




Hydrology and Riparian Vegetation on the Coastal Slope of California



Jon Avery, U.S. Fish and Wildlife Service
Carlsbad, April 24, 2018



Hydrological features supporting least Bell's vireo breeding habitat

- Groundwater
- Flooding
- (Surface water)



- ▶ Groundwater, surface water, and flooding combine to support riparian vegetation depended upon by least Bell's vireo.

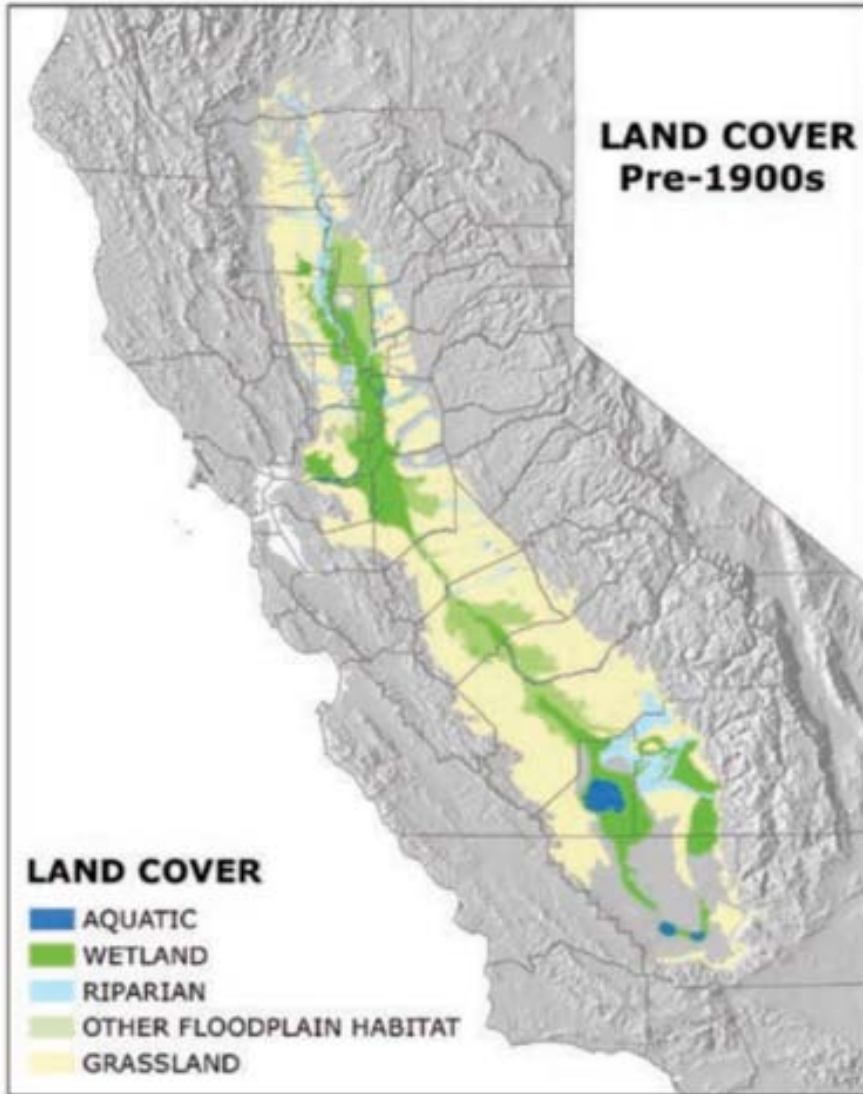
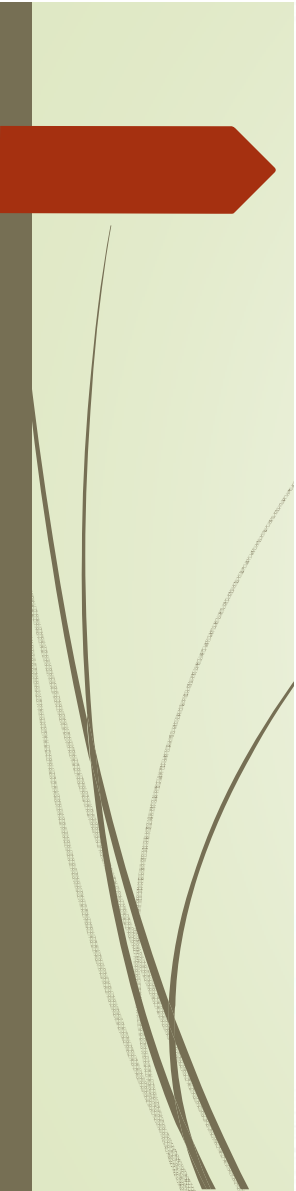


- ▶ Groundwater and surface water are vital resources in California — for agricultural, domestic, and industrial use, and ecosystem sustenance.



- ▶ California riparian environments are particularly vulnerable to water-related land-use practices and are currently threatened by rapid population and socio-economic changes (Postel 2000, Stromberg et al. 1993).





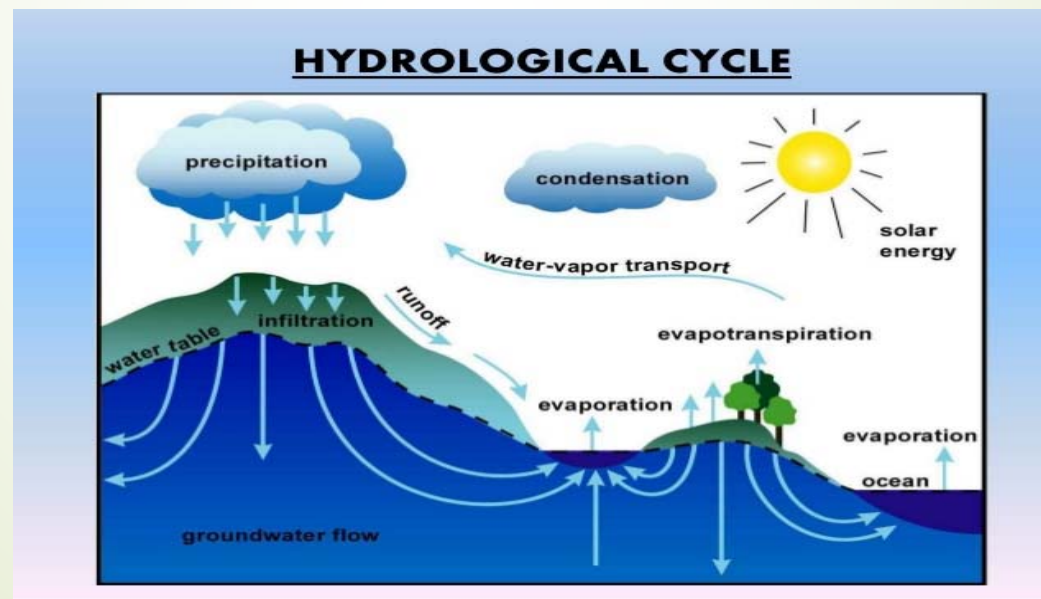
Disappearance of Central Valley wetlands © Central Valley Historic Mapping Project, California State University, Chico, Geographic Information Center, 2003

