University of St Andrews

HISTORIES OF LOCAL VERSUS REGIONAL HYDROLOGY AS RECORDED BY TREE RING ISOTOPES AND DENDROCHRONOLOGY

HOLLY MCKELVEY[1], MICHAEL BLISS SINGER[1,2], HERVÉ PIÉGAY[3], JÉRÉMIE RIQUIÉR[3], ROBERT WILSON[1]

[1] Department of Geography and Geosciences, University of St Andrews, Scotland
[2] University of California Santa Barbara, California
[3] University of Lyon, UMR 5600 – CNRS, Site ENS-LSH, ISIG Platforme, France

OUTLINE

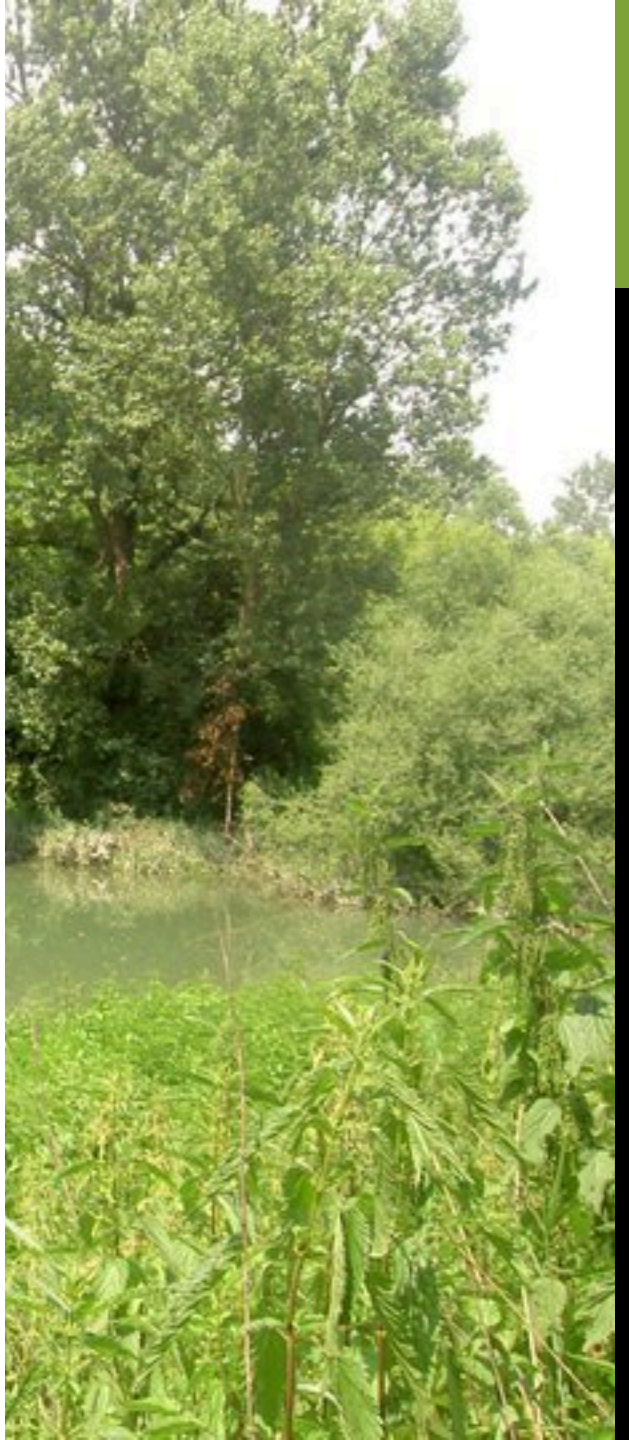
In this presentation I will discuss:

- **Research Question**
- **Study area**
- **Project overview: methods & aims**
- **Results and Interpretation**
- **Future Work**

