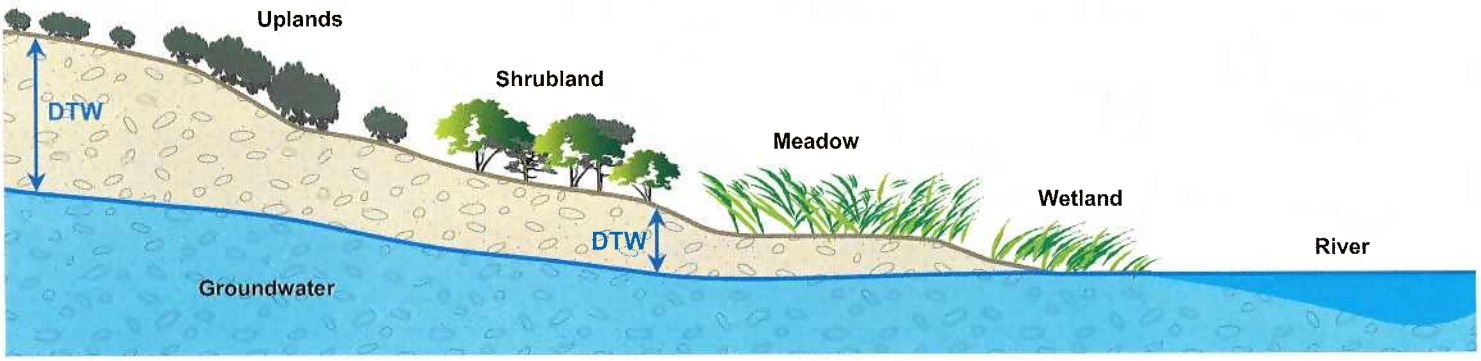
The Science Behind Managing Natural Resources in the Owens Valley

FACT SHEET 2: EFFECT OF DEPTH TO WATER ON VEGETATION CHANGE

June 2005

In the Owens Valley, there are obvious relationships between native vegetation and water. Along the river, where water is most abundant, vegetation consists of riparian species such as cottonwoods and willows, and wet marsh communities. Away from the river, but still within the floodplain, there is a mosaic of meadows and shrubland communities. Farther away from the river, on the lower portions of the slopes, desert shrubs take over on the uplands. Dense at first, they become smaller and less dense further up the slopes.



DTW = depth to water

Other Factors

Take a close look at the Owens Valley landscape. There are many factors that affect plant communities. Depth to water is one factor. Consider how other factors—called confounding factors by plant ecologists—also play a part in plant communities.

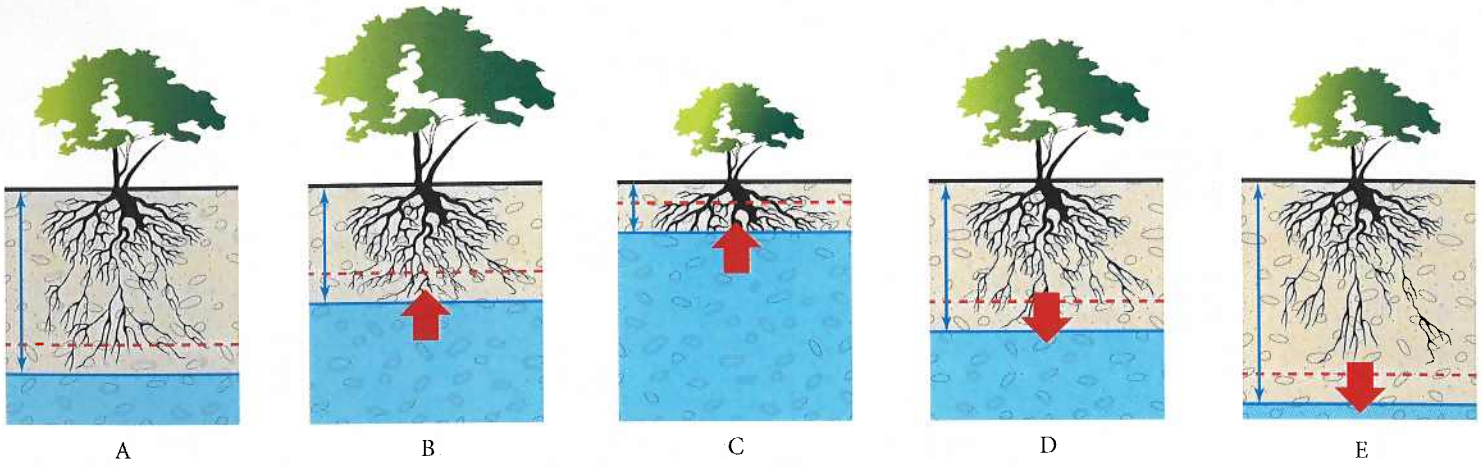
- The landscape is not flat. Lower areas collect more runoff water.
- Soils are not all the same. Some are sandy, some have more clay.
- Some areas stand white in the sun with salts at the surface, but just feet away, there is no evidence of salts.
- There are herds of cattle, horses, mules, and elk.
- There are rabbits and insects.
- There are roads, fields, and old homesteads and the impacts of past fires.

