the watershed.

Hydrographs contain information about periods of continuous surface inundation in pools or if dry-downs occur midseason, which can be overlooked when staff gauge readings are made on a weekly or less frequent basis.

2) Soil moisture sensors

Soil moisture sensors provide information about unsaturated conditions, including during the dry-down stage, and about differences in soil texture in pools and throughout the watershed.

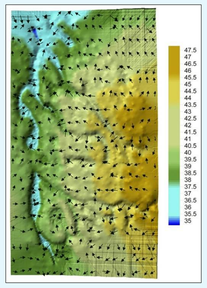


Left: Volumetric soil moisture content differences in a natural versus a created mitigation vernal pool at Beale AFB.

3) Real Time Kinematic Global Positioning System (RTK GPS)

RTK GPS surveys accurate elevations (± 1 cm), providing details on slopes, pool basin areas, pool depths, and watershed discharge points.

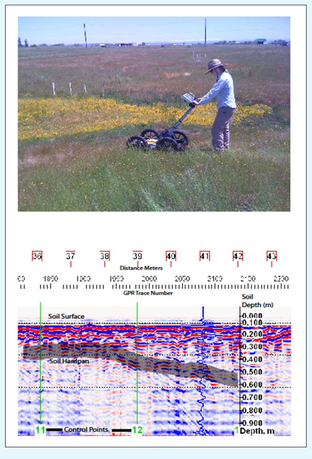
Detailed elevation information is also used in combination with vegetation survey data.



Right: Digital elevation map (DEM) showing elevation changes within a catchment at Beale AFB.

4) Ground Penetrating Radar (GPR)

GPR provides accurate measurement of changes in soil texture, identifying the presence, depth, and continuity of hardpan or other water restricting layers.

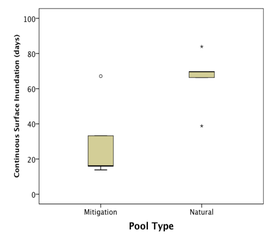


Right, top: GPR measurement in progress.

Right, bottom: Example output obtained from GPR measurements.

Invertebrate sampling

Jamie Kneitel (CSUS)



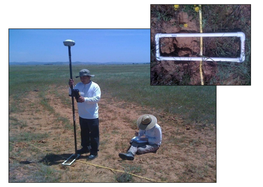
Leveloger data provide information about continuous pool inundation periods.

Linderiella occidentalis (common)

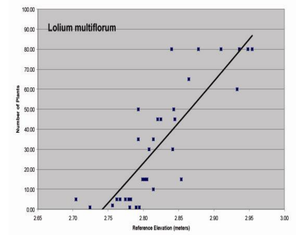
Branchinecta lynchi (threatened)

Lepidurus packardi (endangered)

Vegetation sampling



Combining GPS technology with vegetation surveys allows us to identify relationships between elevation and plant species percent cover.

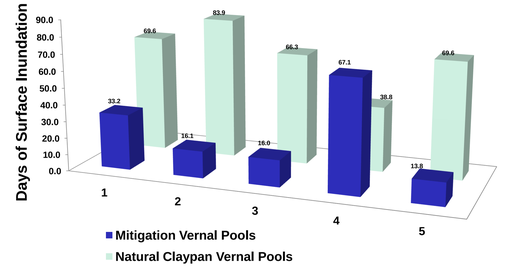


Key results

➢ **The use of these four technologies identified important hydrological differences in the pools on different soil types, and in natural versus created mitigation pools.**

➢ **Soil moisture sensors indicated >15% difference in soil moisture between natural and created pools during the growing season (see left).**

➢ **Leveloggers show that the number of days of surface inundation differ considerably between natural and created pools (see below). This information is also relevant to expressing differences in invertebrate density among pools (see above).**



Left: Number of days of surface inundation in five natural pools compared to five created mitigation vernal pools at Beale AFB.

Conclusions

➢ **The technologies and methods demonstrated in this project are important tools that can assist DoD facilities to understand the extent to which potential projects will impact vernal pools and other wetlands, and provide monitoring tools for habitat management.**

➢ **This information can additionally be used to create better mitigation design plans, including identifying sites for pool construction to achieve better functioning and successful vernal pools for mitigation purposes.**