RESEARCH QUESTION

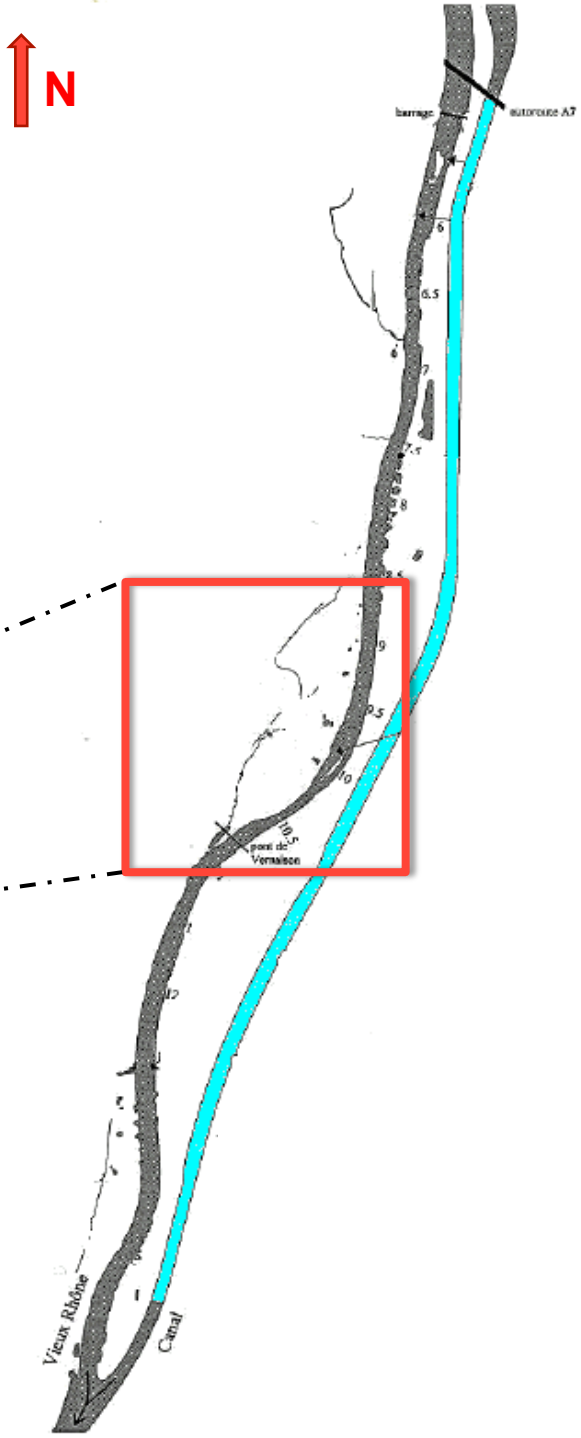
1. Is the isotopic signature of various water sources reflected in tree rings?

