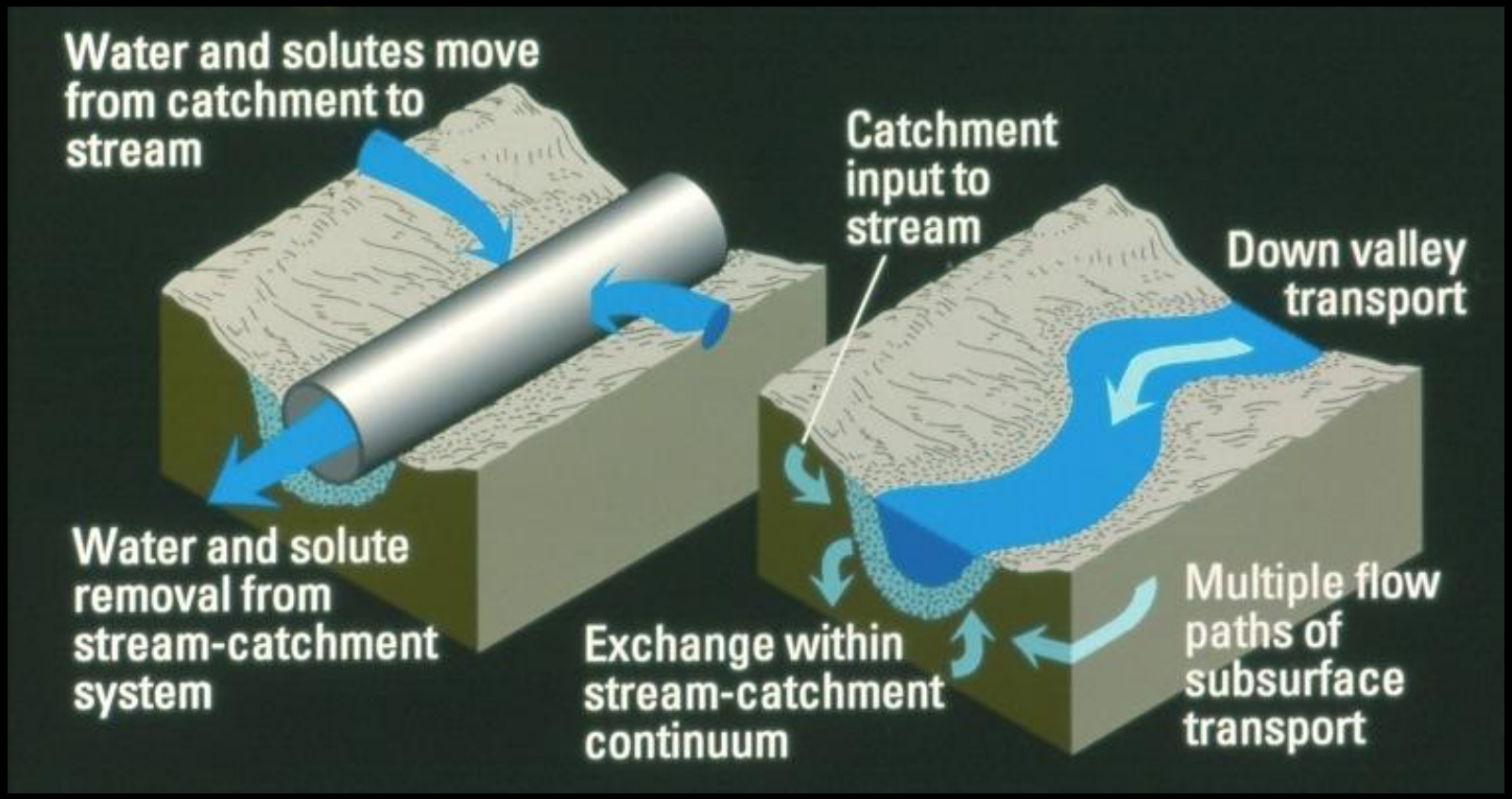
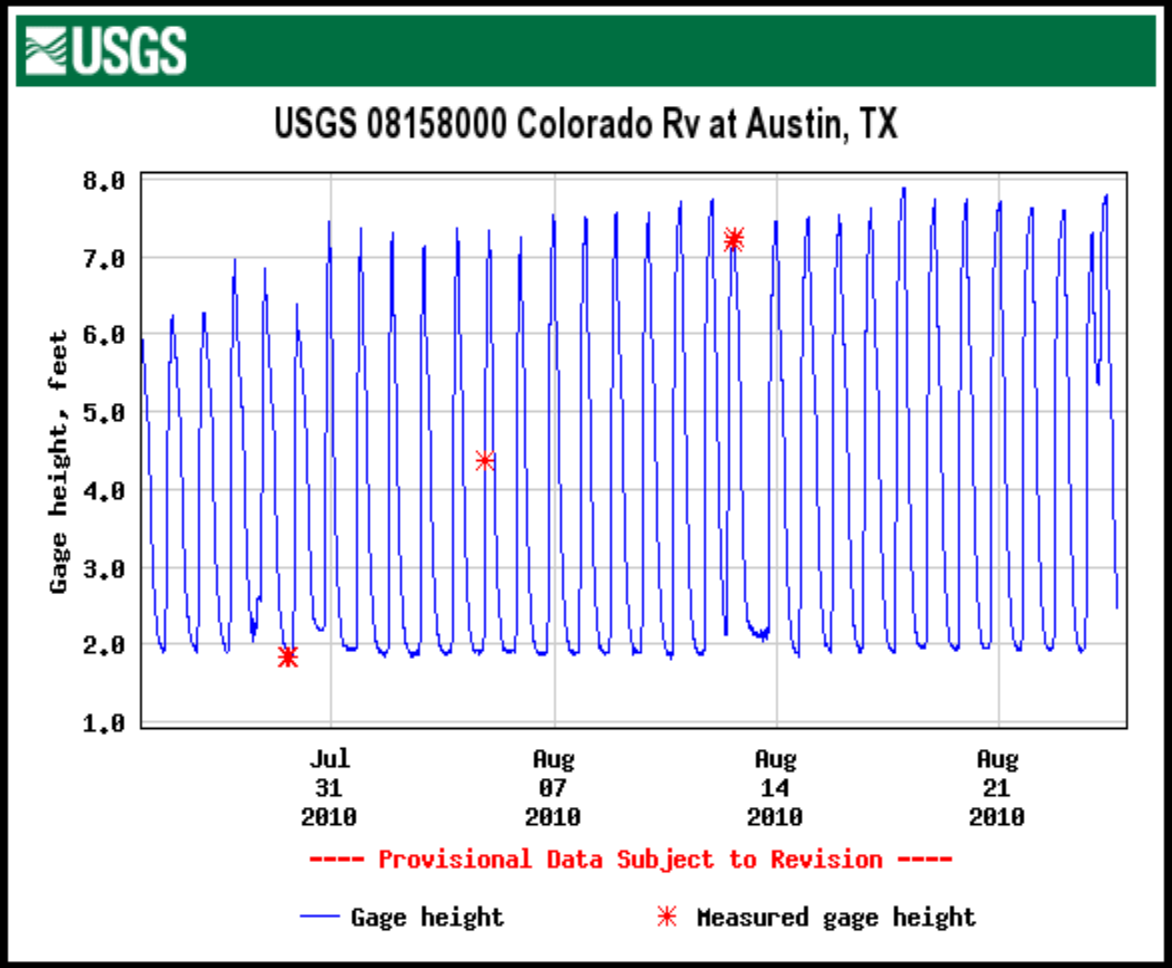
Surface Water-Groundwater Connectivity Under Dam Operations and Potential Trajectories Under Drought