Vireo habitat – floodplain space, flooding, soil moisture, (surface water), and groundwater



HYDROLOGY

Hydrology is concerned with the properties of the earth's water, and especially its movement in relation to land.



Riparian

- ▶ Riparian means “stream-side” and relates to wetlands or other features adjacent to streams. It typically does not refer to the aquatic portion of the stream itself.



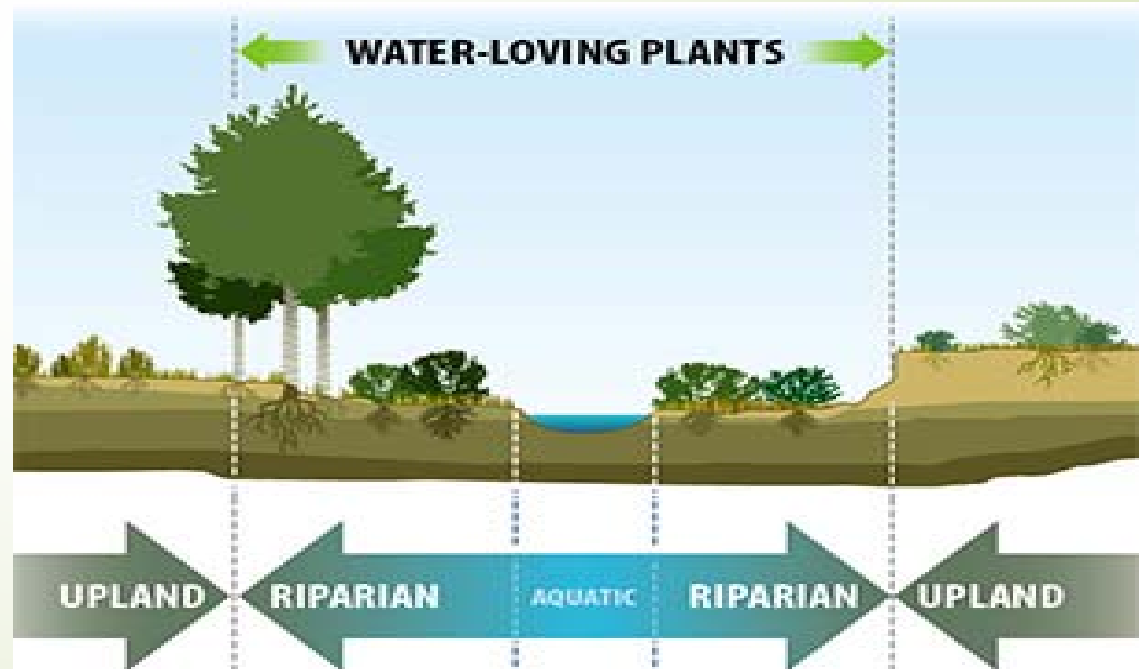
Riparian Zones

- ▶ Riparian zones are transitional areas between terrestrial and aquatic ecosystems that depend on the existence of surface or subsurface water flows.



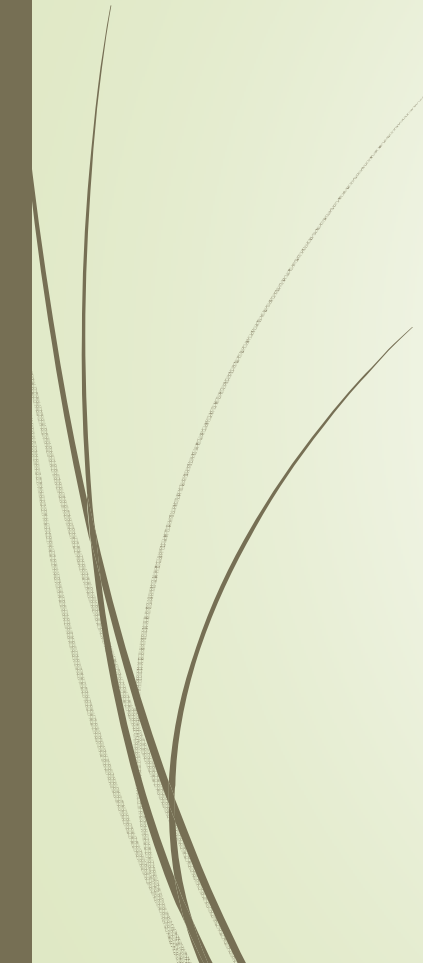
Riparian Vegetation

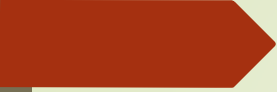
- Riparian vegetation consists of plant communities along stream margins and floodplains characterized by hydrophilic plants.