2. If so, can isotopic signatures in trees rings be used to determine water sourcing?



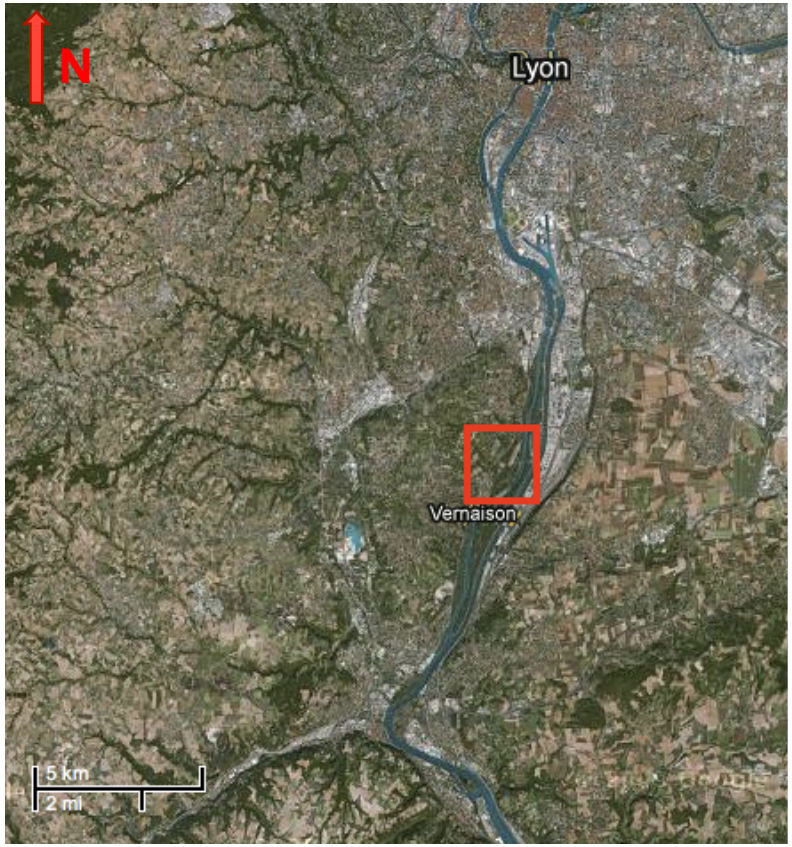
STUDY AREA

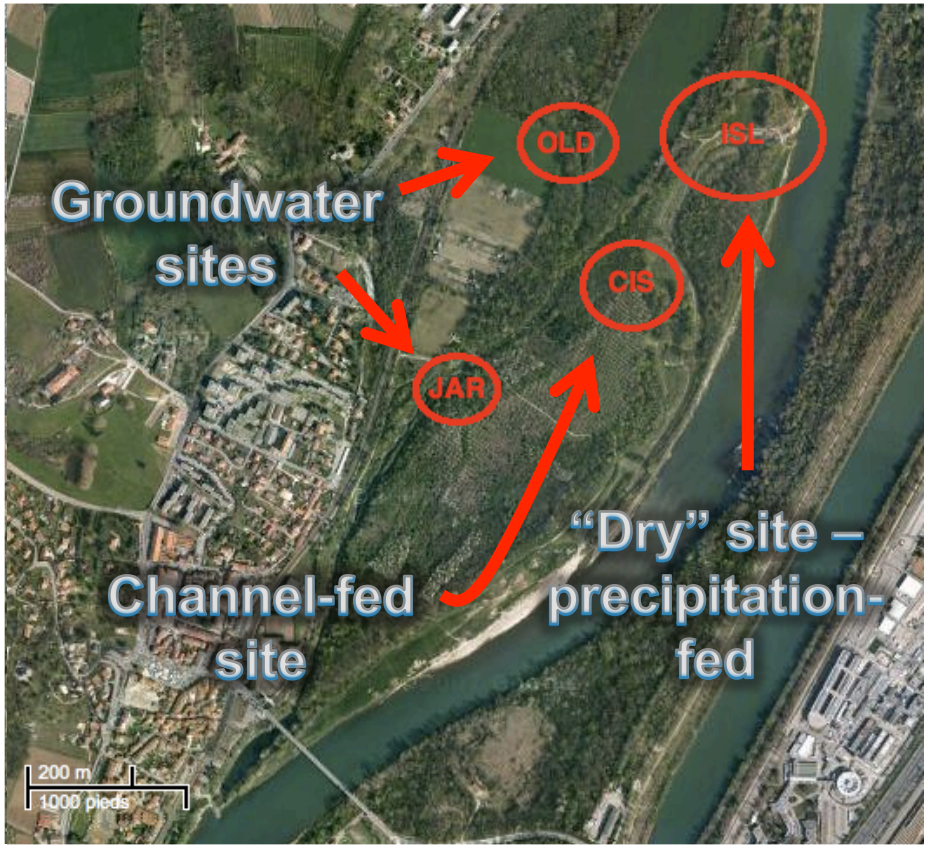

Lyon
Vernaison
5 km
2 mi


N
barrage
autoroute A7
pont de Vernaison
Vieux Rhône
Canal

STUDY AREA

Study area south of Lyon in Vernaison (left); four sampling sites (right)