M. Bayani Cardenas
+ Research Group
+ many collaborators

The STREAM is not a PIPE – Ken Bencala (USGS)

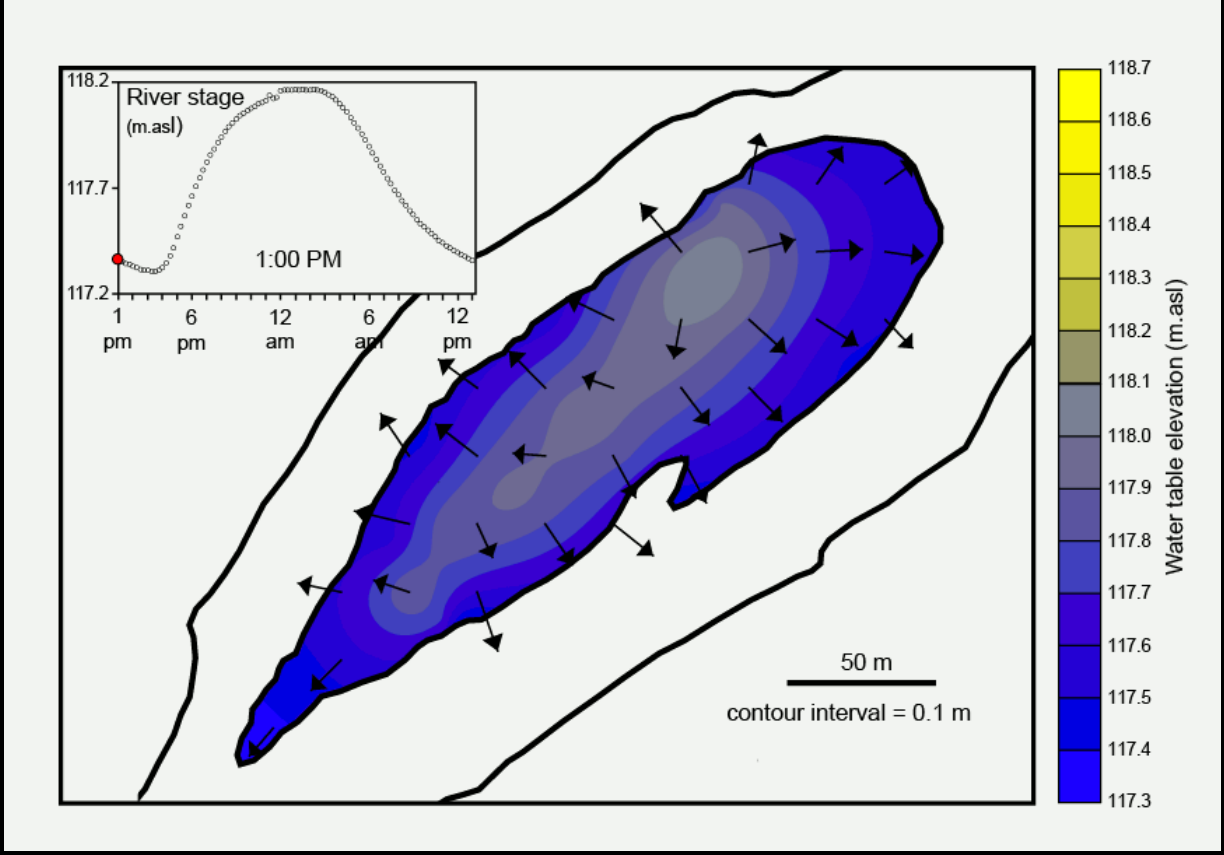


Hydropeaking

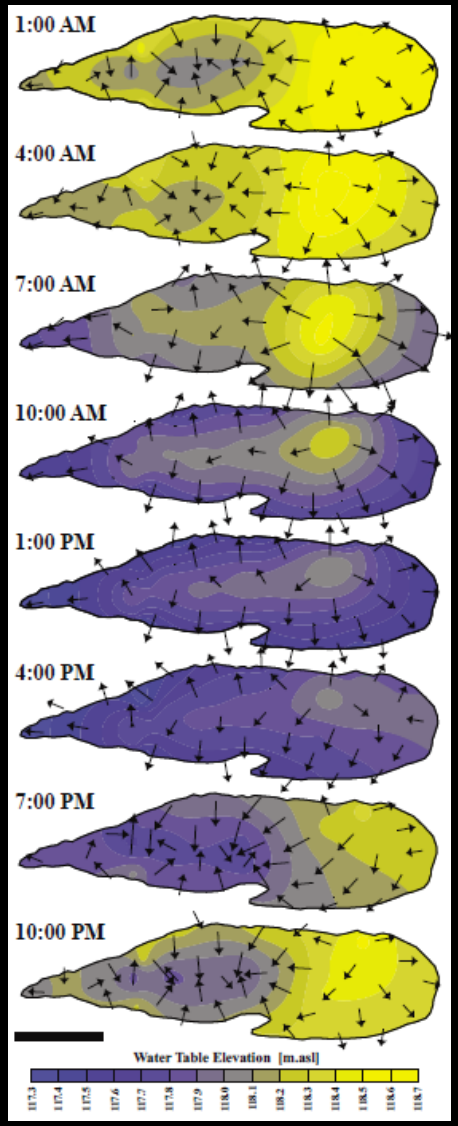


Study Site

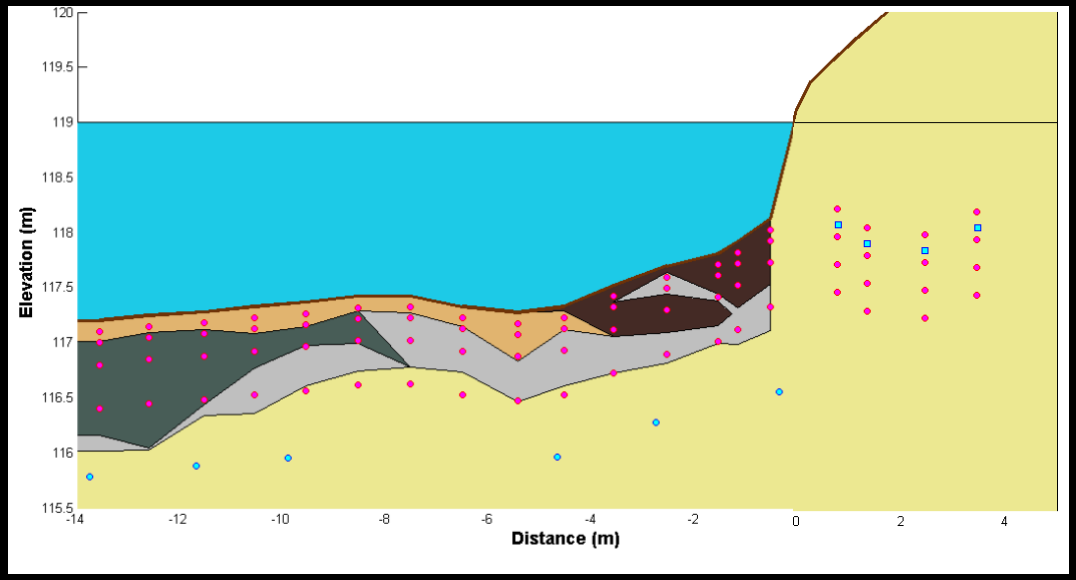
Flushing and filling of an island



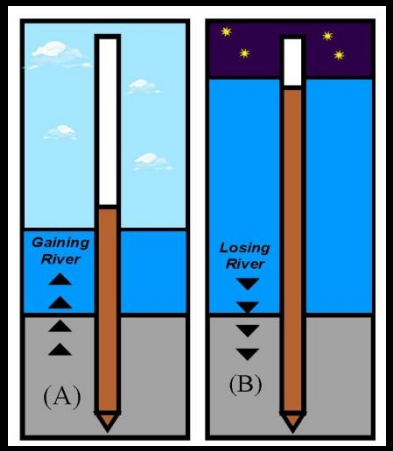
How much water went in and out?