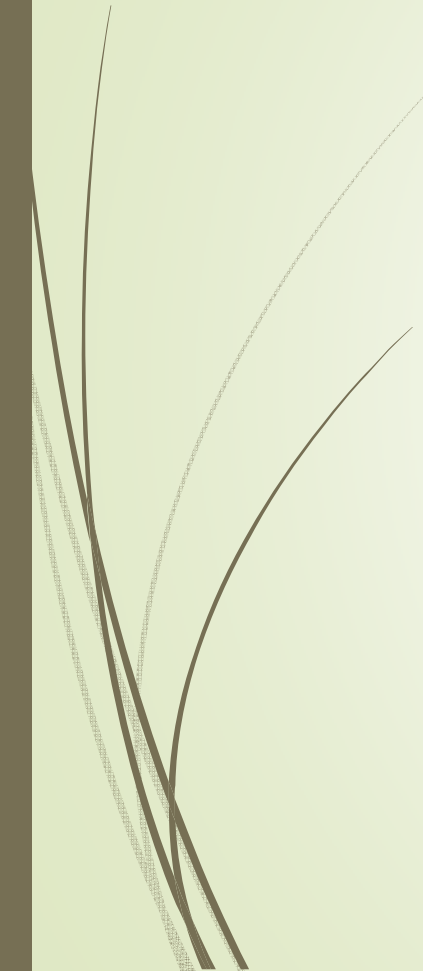


Least Bell's vireo

- Obligate riparian breeders
 - Structurally diverse scrub and woodland areas along water courses
 - Typically utilize willow (*Salix* sp.) dominated areas
- 



Vireo Habitat Vegetation Age and Structure

- ▶ Least Bell's vireo prefer early successional riparian habitat =
 - ▶ Dense cover within 3 to 6 feet of the ground where nests are typically placed
 - ▶ Dense, stratified canopy for foraging for insect prey
 - ▶ Typically utilize 5-10 year old native riparian communities that cyclically develop following periodic floods
- 

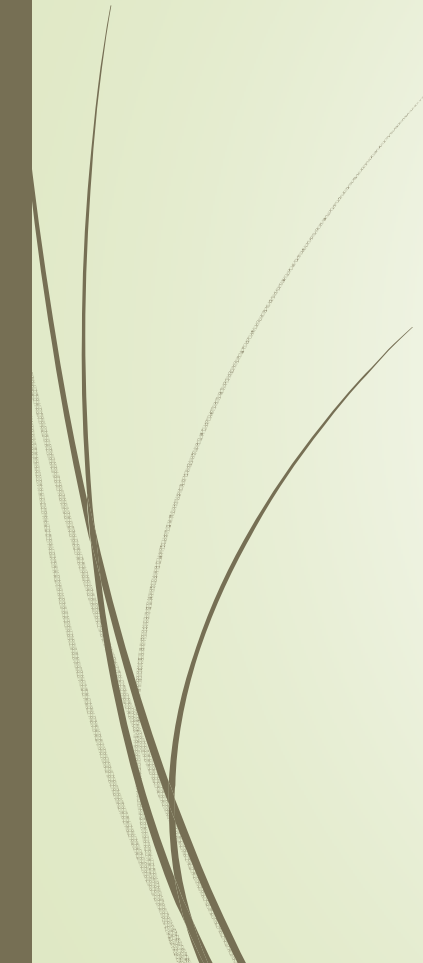


Vireo habitat dominant plant species

- ▶ Overstory:

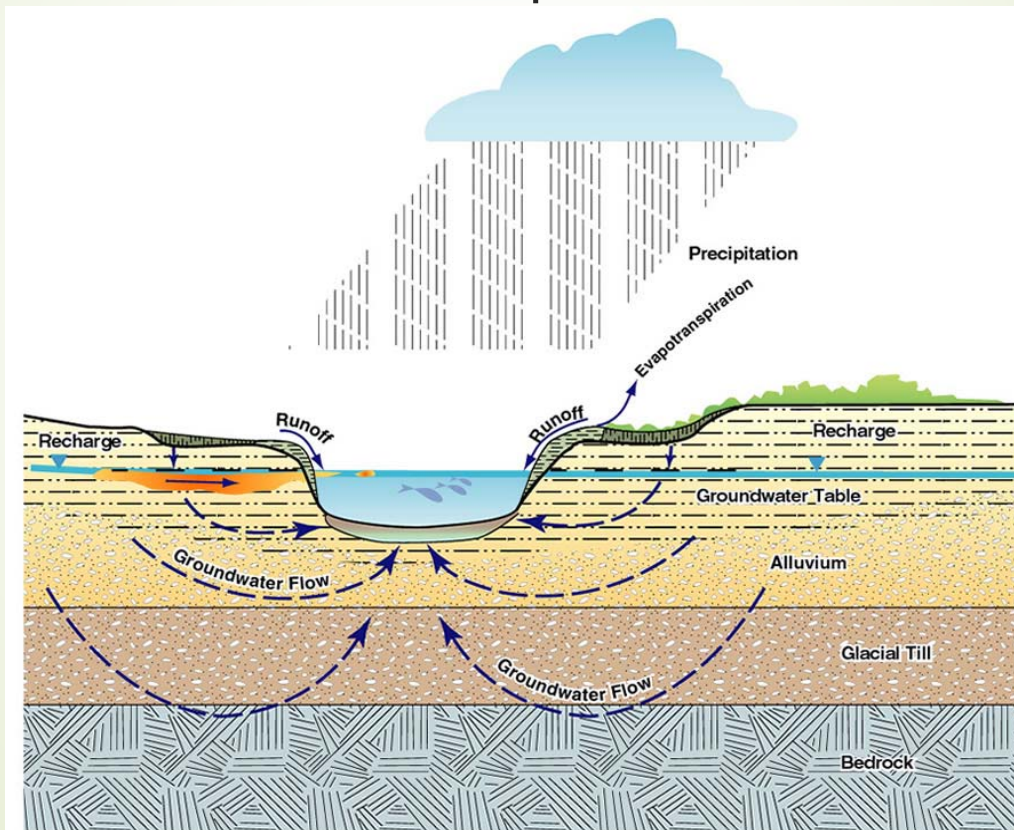
- ▶ Willow trees (*Salix* spp.)
- ▶ Fremont cottonwood (*Populus fremontii*)
- ▶ Mulefat (*Baccharis salisifolia*)

- ▶ Understory:

- ▶ California wild rose (*Rosa californica*)
 - ▶ Poison oak (*Toxicodendron diversiloba*)
 - ▶ California blackberry (*Rubus ursinus*)
- 