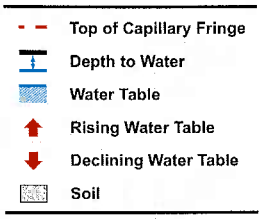
For the last four years, the Los Angeles Department of Water and Power (LADWP) and its team of scientists and experts from MWH have investigated the relationship between two factors: depth to water (DTW) and vegetation change in the Owens Valley.

The study has shown that depth to water does have an affect on changes in vegetative cover, but it is not the only factor—or even the dominant factor—that influences the Owens Valley landscape. Other factors matter a lot. There are no simple answers to the question of what causes changes in native plant cover.

This fact sheet is one in a series addressing the science behind managing natural resources in the Owens Valley. This issue addresses the relationship between depth to water and vegetation change and uses years of data collected by the LADWP and Inyo County Water Department (ICWD) to illustrate key scientific points. Future fact sheets will address other factors that affect native plants.

IN THE ROOT ZONE: WHAT HAPPENS WHEN WATER TABLES RISE OR DECLINE





Naumburg, Elke, Ricardo Mata-Gonzalez, Rachael G. Hunter, Terry McLendon, and David W. Martin. 2005. Phreatophytic vegetation and groundwater fluctuations: a review of current research and application of ecosystem response modeling. Environmental Management (In press)

In these drawings, we see a water table rising and declining. Groundwater reaches the plant through the capillary fringe—where it moves like water into a sponge from the water table to the plant roots. Plants respond not only to the amount of water, but also the amount of air and nutrients available in the soil.

Compare the plants in A and B.

The water table rises somewhat for plant B. Three important ecological responses take place:

1. Soil below the higher water table and the root zone becomes saturated. Water fills the spaces in the soil previously occupied by air.
2. Roots require oxygen. The roots in the saturated zone of the soil die. The roots above survive.
3. The amount of roots in contact with moist soil in the capillary fringe is greater than the amount of roots that die. The plant increases in growth.

Compare the plants in B and C.

The water table rises further. Initially the plant still benefits. But eventually, the water rises high enough to drown too many roots and the plant begins to suffer.

Compare the plants in C and D.

As the water table decreases, the soil drains from a saturated to an unsaturated condition. The volume previously occupied by water becomes occupied by air. Plant roots grow to fill in the available root zone. Roots can extract water that they could not get when they were saturated. The plant benefits.

Compare the plants in D and E.

If water continues to move too far from the roots, then the plant will suffer unless other sources of water become available.