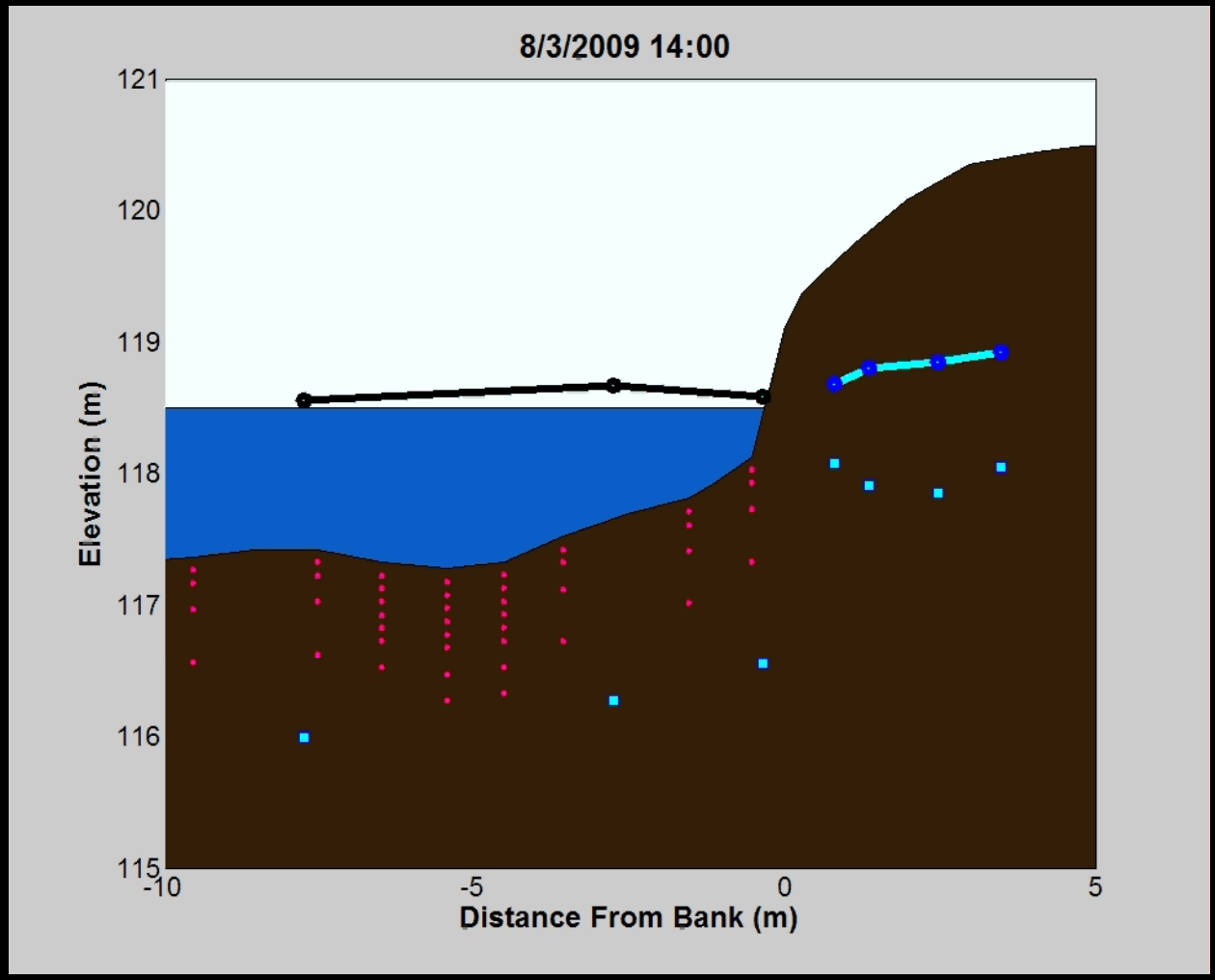


Bed-to-bank studies

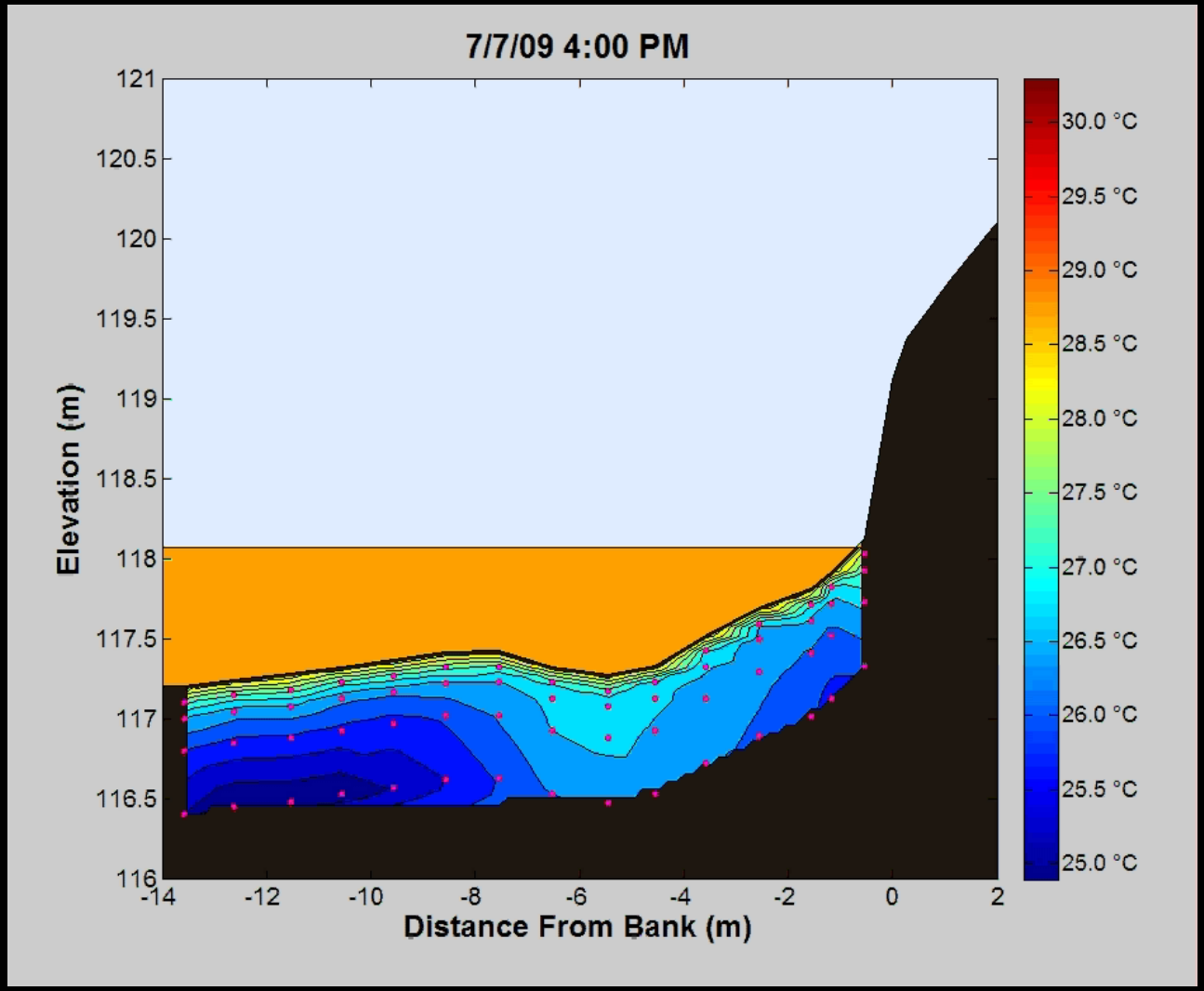


Water table and head fluctuations

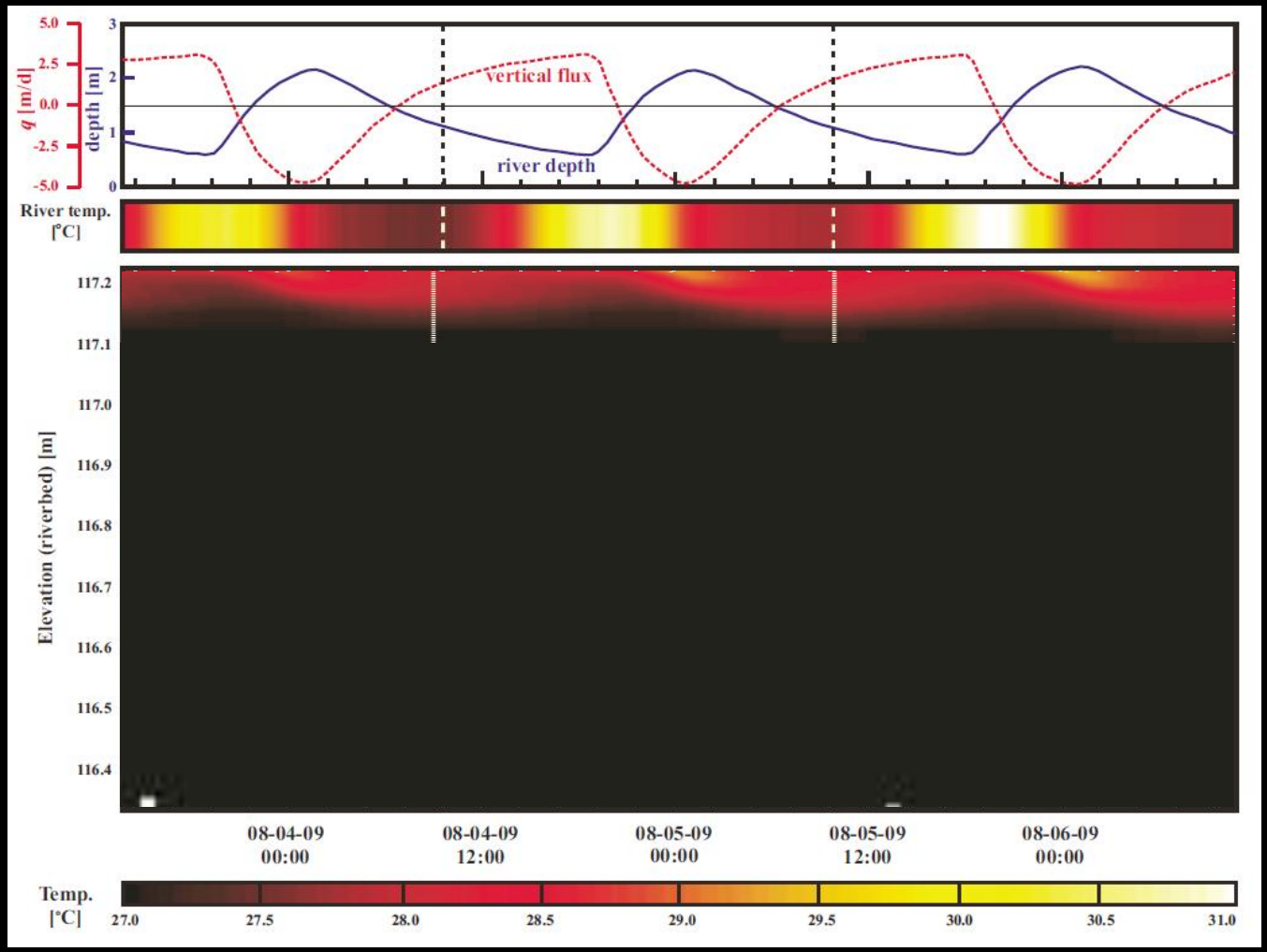




