

# Seeing the landscape for the trees: the development of simple metrics to inform riparian zone management



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# Introduction

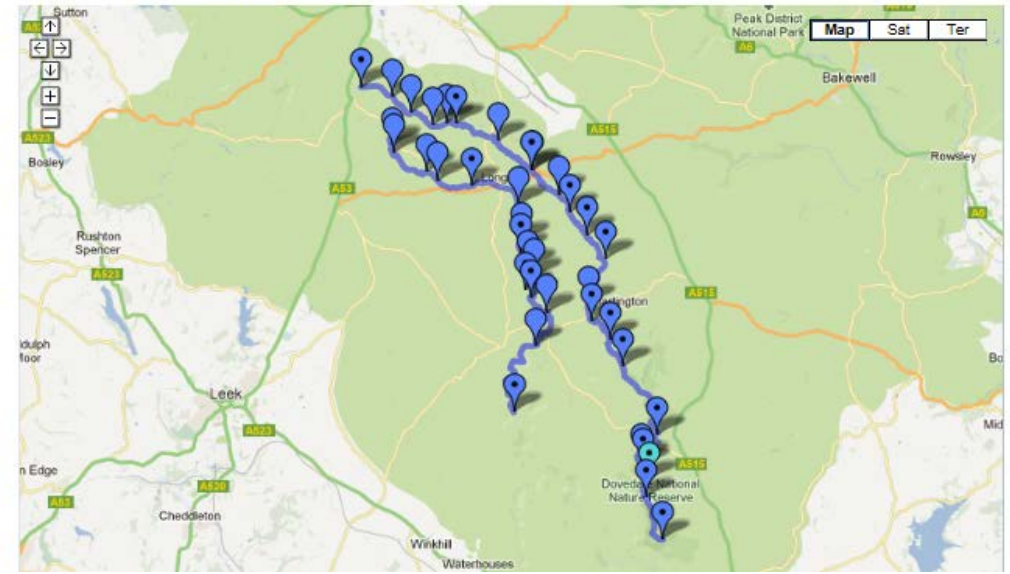
- Rising temperatures due to climate and environmental change will have major consequences for river biota.
- Riparian tree planting to shade rivers is a popular management strategy
- But, in many places planting is currently unfocused





## Loughborough University TEMperature Network

The Loughborough University TEMperature Network (LUTEN) provides detailed measurements of air and water temperature in the Rivers Dove and Manifold, Peak District, UK. The project aims to provide simple landscape metrics that can be used to determine the vulnerability of rivers or river reaches to temperature change and to inform monitoring protocols.