PROJECT OVERVIEW

Methods

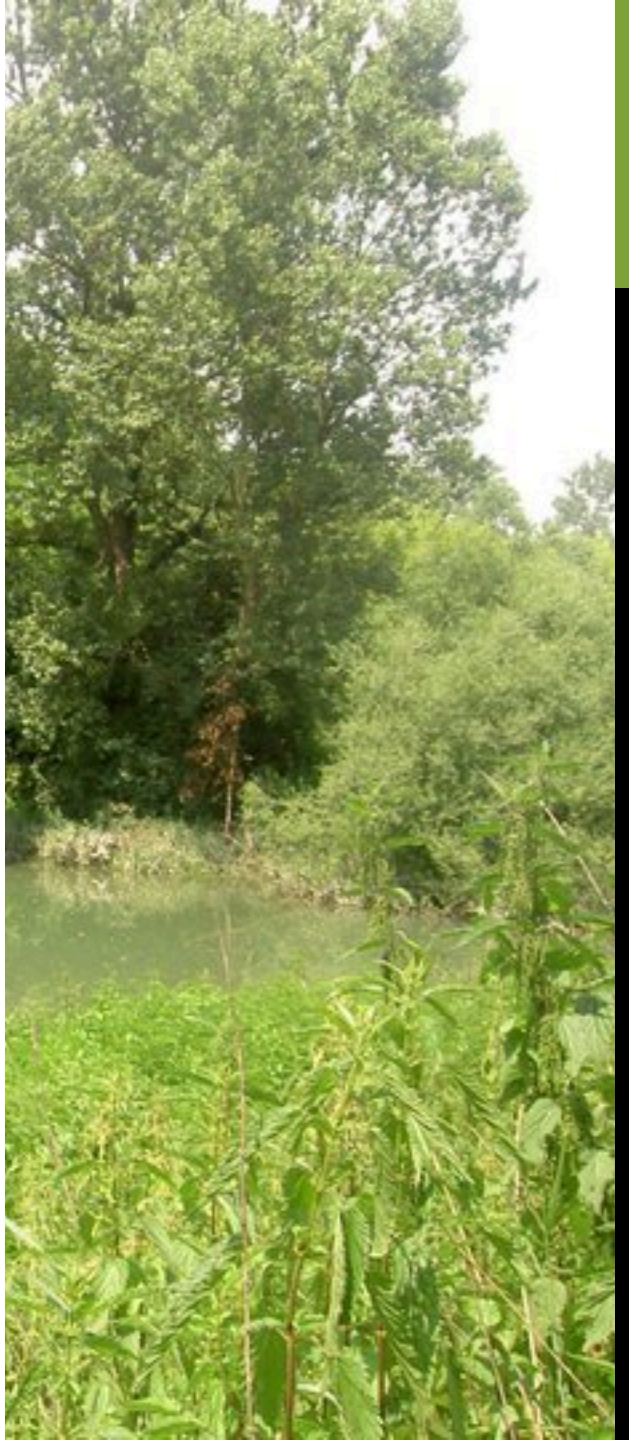
Field work

- 10 ash and 10 poplar randomly sampled at each site
- Depth to gravel layer measured at each tree
- River, channel and spring water samples taken

Lab work

- Dendrochronology: ring width measured for all samples
- Isotopic analysis: cellulose extracted using Brendel method and analysed on mass spec for $\delta^{18}O$ ratio.
  - 1 ash and 1 poplar at each site measured at each even year from 1992-2010
  - 2 ash and 2 poplar at each site measured at 1994, 1998, 2002 and 2006

Piezometer data from 1995-2002 from the Compagnie Nationale du Rhône (CNR) used for groundwater depth



PROJECT OVERVIEW

Tree Species

Black poplar

Populus nigra

- Obligate phreatophyte:
- Roots deeply (>2.5 m)
- Able to penetrate gravel layers