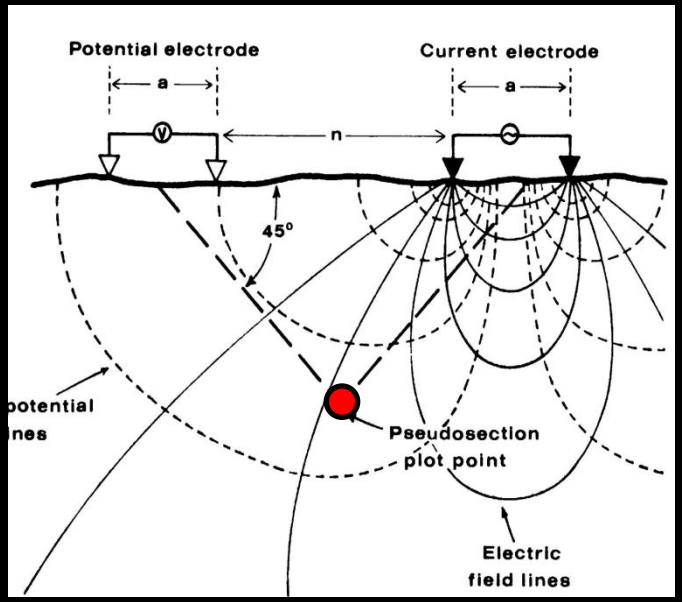
Dynamic thermal regime in the bed



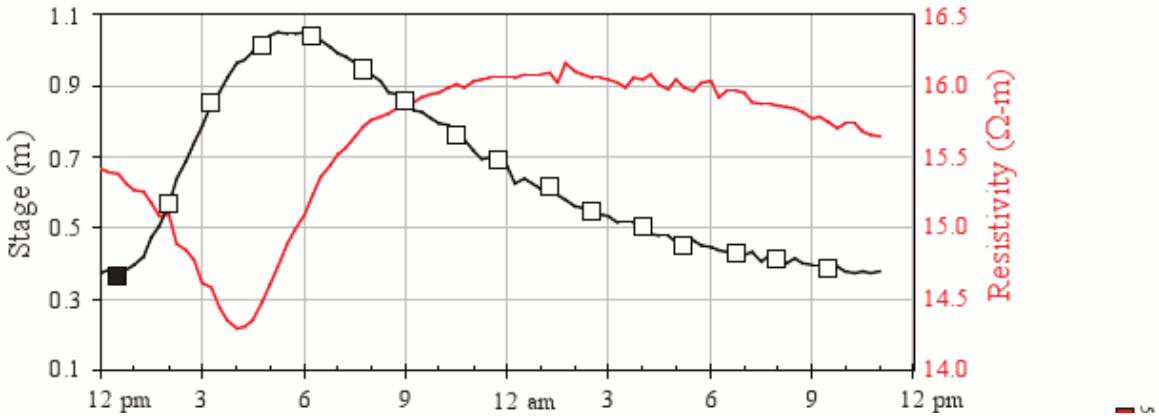
Dynamic thermal regime of riverbed sediment