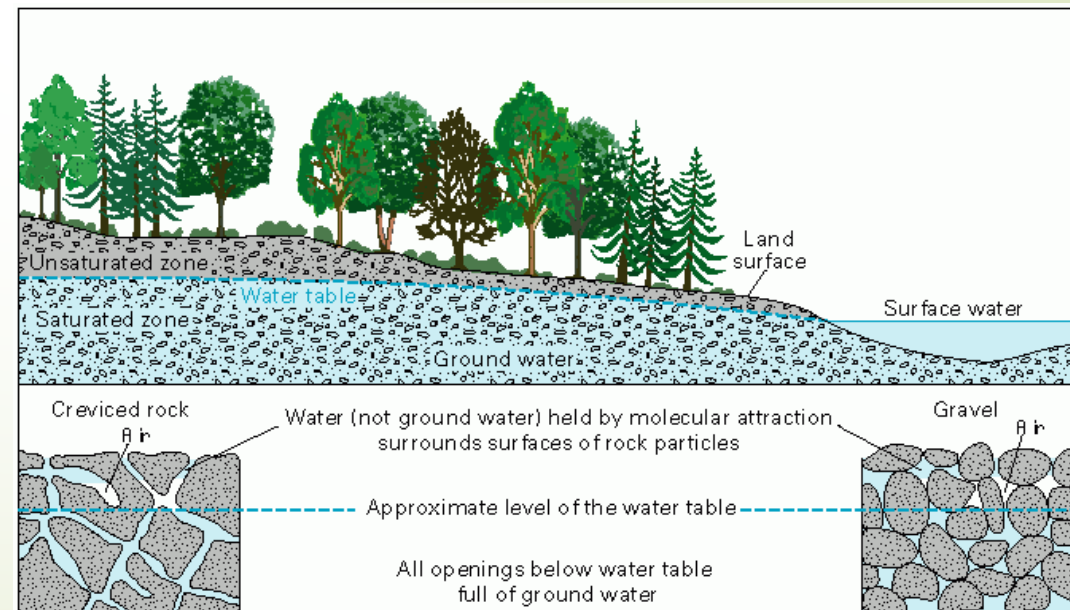
Groundwater - water beneath the surface of the ground, consisting largely of surface water that has seeped down



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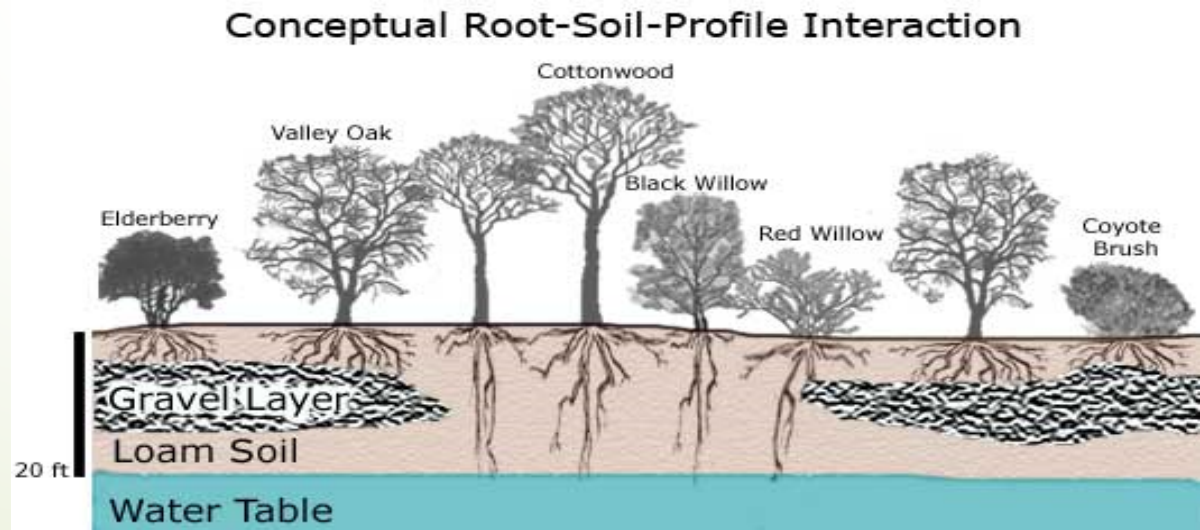
Groundwater


- ▶ The interactions between the surface water in streams and groundwater is stronger than most people think. In many locations in California the surface water flowing in streams comes from seepage of groundwater into the streambed (USGS 2016).



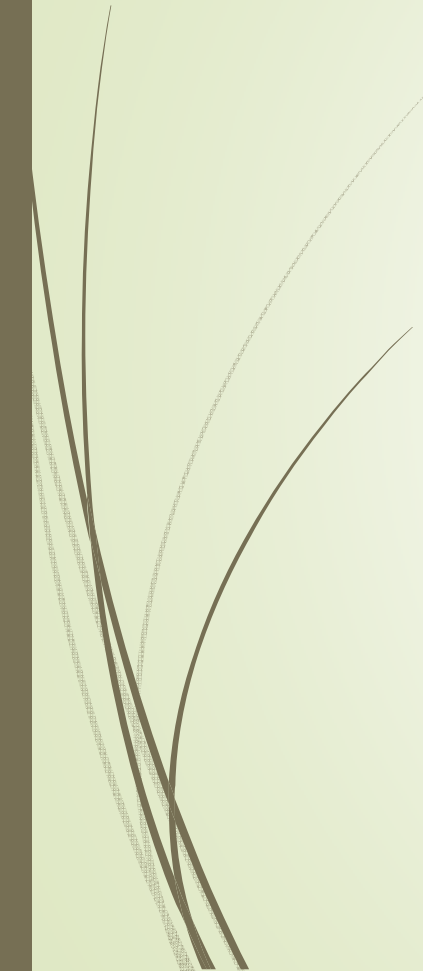
What groundwater does for vireo habitat:

- ▶ Groundwater provides effective moisture to mature and immature riparian vegetation when it is within 1 to 7 feet of ground surface





What groundwater does for vireo habitat (cont.):

- ▶ Provides available moisture to riparian vegetation on floodplain areas away from surface water and channel margins
 - ▶ Provides moisture to riparian vegetation during drought periods
 - ▶ Provides moisture to riparian vegetation along intermittent streams
 - ▶ Surfacing groundwater flows downstream and maintains downstream riparian areas
- 

