GROUNDWATER PUMPING EFFECTS ON NATIVE VEGETATION IN OWENS VALLEY

Sally Manning, Ph.D.
Big Pine Paiute Tribe Environmental Director
s.manning@bigpinepaiute.org
William Mulholland
Los Angeles Dept. of Water & Power (LADWP) Aqueduct
Owens Valley is in the GREAT BASIN

No Outlet to the Sea

- Low Precipitation
  5 ½ inches
  ¾ in winter
- Cold Winters
- Hot Summers
Fig. 1. Map of present day and pluvial Owens Lake, and other lakes hydrologically connected upstream and downstream from it during pluvial periods of the Pleistocene. B, Bishop; I, Independence; LP, Lone Pine; VT, Volcanic Tableland (figure modified from Smith and Bischoff (1997)).
Wet Places = REFUGIA

Owens Pupfish

springsnails
Wet Places = REFUGIA

Alkali Meadow
Of the view in this picture, summer 1859, Davidson wrote, “The eye wanders over a sea of green.” He concluded that Owens Valley was some of the finest country he had ever seen, calling it, “a vast Meadow, watered every few miles with clear, cold mountain streams, and the grass (although in August) as green as in the first of spring.”
Dominant Grass Species

Sporobolus airoides, alkali sacaton

Distichlis spicata, saltgrass

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**Calochortus excavatus**
candidate for listing

**Sidalcea covillei**
state listed
Also Habitat for Other Species

Western Meadowlark, nesting
*Sturnella neglecta*

“Owens Valley” vole, an endemic
*Microtus californicus* ssp. *vallicola*

Other California Species of Concern, birds, invertebrates, plants
Alkali Meadow in California:
61,114 ha
150,900 acres

Shallow Groundwater

Roots of meadow plants tap into shallow groundwater. Our meadow grasses grow roots down to ~2m (~8ft)

Plants that tap groundwater are known as *phreatophytes* (“well plants”).

Conceptual Illustration of Owens Valley Aquifer System

- **Sierra Nevada**
- **Inyo Mtns**
- **Alluvial Fan**
  - Area of Unconfined Aquifer
- **Valley Floor**
  - Lower Zones Confined; Upper Zone is Free Water Table

**Runoff/Recharge**
- Runoff/Recharge
- Free Water Table
- Base of Valley Fill

**Transition Zone**
- Transition Zone
- Evapotranspiration
- Owens River
- Pressure Level

**Confined** Aquifers

Redrawn from Fig. 9-7 Inyo/LA DEIR 1990
Conceptual Illustration of Owens Valley Aquifer System

Alluvial Fan
Area of Unconfined Aquifer

Valley Floor
Lower Zones Confined; Upper Zone is Free Water Table

Runoff/Recharge
Free Water Table
Base of Valley Fill

Meadow Zone
Evapotranspiration
Recharge
Owens River
Pressure Level

“Confined” Aquifers

Redrawn from Fig. 9-7 Inyo/LA DEIR 1990

Details show groundwater depths, vegetation types, and other useful features, which we digitized in GIS.
Aug. 1908 – May 1911: Seasonal Water Table Fluctuation due to ET

T481: 1974 - 2007

Water Table: Spring to Fall Cycling
Effect of Runoff Variability on Groundwater

T481 April Water Table

Runoff OV

Ac-ft/1000


average
This hydrology – the stable, reliable water table, gave rise to and sustained meadows, wetlands, and their plants and animals. The hydrology and biology were in balance.
Conceptual Illustration of Owens Valley Aquifer System

- **Sierra Nevada**: WEST
- **Inyo Mtns**: EAST

**Alluvial Fan**
- Area of Unconfined Aquifer
- Runoff/Recharge

**Valley Floor**
- Lower Zones Confined; Upper Zone is Free Water Table
- Meadow Zone
- Evapotranspiration
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Alluvial Fan
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Runoff/Recharge
Free Water Table
Base of Valley Fill

LA Aqueduct!
Evapotranspiration
Owens River
Pressure Level

“Confined” Aquifers

Redrawn from Fig. 9-7 Inyo/LA DEIR 1990
DWP recognized the abundance of water and commenced to systematically drain it from the watershed.