Common ash

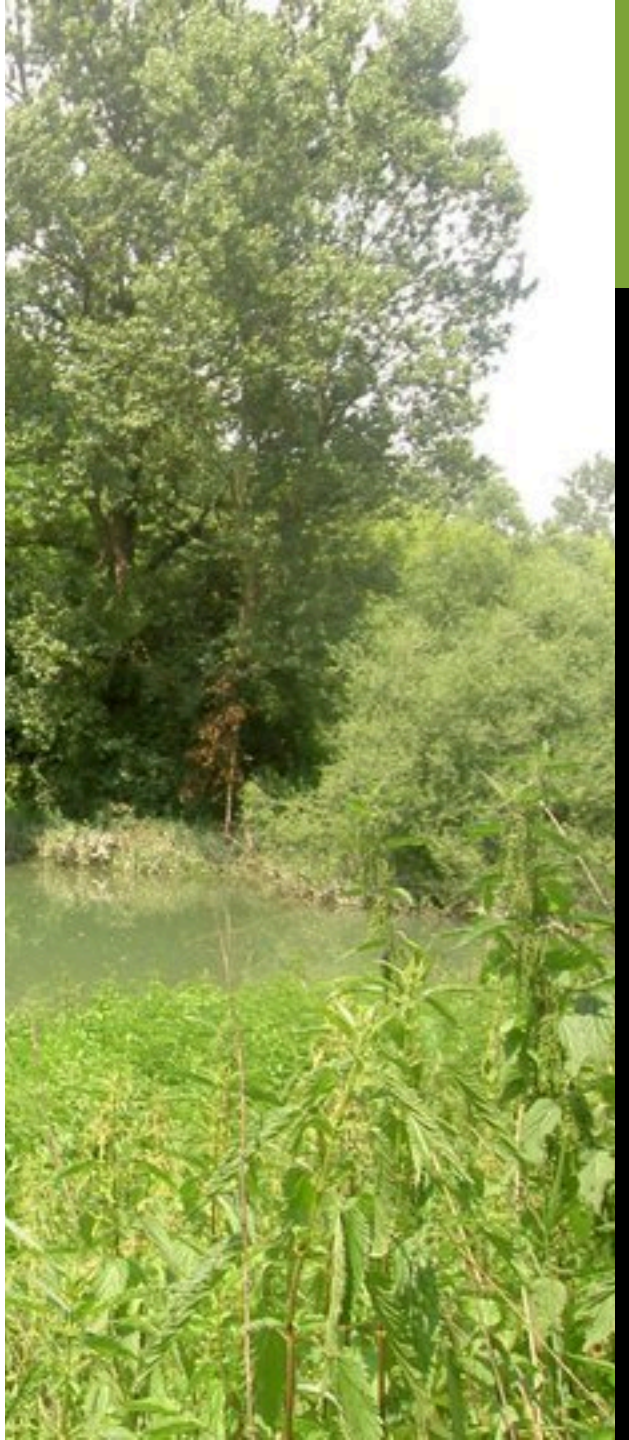
Fraxinus excelsior

- Non-obligate phreatophyte
- Roots to about 2.5 m depth
- Unable to penetrate gravel layers