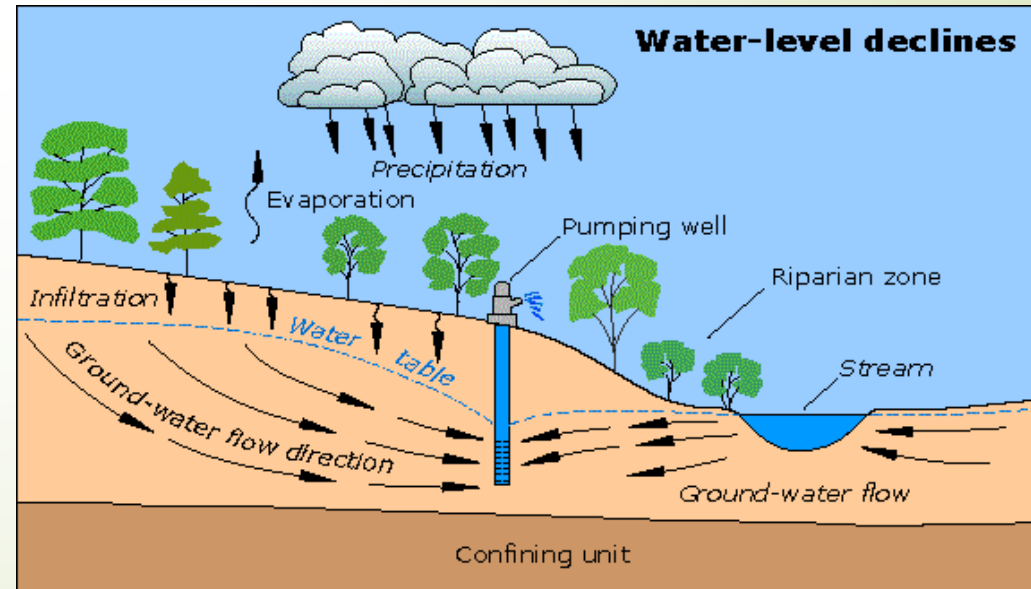
Groundwater pumping

- ▶ Groundwater pumping can alter how water moves between an aquifer and a stream by either intercepting groundwater flow that discharges into the surface-water body under natural conditions, or by increasing the rate of water percolation from surface flows into an aquifer.

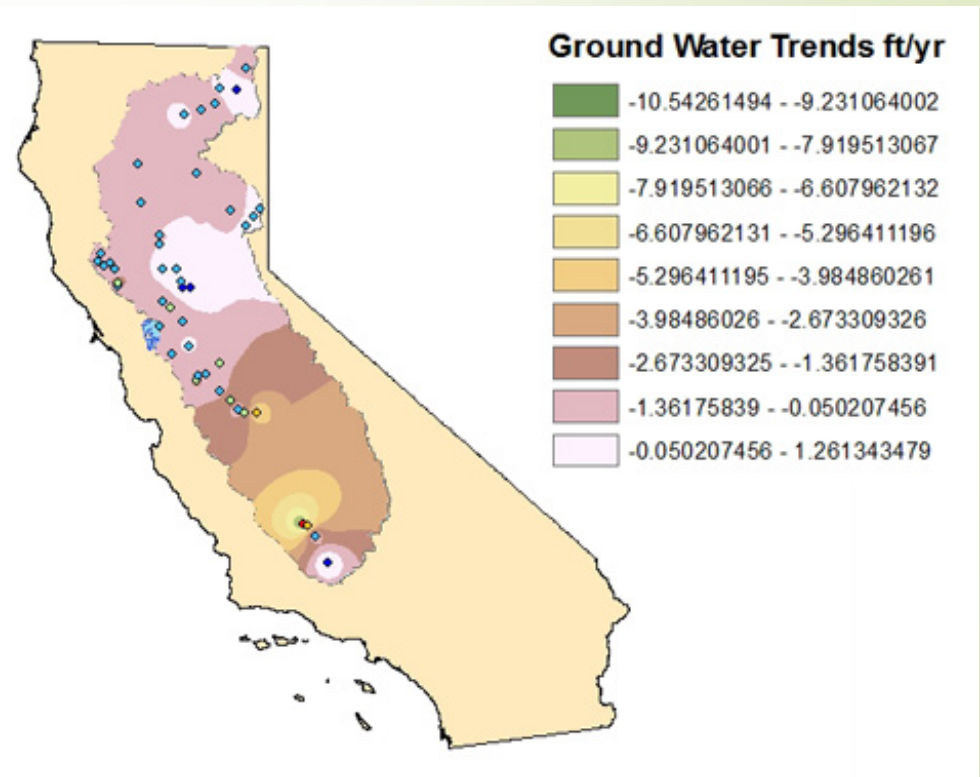


Groundwater pumping

- ▶ A related effect of groundwater pumping is the lowering of groundwater levels below the depth that riparian vegetation needs to function or survive. The overall effect is a loss of riparian vegetation and wildlife habitats (USGS 2016).



As groundwater levels drop riparian ecosystems in the California become degraded or are eliminated (Laity 2003, Snyder 2000, National Park Service 2004).



- ▶ Riparian ecosystems of the American southwest have been and continue to be adversely affected by falling groundwater levels caused by water well pumping (Stromberg et al. 1993).





TABLE 4. Mean depth to groundwater, standard deviation, minimum and maximum depth, range, and wetland indicator class (Reed 1988) for common woody species in San Pedro River floodplain study plots.

Species	Depth to groundwater (m)				Wetland class
	Mean \pm 1 SD	Min	Max	Range	
Juvenile tree species					
<i>Salix gooddingii</i>	0.6 \pm 0.6	0.1	2.0	1.9	Obligate wetland
<i>Populus fremontii</i>	0.9 \pm 0.5	0.2	2.0	1.8	Facultative wetland
<i>Fraxinus velutina</i>	1.2 \pm 0.7	0.3	2.1	1.8	Facultative
<i>Tamarix chinensis*</i>	1.3 \pm 0.6	0.2	2.5	2.2	Facultative wetland
<i>Juglans major</i>	1.9 \pm 1.0	0.3	3.9	3.6	Facultative wetland
<i>Celtis reticulata</i>	2.8 \pm 1.3	1.2	6.2	6.0	Facultative upland
<i>Prosopis velutina</i>	2.9 \pm 1.6	0.7	6.6	5.9	Facultative upland
<i>Rhus microphylla</i>	3.2 \pm 2.1	0.7	6.6	5.9	Upland
<i>Acacia greggii</i>	4.4 \pm 1.8	1.7	6.2	4.5	Upland
Mature tree species					
<i>Salix gooddingii</i>	1.4 \pm 0.9	0.1	3.2	3.1	Obligate wetland
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Shrub species					
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<i>Hymenoclea monogyra</i>	2.1 \pm 1.3	0.8	5.8	5.0	Upland

- Stromberg, J.C., R. Tiller, and B. Richter. 1996. Effects of groundwater decline on riparian vegetation of semiarid regions: The San Pedro, Arizona. *Ecol. Applications* 6:113–131.