Depth to water is the distance between the ground surface and the top of the water table below. The actual effect of the depth to the water table on vegetation change varies from site to site and year to year. The ecological importance of the fluctuations seems to depend upon a complex set of factors, including:

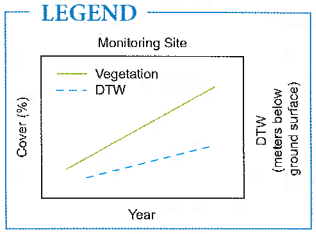
- How far the water table rises or declines
- How fast the water table rises or declines
- Ecophysiological characteristics of the plants
- Environmental factors like precipitation and temperature
- Other ecological factors like composition of the plant community and soil type

RELATIONSHIPS BETWEEN DEPTH-TO-WATER AND VEGETATION CHANGE—USING MONITORING DATA FROM 30 PERMANENT SITES

MWH reviewed the available data from the 30 permanent monitoring sites in the Owens Valley collected by LADWP and ICWD between 1987 and 2002. MWH's hypothesis for their investigation was that a rising water table should increase plant cover and a declining water table should reduce plant cover. MWH ecologists examined 1361 relationships between the depth to water and total perennial cover on those 30 sites (see graphs of some examples on next page). This is the best annual monitoring data available.

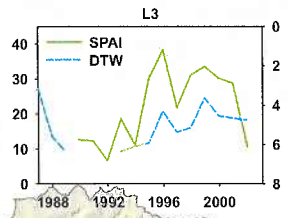
ANALYZING THE DATA FROM OWENS VALLEY MONITORING SITES

A simple way to begin investigating the relationship between depth to water (distance to the water table from the surface) and vegetative cover is to graph the data available for each and compare. The graphs shown below on the left show six sites where there is a good link between depth to water and plant cover. The graphs on the right show another six sites where there is no correlation between depth to water and vegetation.

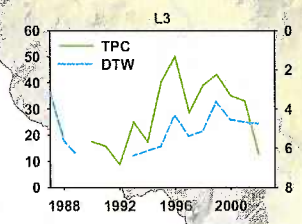


Some Sites that Support Hypothesis

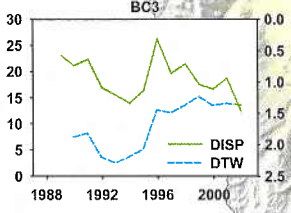
Alkali sacaton (SPAI) is a common Owens Valley grass. Sacaton at this site followed the pattern of depth to water. As the water table rose and fell, the amount of sacaton measured increased and decreased accordingly.



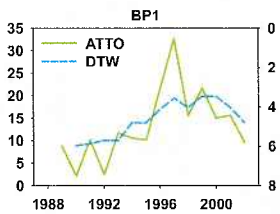
Total perennial cover (all plant species) followed the pattern of depth to water at this LAWS site.



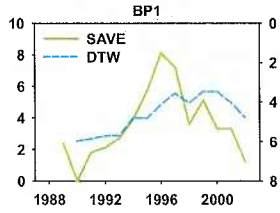
Changes in saltgrass (DISP) closely followed changes in depth to water at this Bishop control site.



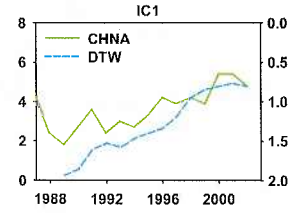
Nevada saltbush (ATTO) increased and decreased following the pattern of depth to water.



Greasewood (SAVE) cover also increased and decreased along the pattern of depth to water.



Rabbitbrush (CHNA) is a common shrub in the Owens Valley. This shrub grew in a pattern similar to the depth to water at this Independence control site.



Some Sites that Do Not Support Hypothesis

The water table at this Big Pine site rose gradually from 1990–2000, and then declined gradually from 2000–2002. However, during this period, greasewood (SAVE) fluctuated sharply, increasing then decreasing three different times. The fluctuations in vegetative cover were not the result of a change in the water table because the water table rose gradually during most of this 12-year period.

The water table has risen steadily at this Taboose-Aberdeen control site. In 1990, the water table was about 11 feet below the surface; in 2002 the water table had risen to five feet. In 1990, the site supported about a 25% cover of saltgrass. That has decreased steadily since 1990, in spite of the rising water table. The site is fenced, so grazing is not the confounding factor. Some other factor is affecting saltgrass here.