Export *began* 100 years ago with completion of the LA Aqueduct. Neither the extraction nor its environmental consequences have reached an end point.
Besides taking the Surface Water
Groundwater Pumping
Inyo County Water Department

• Implement Long Term Water management Agreement between City of Los Angeles and County of Inyo

• Monitor environmental conditions for changes due to LA’s water management activities
The overall goal of managing the water resources within Inyo County is to avoid certain described decreases and changes in vegetation* and to cause no significant effect on the environment which cannot be acceptably mitigated while providing a reliable supply of water for export to Los Angeles and for use in Inyo County.

* “baseline” defined as mid 1980s
Big Pine-area pumping 1929-2009
and flow from Fish Springs 1935-2009

BP Pumping ac-ft


pumping  springflow
April Water Table, T24

Pumping in vicinity

Runoff OV

Ac-ft

Ac-ft/1000

avg

1929-2005

0
-1
-2
-3
-4
-5
-6

-6
-5
-4
-3
-2
-1
0

0
200
400
600
800
1000

Fish Springs Area, 1947 and 2009
Digitizing Lee’s 1912 contours of shallow groundwater
Lee’s 1912 meadow vegetation

DWP’s 1980s vegetation map

Meadow ~1912

28,659 acres

Meadow ~1986

17,929 acres
17,929 acres
vegetation monitoring 1991 onward

DWP’s 1980s vegetation map

16,292 acres

Meadow ~1986

Meadow ~2004

LA Aqueduct
Highway 395
Lee_grass_1912.shp
DWP1986CDE

LA Aqueduct
Highway 395
Lee_grass_1912.shp
SM2004mdw
Excessive pumping from these (fish hatchery) wells has degraded a meadow mapped by Lee in 1912 – and by DWP in 1986.

Affected area is known as Blackrock 94.
grass root zone
grass root zone
Permanent Transect
Blackrock 94

1988 33% cov
Green grass 29%
Some shrubs 4%

2007 15% cov
~Dead grass 4%
Shrubs dominate 11%
Loss of viable population of rare plant
Permanent Transect
Blackrock 94

1987 53% cov
Green grass 42%
Some shrubs 11%

2007 14% cov
~Dead grass 1%
Shrubs dominate 13%
Permanent Transect
Blackrock 94

1987 53% cov
Green grass 42%
Some shrubs 11%

Burned 2007
No groundwater = poor recovery

2012 4%? cov
grass ~ 1%
Shrubs ~ 4%
March 30, 2010. View ESE from BP showing the dust rising high in sky and probably into the Inyo Mountains.
DWP Pumping results in:

- Depressed water tables, “permanently”
- Loss of springs & wetlands
- Loss of meadow - Ecosystem conversion from groundwater to precipitation dependence
- Loss of animal habitat, native perennial grass cover, rare species
- Dominance by shrubs (or non native species)
- Increased potential for non native weedy species to thrive
- Erosion, dust storms
- Reduced forage for livestock
- And, it just looks bad!
DWP’S 1976 EIR

“The alkali grasslands will probably be the most noticeably impacted vegetation type”

<table>
<thead>
<tr>
<th>Water Table Depression (Feet)</th>
<th>Tule Marsh</th>
<th>Riparian/ Woodland</th>
<th>Alkali Grassland</th>
<th>Alkali Scrubland</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>N-M-VH**</td>
<td>N-L-M</td>
<td>N-M-H</td>
<td>N-L</td>
</tr>
<tr>
<td>10-15</td>
<td>E</td>
<td>H</td>
<td>VH-E</td>
<td>M-H</td>
</tr>
<tr>
<td>15+</td>
<td>E</td>
<td>VH</td>
<td>E</td>
<td>H-VH-E</td>
</tr>
</tbody>
</table>

* 6/8 = Chronic response threshold/acute response threshold (DTW in Feet).

**N = none, L = low, M = moderate, H = high, VH = very high, E = extreme
Blackrock 99
Baseline Cover
Alkali Meadow

Root Zone: grass shrub

(Depth to water table estimated using kriging with external drift.)
Water Table Based Management: Set baseline (A), allow pumping, but only to the point from which water table can recover (B) in the specified amount of time. (C). After recovery period (D), monitor (E) to see how it worked.
What’s been learned:

- Understand the ecosystem and hydrology
- Identify values
- Manage the hydrology
- Monitor response
- Modify management as needed
Conclusion:

- Gather the stakeholders
  - Understand the ecosystem and hydrology
  - Identify values
  - **MANAGE the HYDROLOGY**
  - Monitor response
  - Modify management as needed
- Officially include stakeholders in decisions