Black willow, *Salix gooddingii*



Black willow, juvenile

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Black willow, mature

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10 feet max



Fremont cottonwood, *Populus fremontii*



Cottonwood, juvenile

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Shrub species					

Cottonwood, mature

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Mulefat, *Baccharis salicifolia*



Mulefat

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<i>Acacia neovernicosa</i>	2.8 \pm 1.1	1.3	9.9	.9	Upland
<i>Celtis reticulata</i>	3.8 \pm 2.1	0.9	6.2	.2	Facultative upland
<i>Prosopis velutina</i>	3.4 \pm 1.7	0.9	7.1	7.1	Facultative upland
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<i>Hymenoclea monogyra</i>	2.1 \pm 1.3	0.8	5.8	5.0	Upland

9 feet max



Increased distance to groundwater – Least Bell's Vireo

- ▶ Stressed or eliminated native woody riparian vegetation on floodplain
- ▶ Decreased or eliminated riparian woody plant recruitment
- ▶ Increased invasion of exotic plants
- ▶ Conversion of riparian to upland vegetation



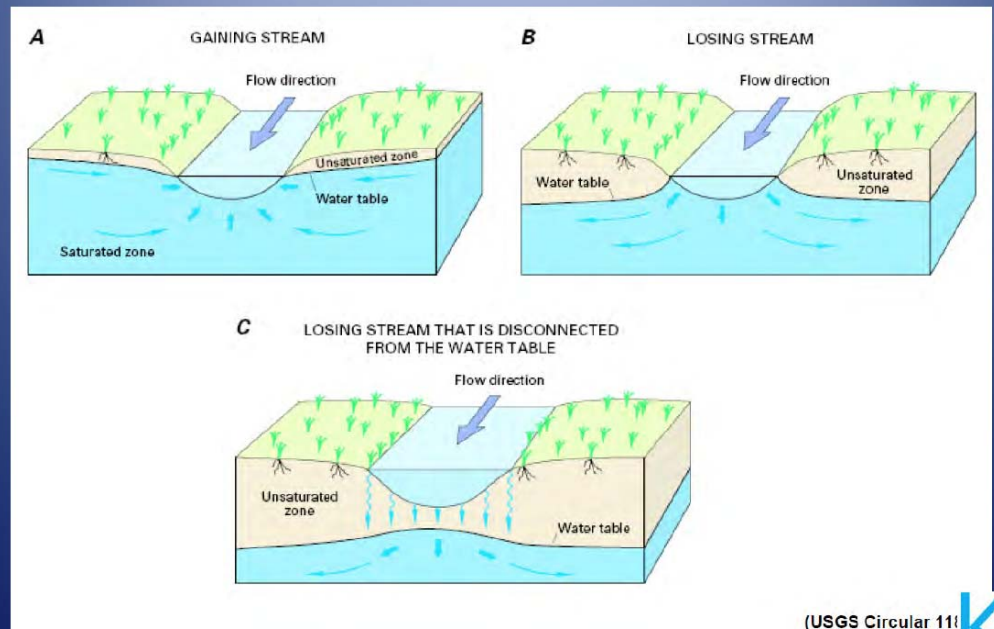
Increased distance to groundwater – Least Bell's Vireo (cont.)

- ▶ Decreased leaf-out of native riparian woody plants
- ▶ Decrease plant productivity
- ▶ Decreased insect prey biomass
- ▶ Decrease or eliminated vireo productivity and occupation
- ▶ Fewer vireo pairs, reduced fledgling productivity