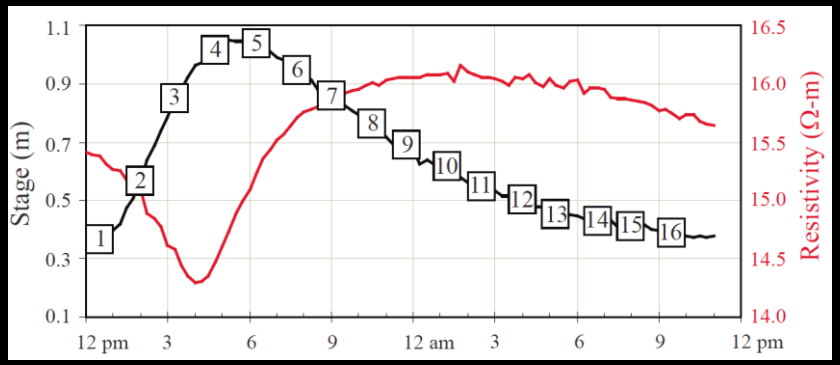
Electrical Resistivity Tomography



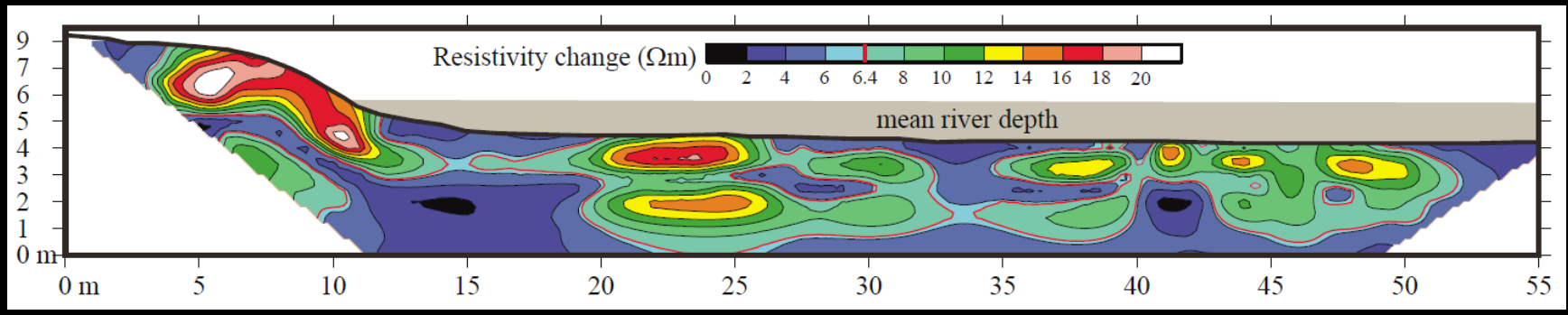
Mixing of groundwater and river water in the riverbed