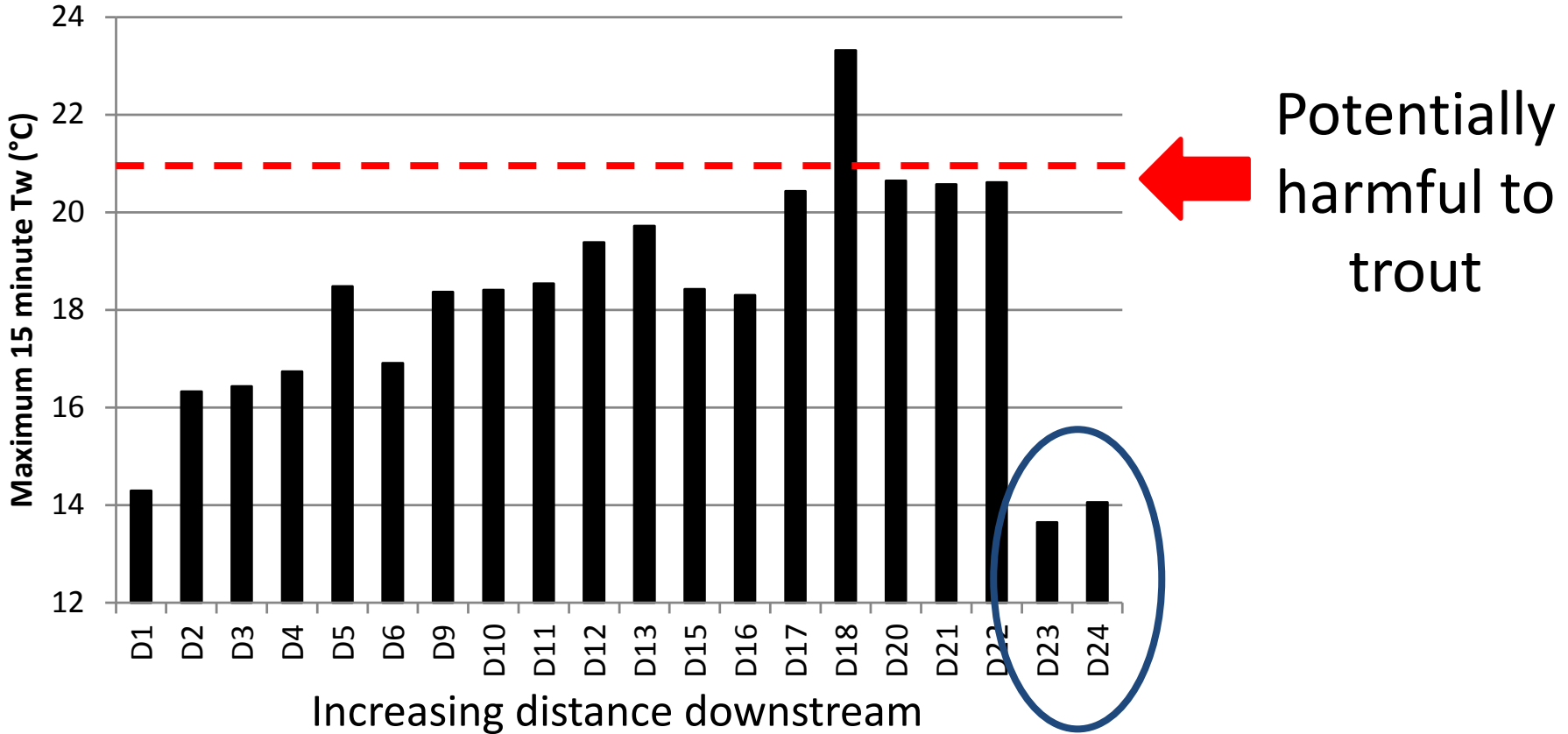


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# Thermal regime

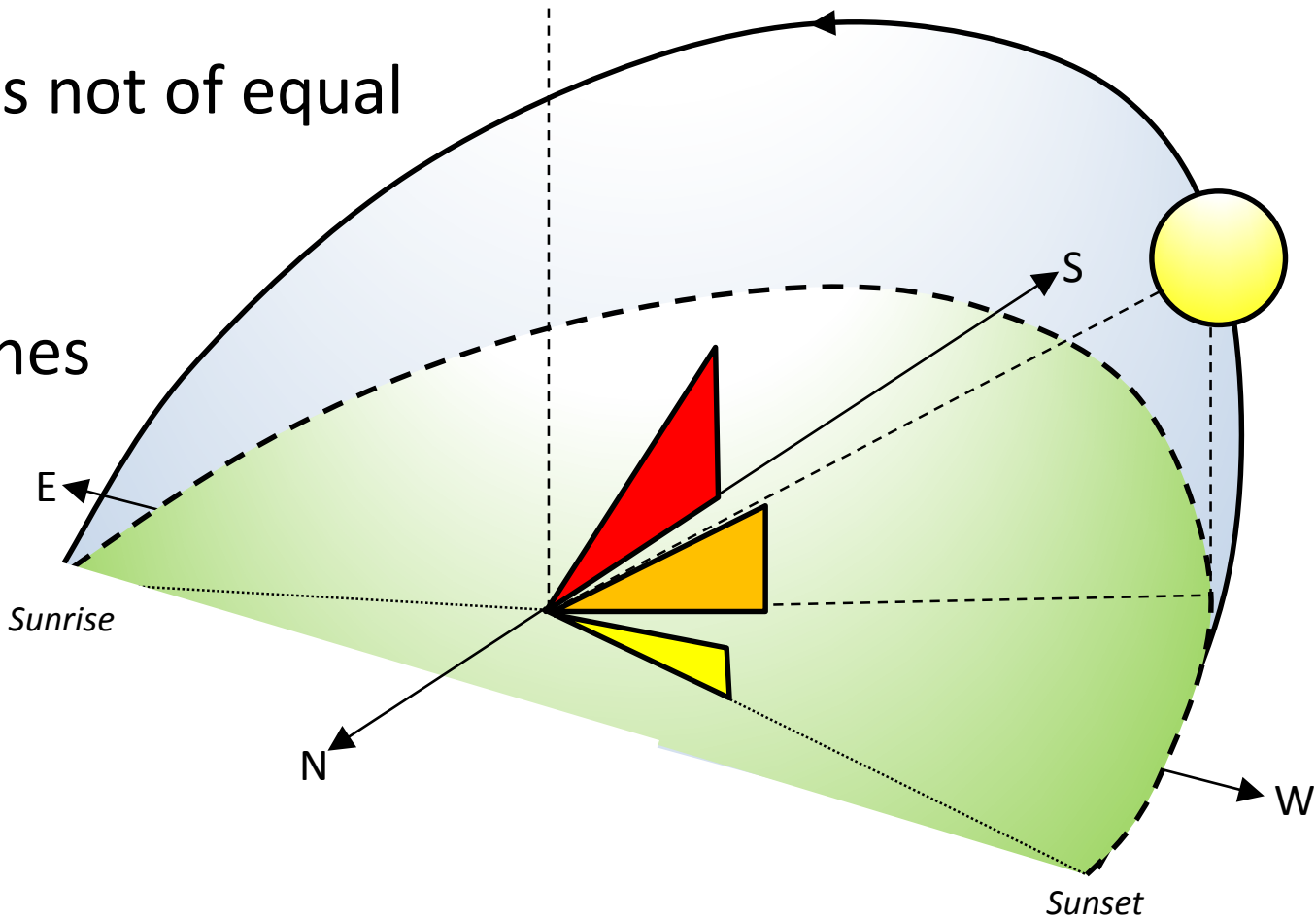
Water temperature is spatially patchy and temporally variable.



# Riparian shade

However, shade is not of equal magnitude

Not all river reaches will benefit from shade to the same degree.