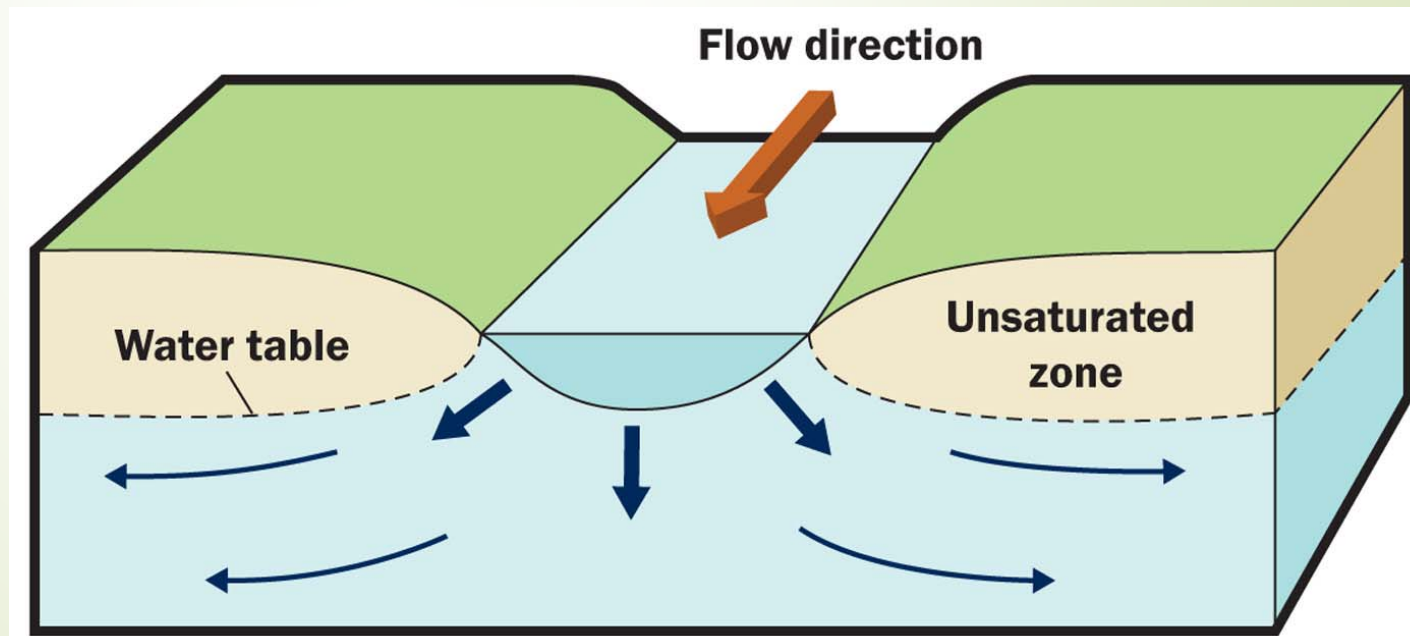


Groundwater and surface water often contribute to each other, depending on the type of stream

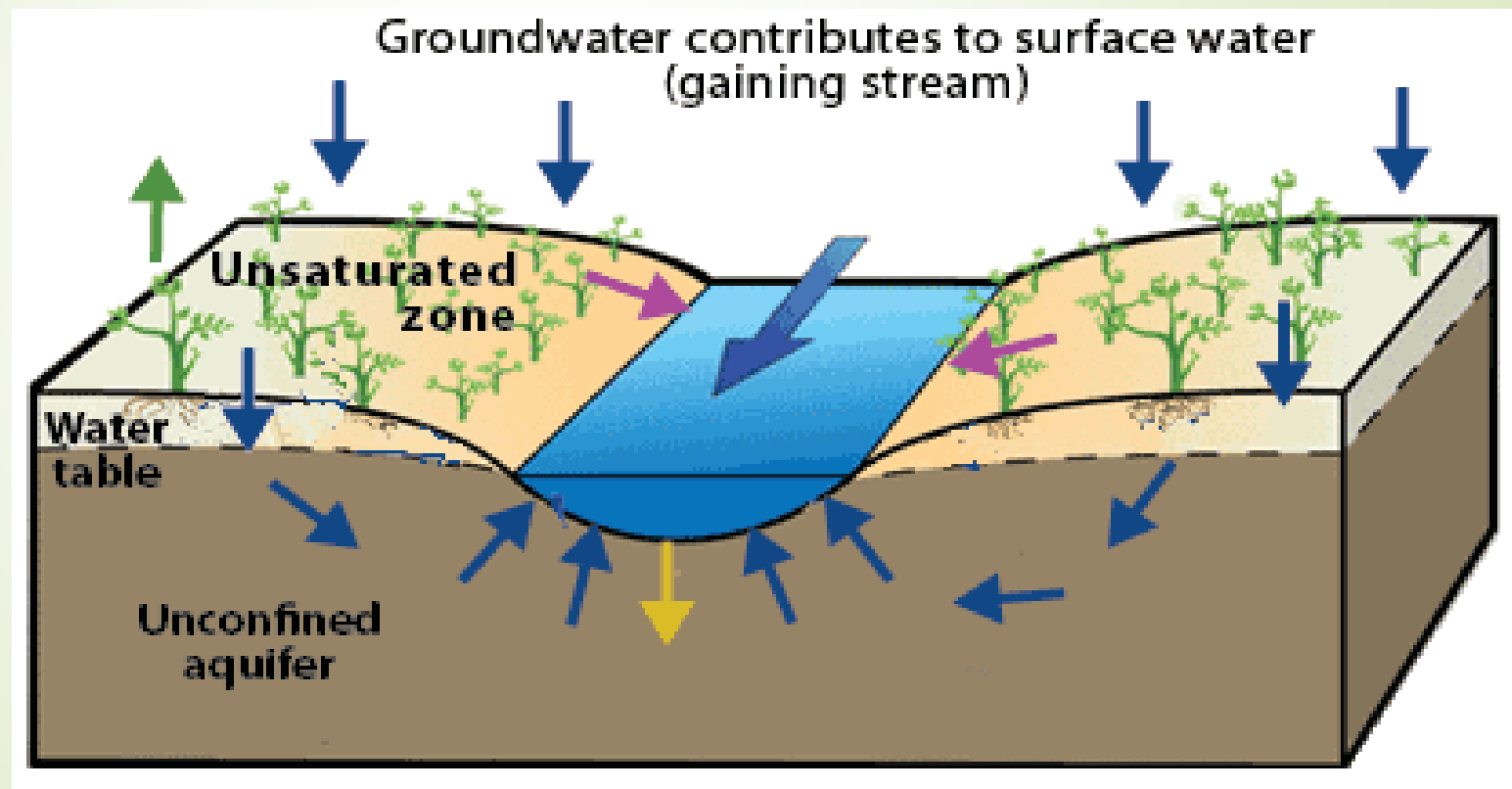
Basic Types of Surface & Groundwater Interaction



Surface water contributes to groundwater in a losing stream



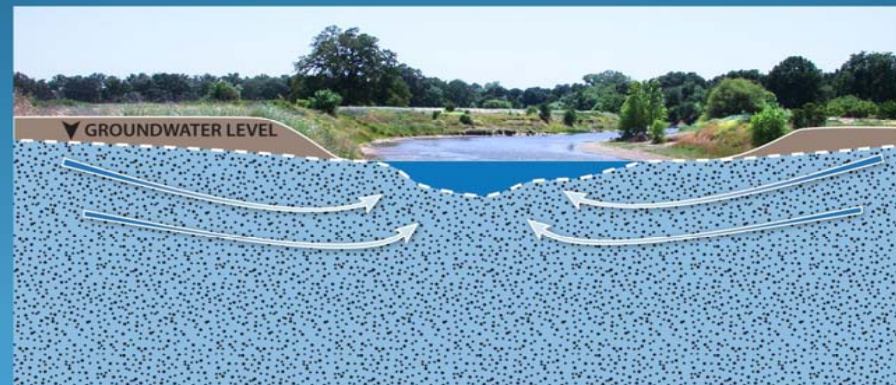
Groundwater contributes to surface water
in a gaining stream