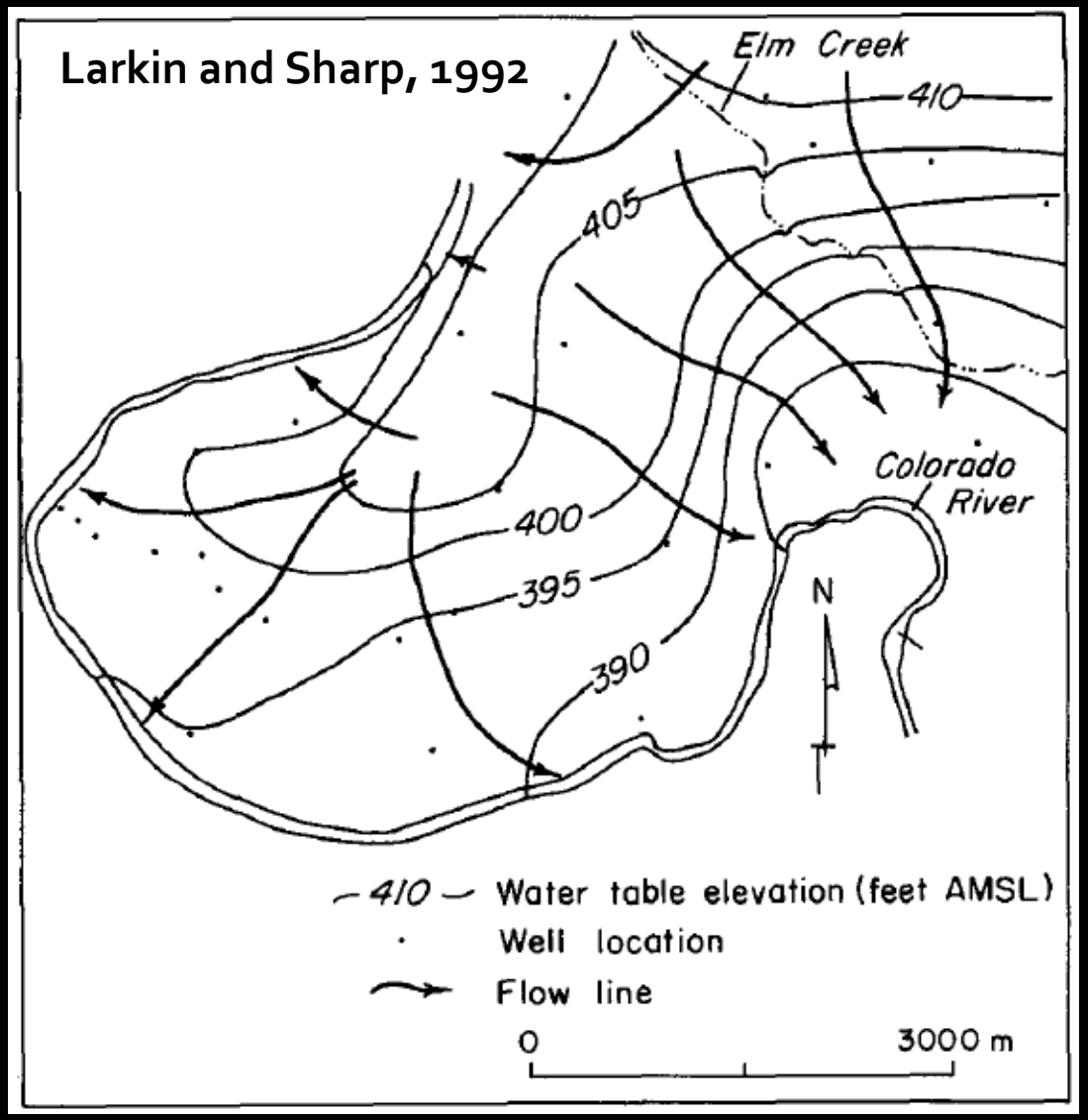
Delineation of Mixing Zones



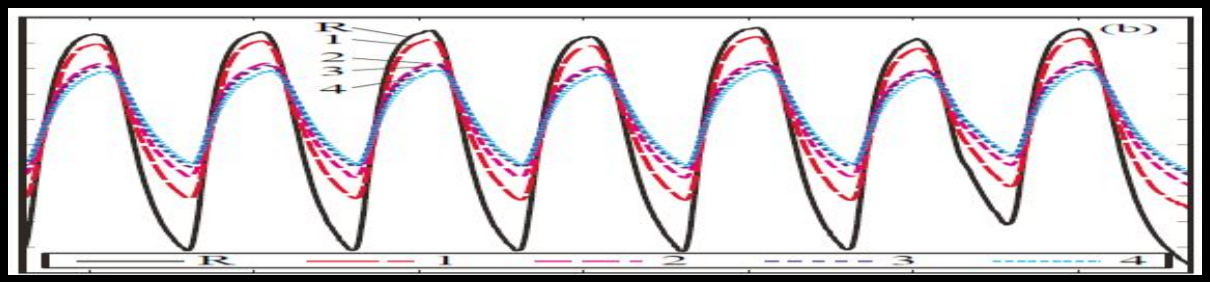
GW res=8.25 Ωm



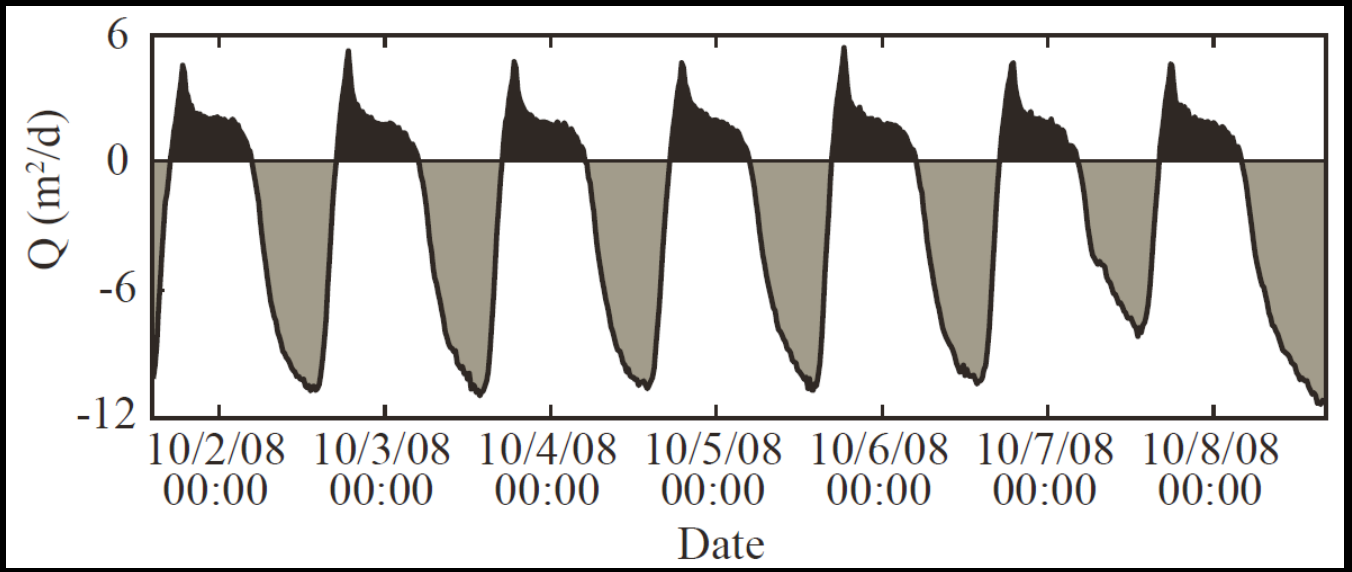
The LCR is naturally groundwater (base) flow fed



Exchanges fluxes between the river and aquifer across the bank



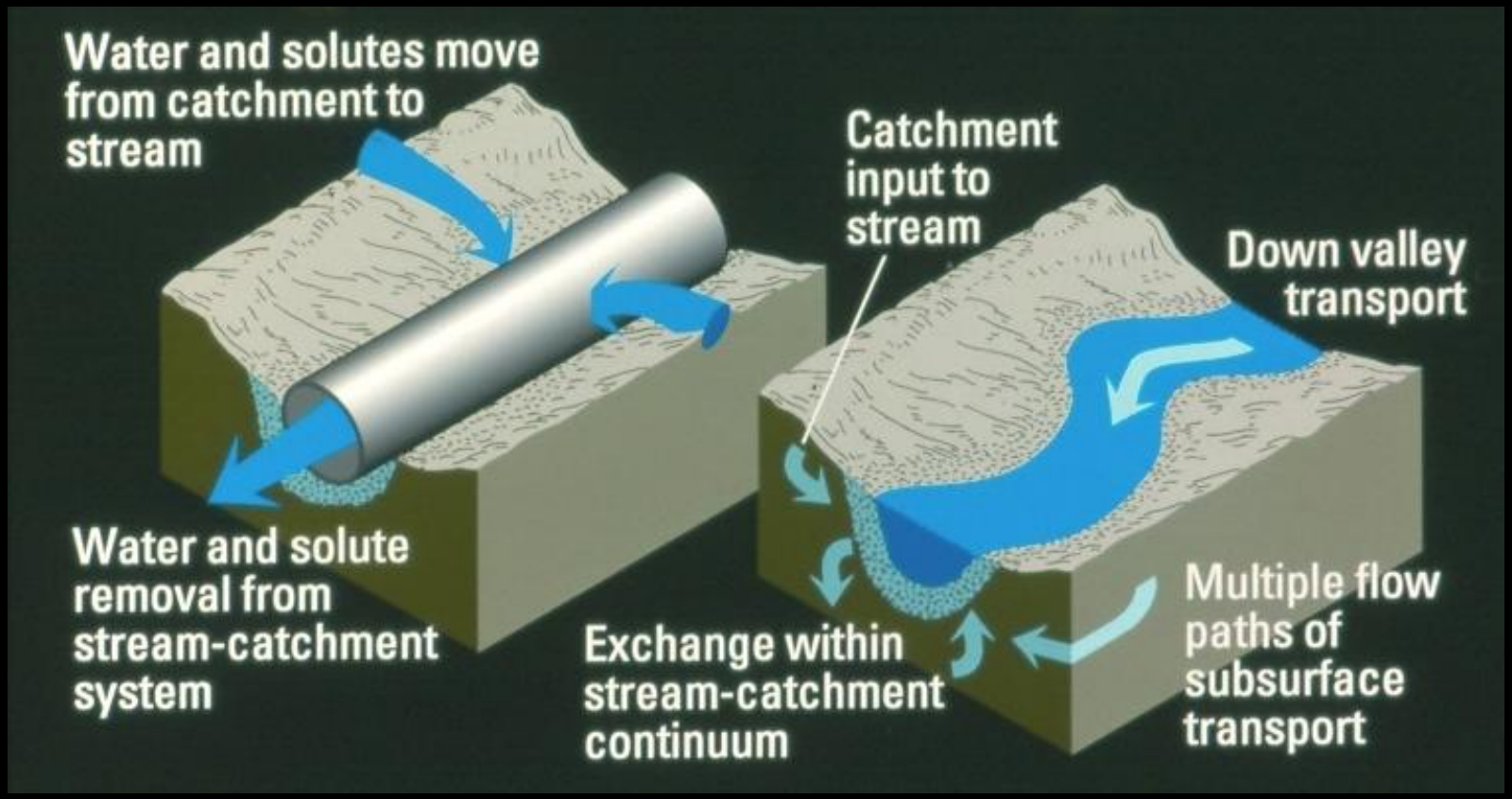
Water levels of river (black) and near-stream wells