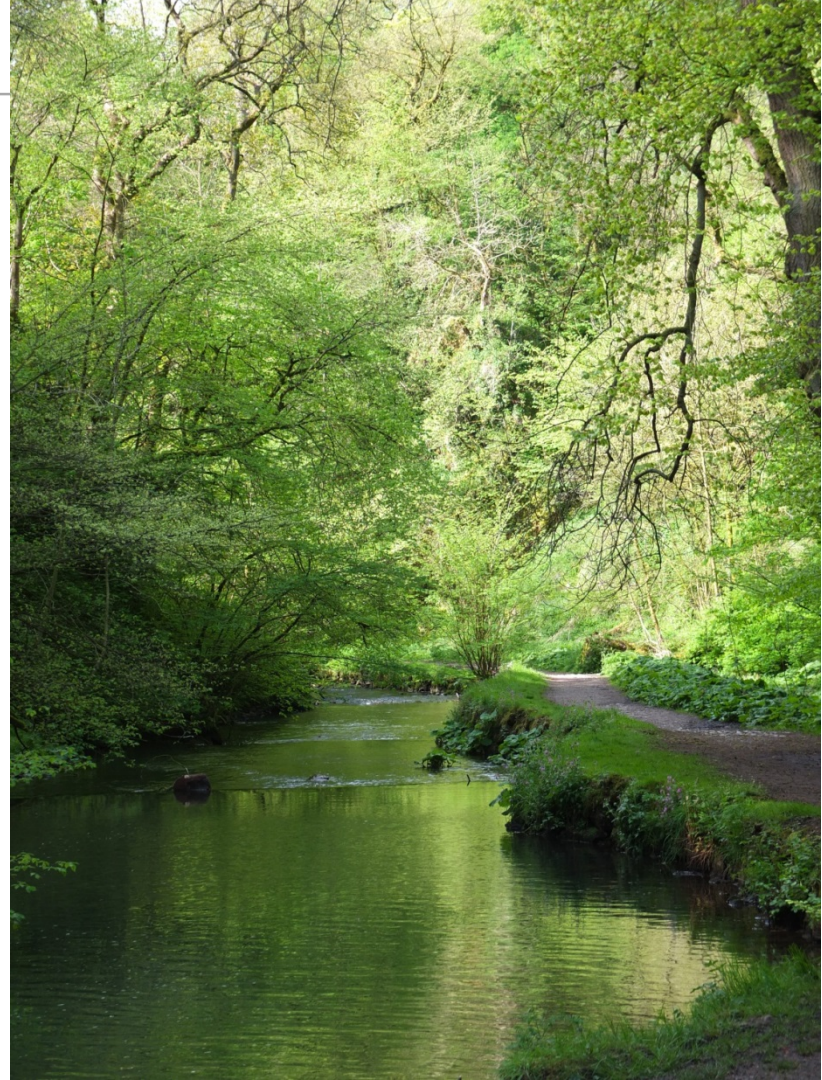


# Aims

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To provide simple metrics to inform where riparian shading will have maximum benefit in mitigating against rising water temperature

Using existing and routinely-collected data.