High groundwater levels often maintain stream flow

Groundwater – Surface Water Connection

“Gaining Stream”



Courtesy of:
The Nature Conservancy

High Groundwater Levels
Groundwater Maintains Stream Flow

What surface water does for vireo:

- ▶ Maintains high groundwater levels in nearby riparian floodplains
- ▶ Maintains surface soil moisture levels for riparian vegetation that occurs adjacent to channels (particularly in areas where groundwater is distant)
- ▶ (Surface water is not a direct feature of vireo habitat, but indirectly helps maintain riparian vegetation actually utilized by vireos)



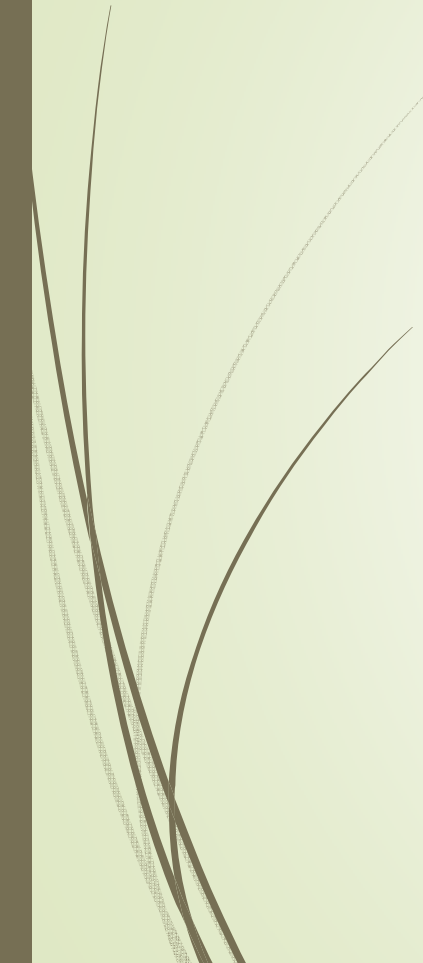
Decreased surface water

- Reduces groundwater recharge in downstream areas
- Decreases surface soil moisture in riparian areas along naturally wetted channels
- Reduces riparian plant and insect prey productivity in adjacent riparian areas where groundwater is not high or artificially reduced.
- Reduces vireo pair numbers and nest productivity in areas where groundwater is not high



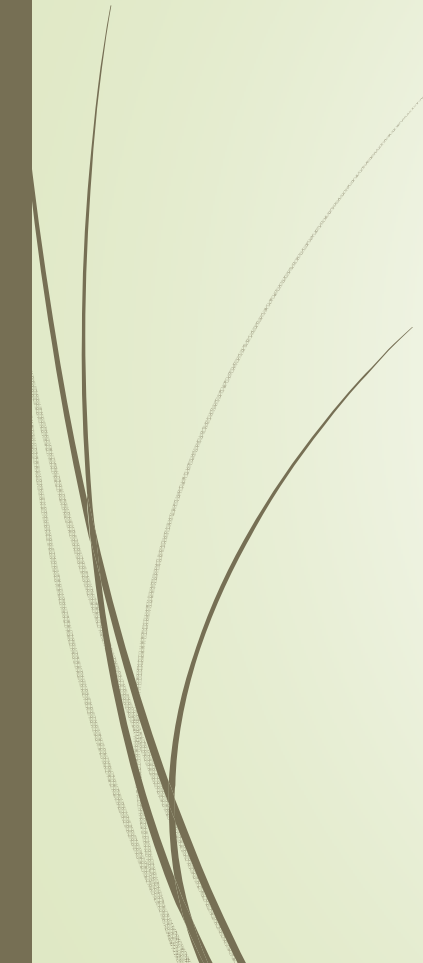


What flooding does for vireo:

- Episodically covers or submerges floodplain with water
 - Temporarily increases surface soil moisture in floodplain
 - Recharges groundwater levels
- 



What flooding does for vireo (cont.):

- ▶ Moves and deposits sediment along channel and floodplain
 - ▶ Knocks down and denudes vegetation along floodplain – scour
 - ▶ Cyclically resets successional stages for riparian scrub/woodland/forest
 - ▶ Prepares essential seedbeds for important woody plant recruitment (e.g., Fremont cottonwood)
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Flood inundation



Flood scour, Ventura River



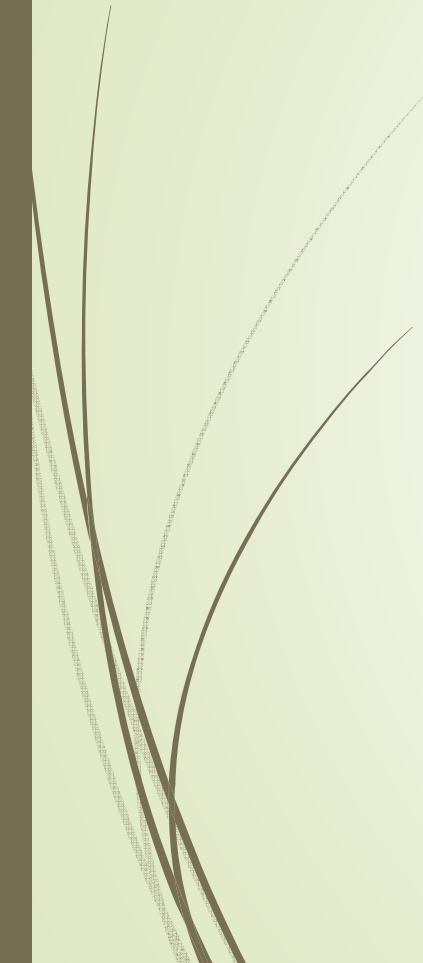


Mixed Riparian Forest

Willow Scrub



Decreased flooding regimes

- ▶ Decreased or eliminated successional stage cycling essential for development of high function riparian scrub/woodland/forest age classes
 - ▶ Reduced or eliminated recruitment of some important riparian woody plants, such as cottonwood
 - ▶ Reduced vireo nesting and productivity
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Water - Riparian Vegetation - Arthropods

Riparian trees with decreased water stress have more arboreal arthropod biomass compared to riparian trees with increased water stress. (Kirkpatrick, Conway, and LaRoche 2009)