Alkali sacaton (SPAI) acted in a manner similar to saltgrass at this site. This grass should have continued to increase as groundwater got closer to the surface, but it decreased over six years (1996–2002), refuting the hypothesis.

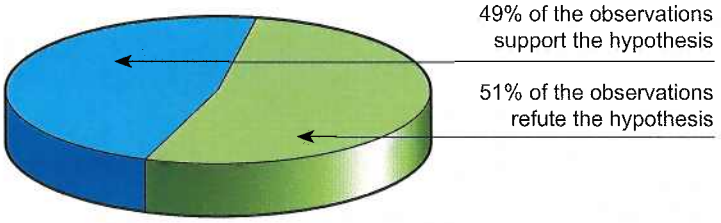
Data from this site illustrate the complexity of ecological response of vegetation to changes depth to water. Between 1990–97, rabbitbrush cover corresponded with changes in depth to water. But after 1997, the water table continued to rise, yet rabbitbrush decreased sharply (by 70%). This is opposite what would be expected.

At this Thibault-Sawmill site, the water table remained relatively constant throughout the monitoring period, gradually rising between 1995 and 1999. In contrast, the cover of Nevada saltbush (ATTO) increased from 1% to 9% between 1990 and 1995, and then fluctuated despite a constant water table depth. The 10-fold changes in saltbush at this site do not correlate with the relatively steady water table during the same period.

The water table at this Thibaut-Sawmill site declined, then rose, and then slightly declined again over the 12-year monitoring period. Throughout this period, the total perennial cover (TPC) fluctuated from year-to-year, with no overall trend. Three of the six high points in TPC occurred during periods when the water table was declining. Three of the four low points in TPC occurred when the water table was rising. These patterns do not support the

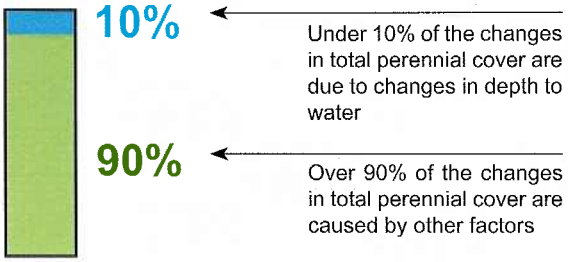
1361 OBSERVATIONS OF MONITORING DATA

By considering all of the data from the permanent monitoring sites, 1361 observations, MWH found a nearly even split between observations that either supported or refuted the hypothesis that there is an inverse relationship between depth to water and vegetation change.



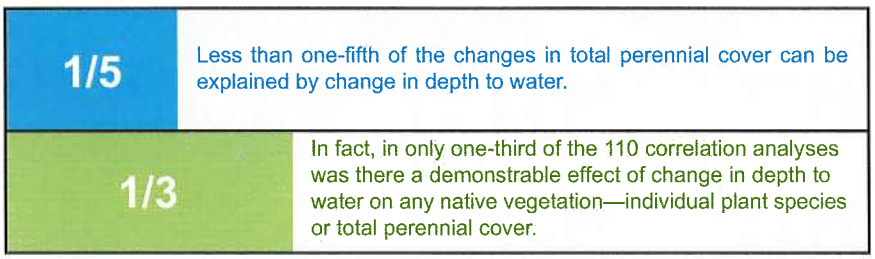
RESULTS OF CORRELATION ANALYSES OF MONITORING DATA

Correlation analysis is a common statistical method. MWH performed correlation analyses on two different available data sets, all 30 permanent monitoring sites in the Owens Valley and the 31 parcels with the most data monitored by ICWD.



31 Parcels Monitored by ICWD

In 110 Correlation Analyses:



30 Permanent Monitoring Sites

The major conclusion of the study is that, the majority of the time, changes in depth to water cannot solely explain changes in vegetative cover. Therefore, other (confounding) factors must be affecting vegetative cover. All factors must be considered when analyzing the monitoring data.

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