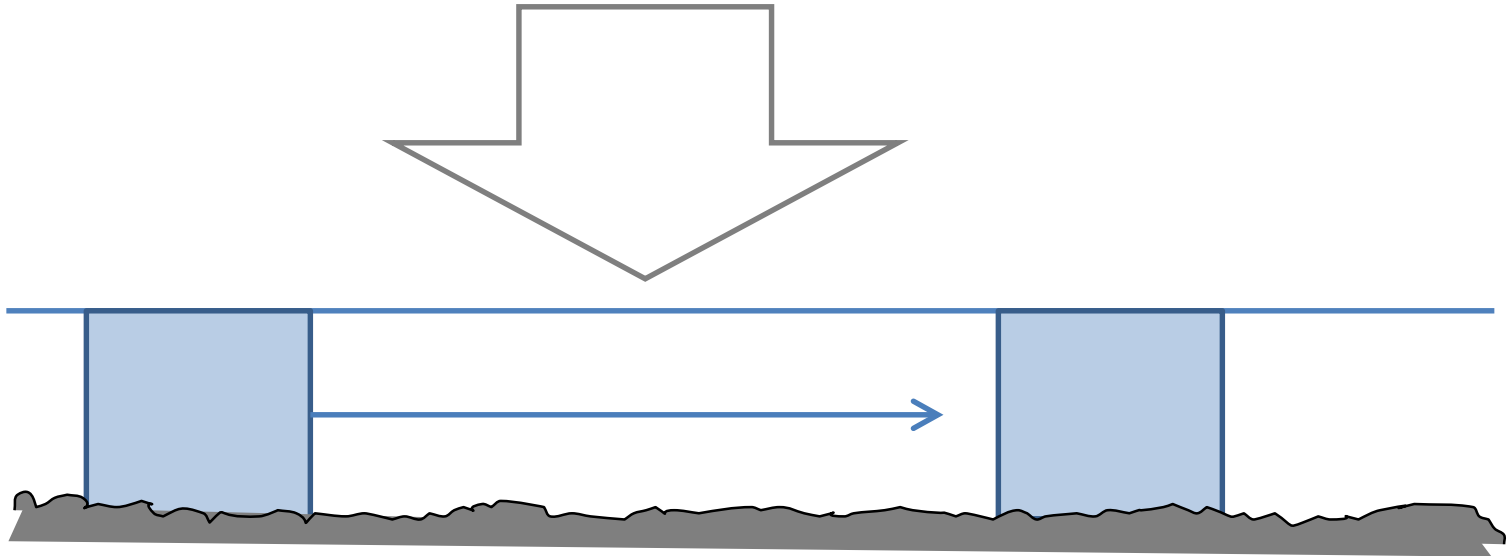


# Heat capacity and shade length

4181 J required to heat 1 kg of water by 1 °C

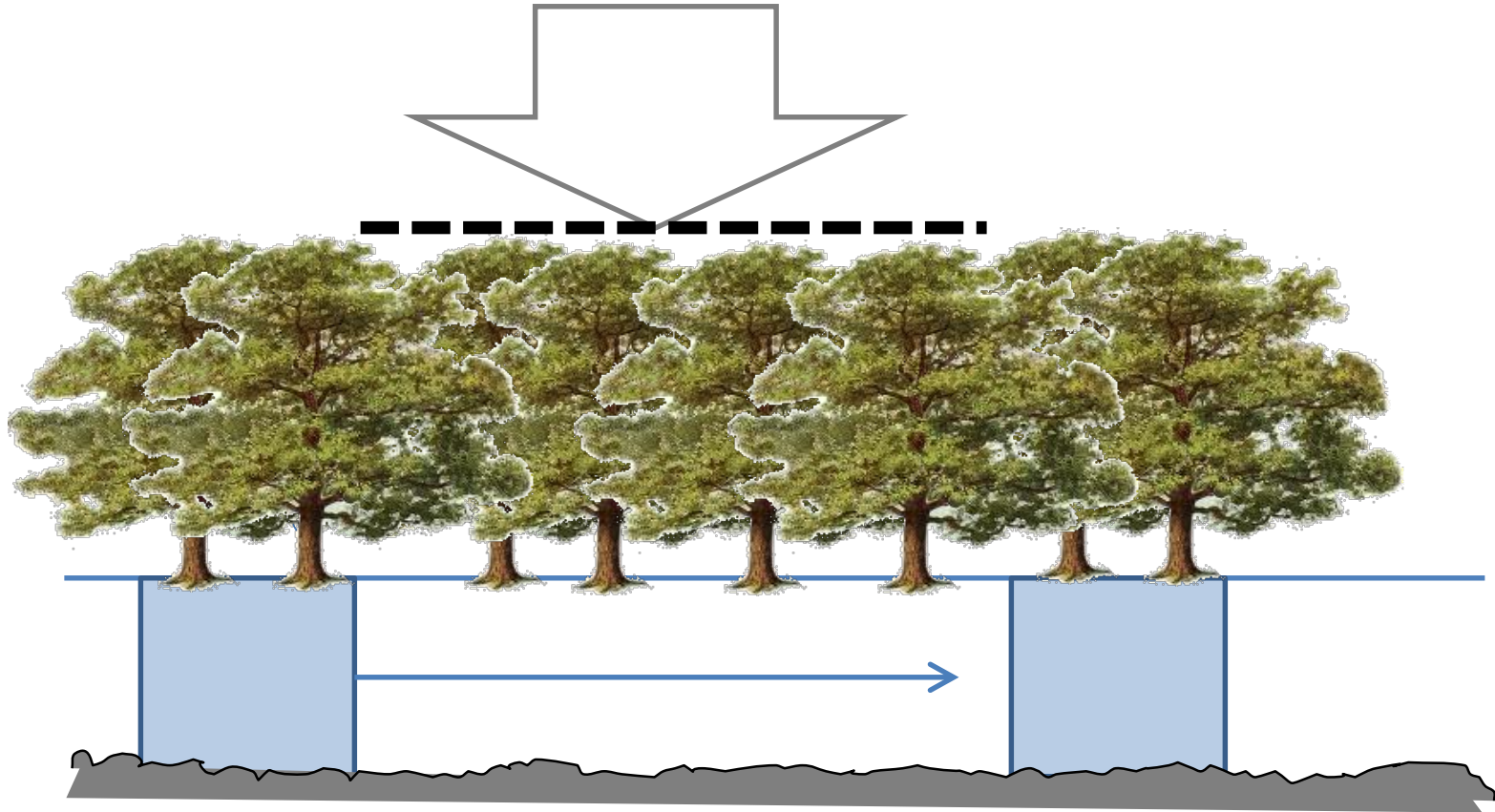
Know volume (and therefore weight) of water at a gauge