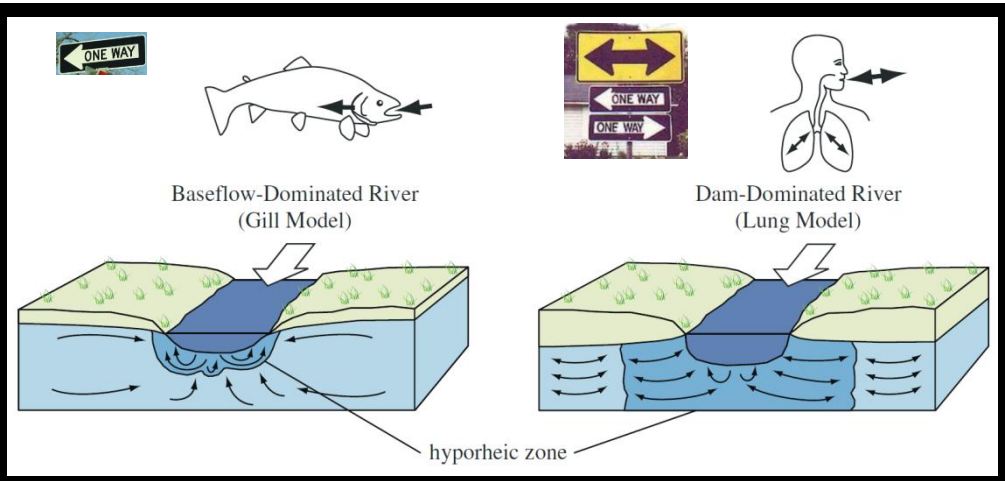
↑ Flow out of the river

↓ Flow into of the river

The STREAM is not a PIPE – Ken Bencala (USGS)



Revising the prevailing model

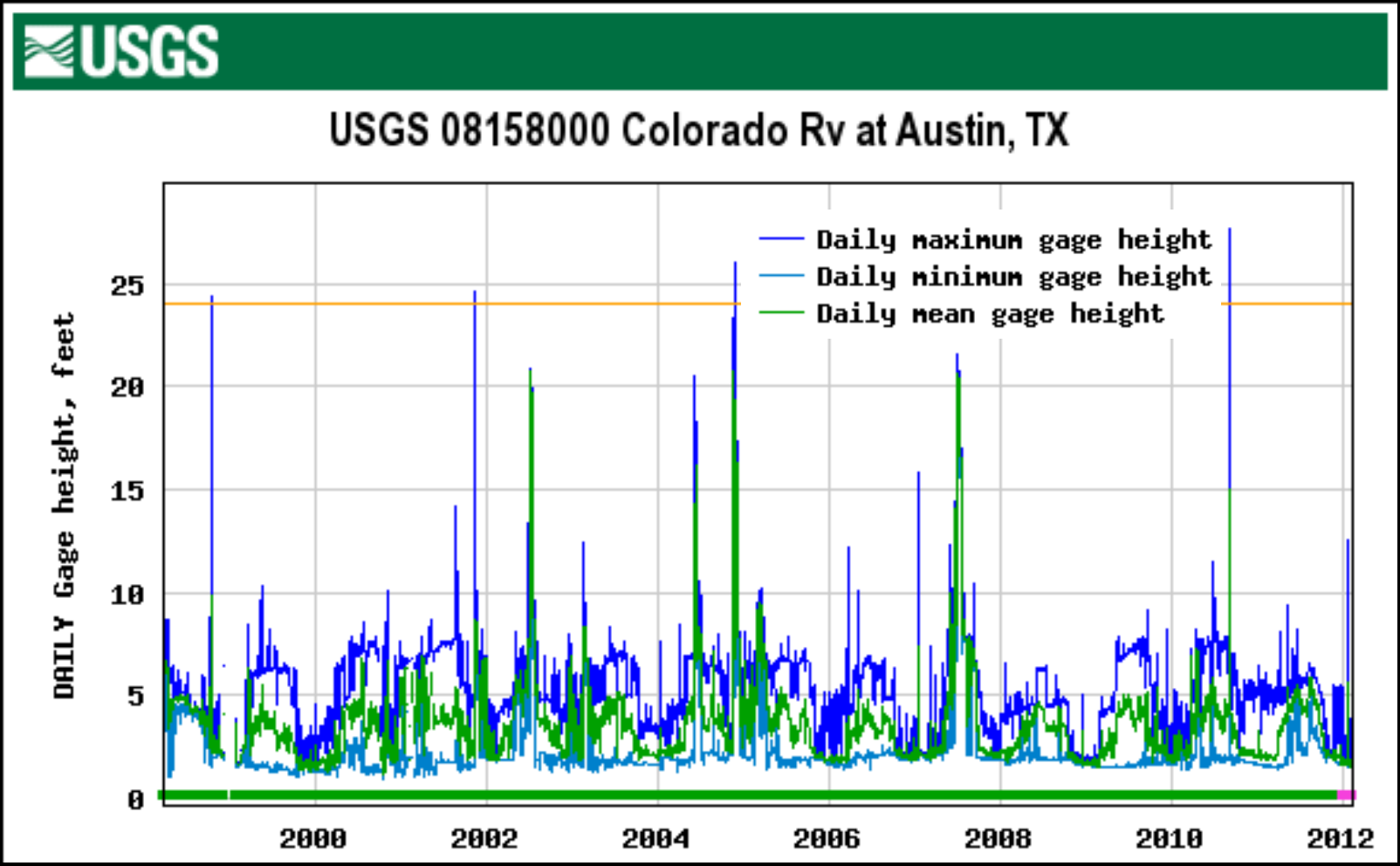


- Larger pressure gradients (up to 3 orders of magnitude larger)
- Shorter time-scales but larger length-scales
- Interfacial exchange is less patchy (no scattered upwelling/downwelling areas)