PROJECT OVERVIEW

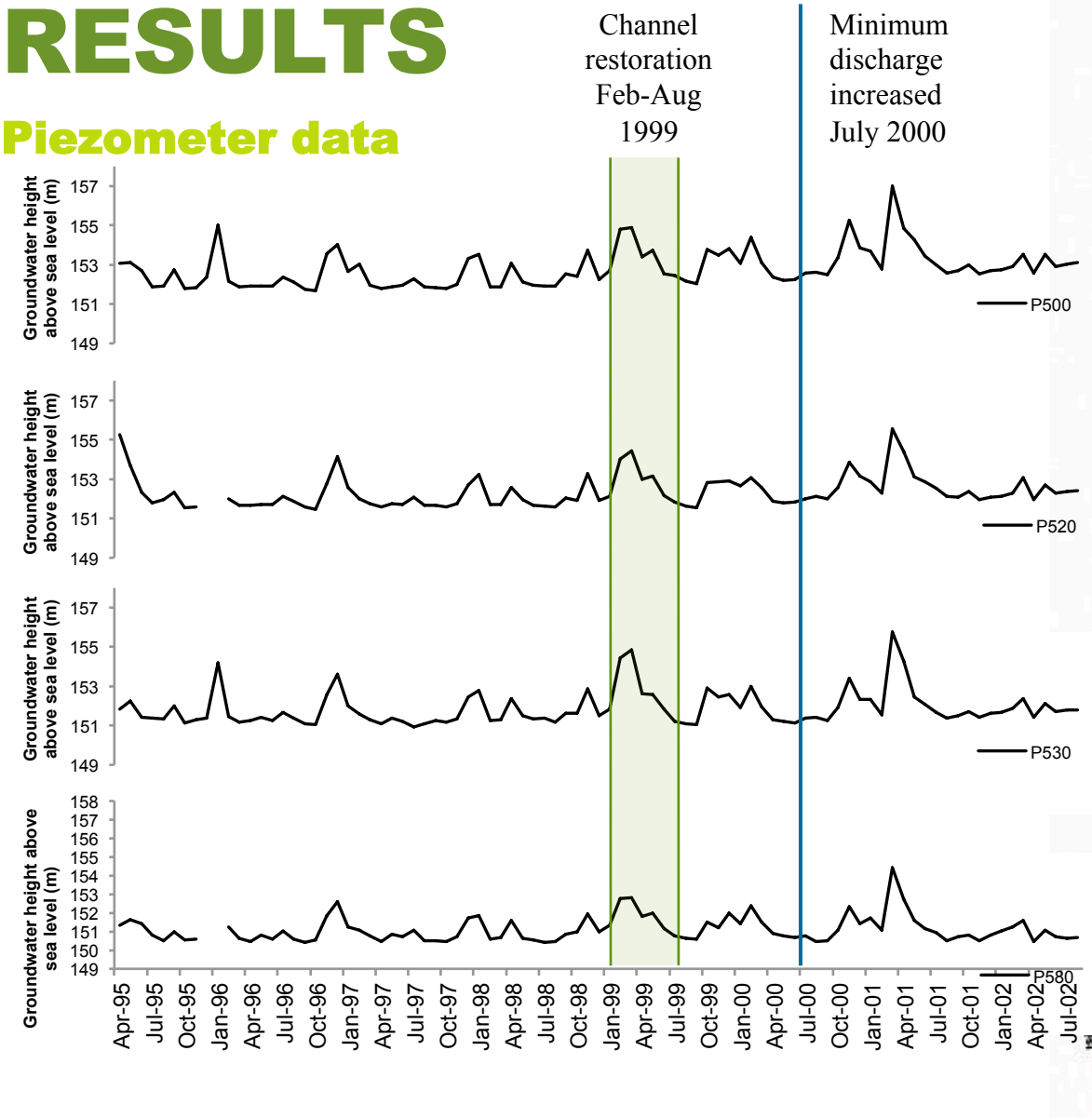
Aims

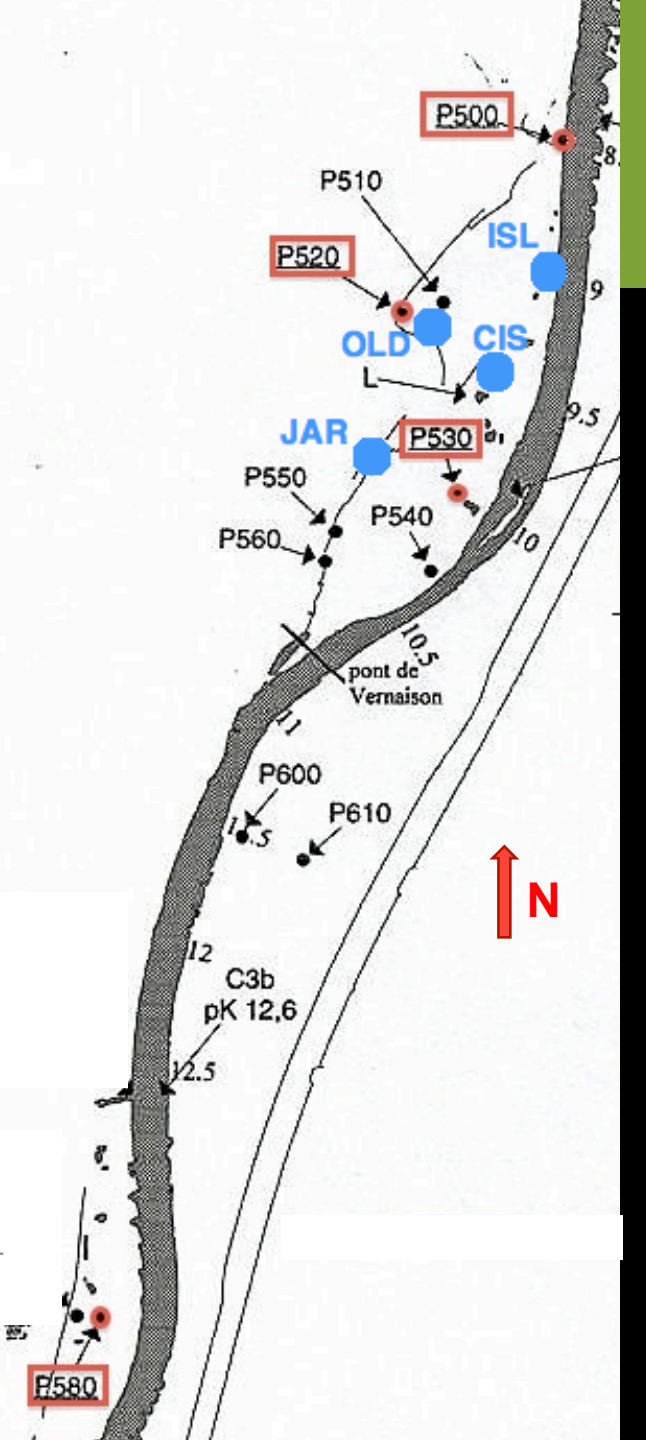
- Observe whether the rise in groundwater post-restoration was reflected in the isotopic signatures of ash and poplar
- Compare the two species' isotopic signatures to determine whether ash was consistently less able than poplar to access groundwater
- Determine whether the restoration affected ash's ability to access water.