Predict how long it takes to attain sufficient solar energy to reach heat capacity



# Heat capacity and shade length

Which is the length of continuous shade required



# Shade requirement

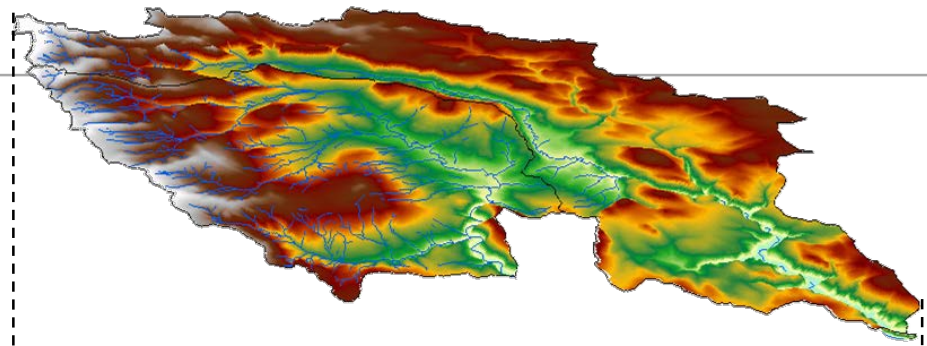
A river that is 6 m wide, 0.4 m deep and velocity is  $0.5 \text{ m s}^{-1}$  requires 1 km of continuous shade

- at midday on hottest day
- At  $52^\circ\text{N}$  latitude

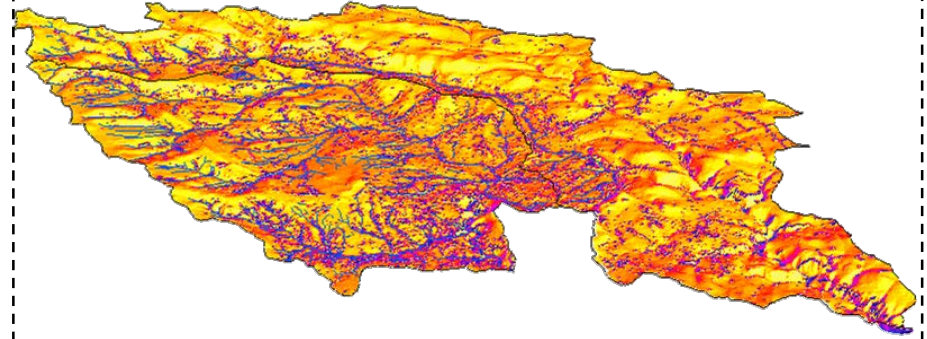
		Velocity (m/s)									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Depth (m)	0.1	48	96	144	192	240	288	336	384	432	480
	0.2	102	204	306	408	510	612	714	816	918	1020
	0.3	150	300	450	600	750	900	1050	1200	1350	1500
	0.4	192	384	576	768	960	1152	1344	1536	1728	1920
	0.5	240	480	720	960	1200	1440	1680	1920	2160	2400
	0.6	300	600	900	1200	1500	1800	2100	2400	2700	3000
	0.7	360	720	1080	1440	1800	2160	2520	2880	3240	3600
	0.8	390	780	1170	1560	1950	2340	2730	3120	3510	3900
	0.9	450	900	1350	1800	2250	2700	3150	3600	4050	4500
	1	498	996	1494	1992	2490	2988	3486	3984	4482	4980