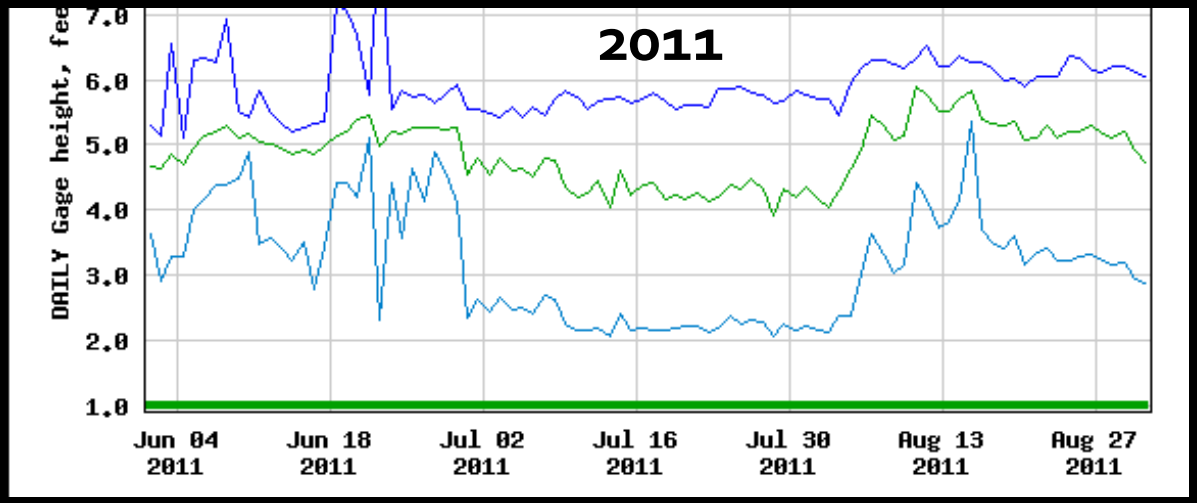
Potential Biogeochemical and Ecological Consequences

- Thermal perturbation of near-stream zones and buffering of the river
- Diurnal cycles are altered in the stream, riparian zone and hyporheic zone
- No well-established redox ladder in the near-stream zone
- Less contact time for non-equilibrium processes

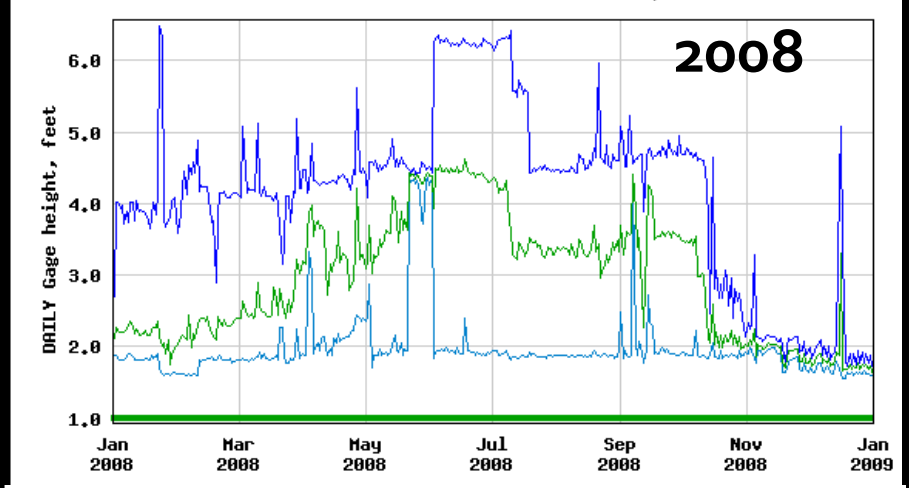
Long-term and seasonal variation in water releases

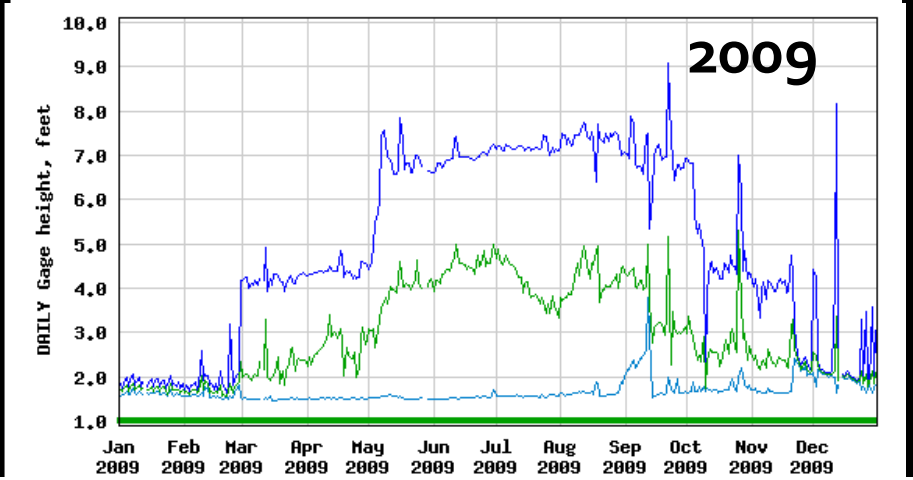


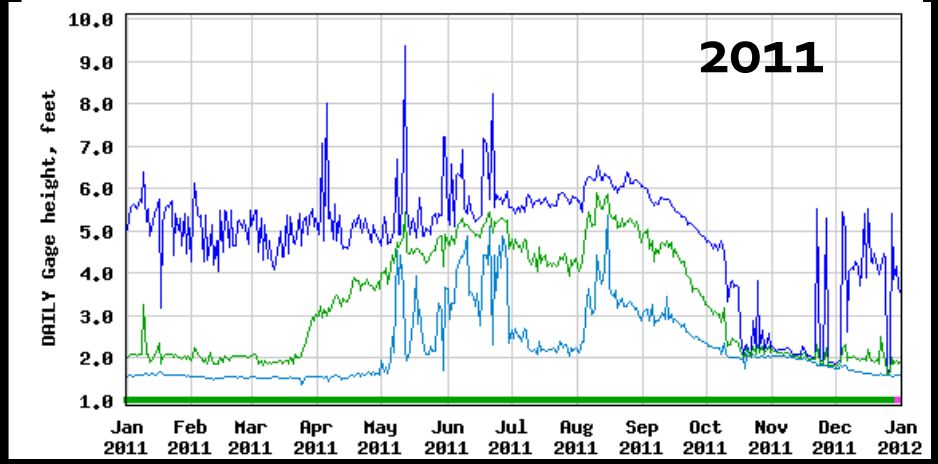
No change yet in release regimes with last year's drought

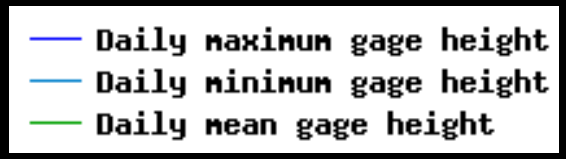


Daily maximum gage height
Daily minimum gage height
Daily mean gage height


2008
DAILY Gage height, feet
6.0
5.0
4.0
3.0
2.0
1.0
Jan 2008
Mar 2008
May 2008
Jul 2008
Sep 2008
Nov 2008
Jan 2009


2009
DAILY Gage height, feet
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Jan 2009
Feb 2009
Mar 2009
Apr 2009
May 2009
Jun 2009
Jul 2009
Aug 2009
Sep 2009
Oct 2009
Nov 2009
Dec 2009


2011
DAILY Gage height, feet
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
Jan 2011
Feb 2011
Mar 2011
Apr 2011
May 2011
Jun 2011
Jul 2011
Aug 2011
Sep 2011
Oct 2011
Nov 2011
Dec 2011
Jan 2012


Daily maximum gage height
Daily minimum gage height
Daily mean gage height

Under a drought regime, there will be adaptive management of water releases

Therefore, we need to think about the following processes or effects on them:

1) Downstream thermal regime: habitat quality, temperature dependent uses
2) Increase/ decreases in baseflow contribution to rivers, and changes in coupling of rivers and aquifers
3) Surface and subsurface flow regimes in riparian zones
4) Flow regimes in hyporheic zones
5) Intelligent and holistic methods in modeling and management of the river-aquifer continuum