# Sensitivity to shade

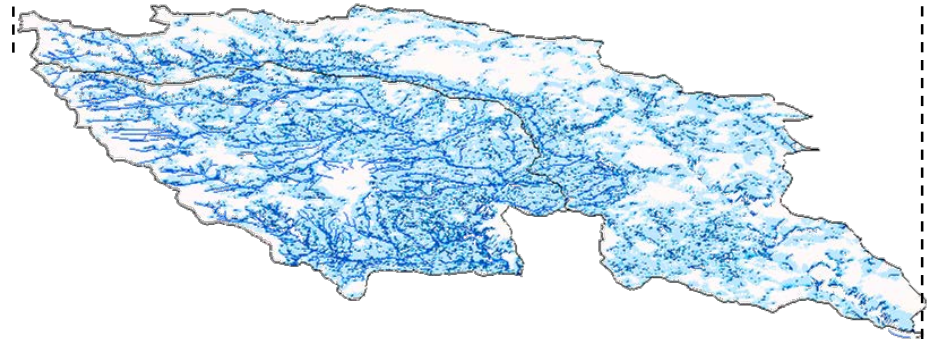
Landscape



Where shade is lacking

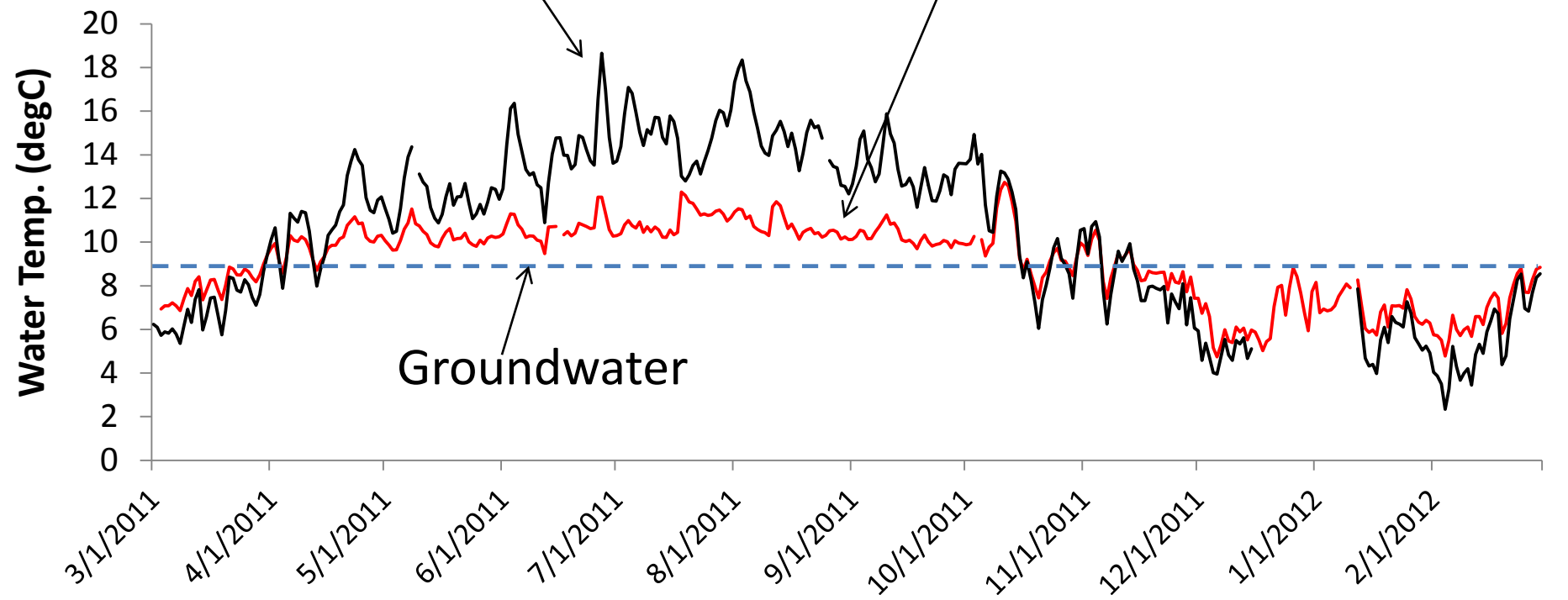


Where is sensitive to riparian shade



# Groundwater Inputs

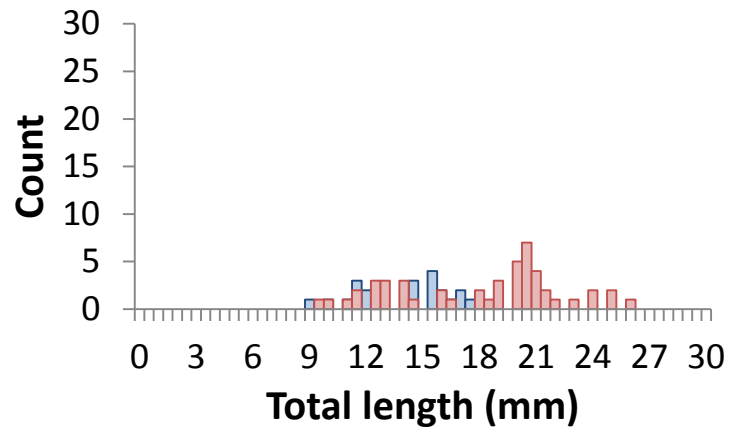
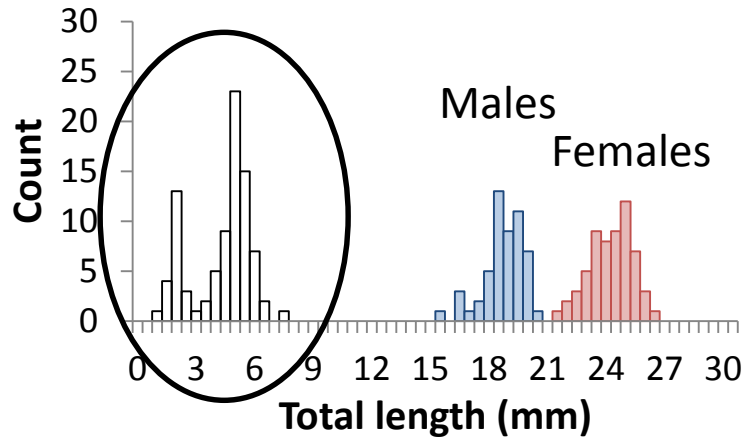
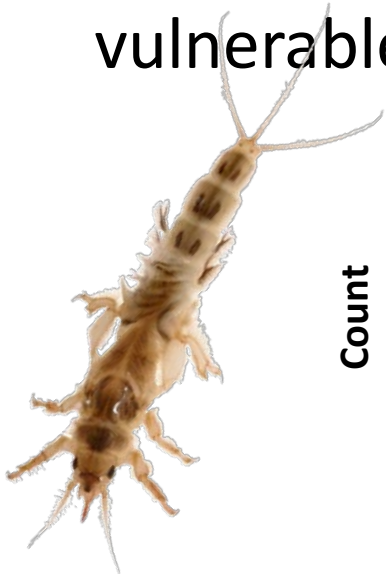
Surface water dominated      Groundwater dominated



# Groundwater refuge

Dovedale is an important thermal refuge

- Robust Mayfly phenology maintained in this reach
- Substantial changes upstream to a more vulnerable structure



# Conclusions

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Sensitivity to shading will vary greatly between and along rivers

Riparian planting is likely to be successful on:

- Relatively limited regions of catchments
- But impacts will be propagated downstream
- And there are numerous mutual benefits!

Important to identify and maintain existing thermal refuge, particularly those associated with cool groundwater inputs.

- Protect such areas from other adverse pressures.



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