RESULTS

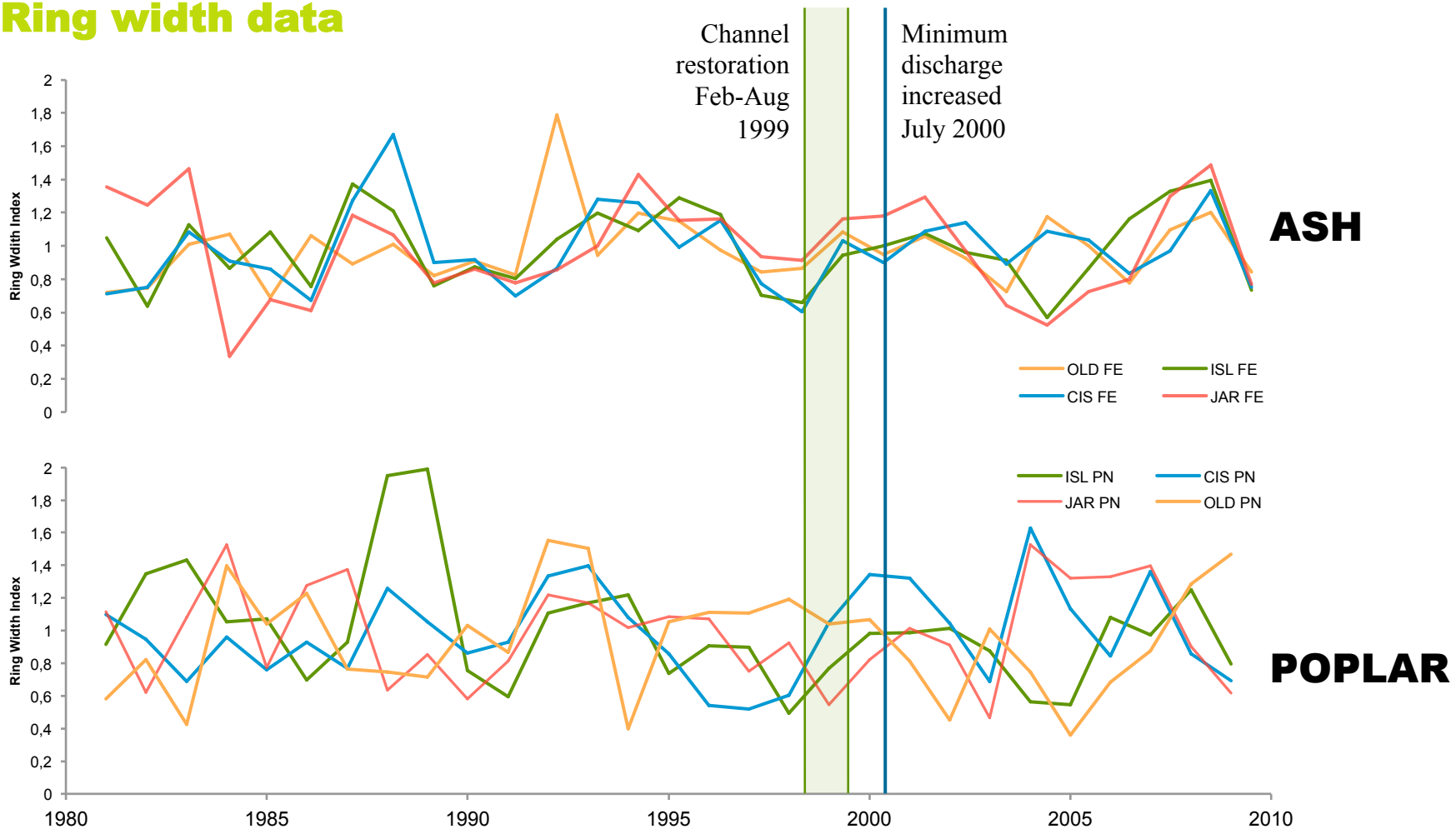
Piezometer data





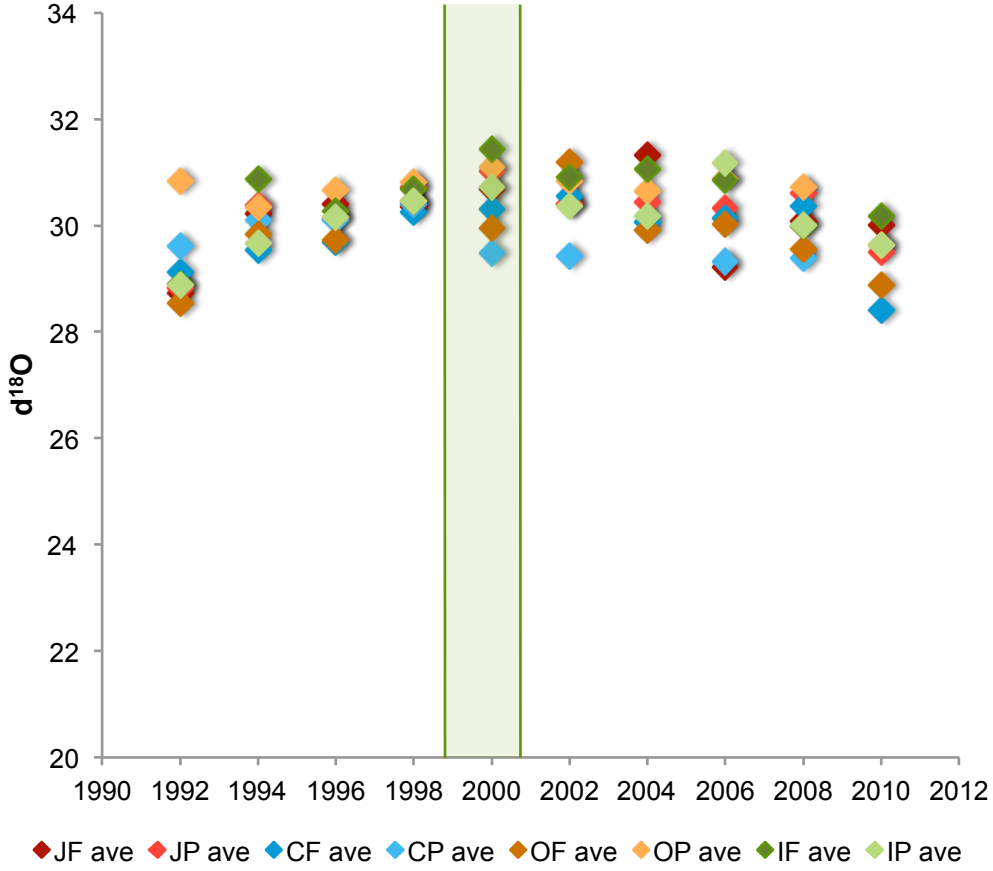
RESULTS

Ring width data

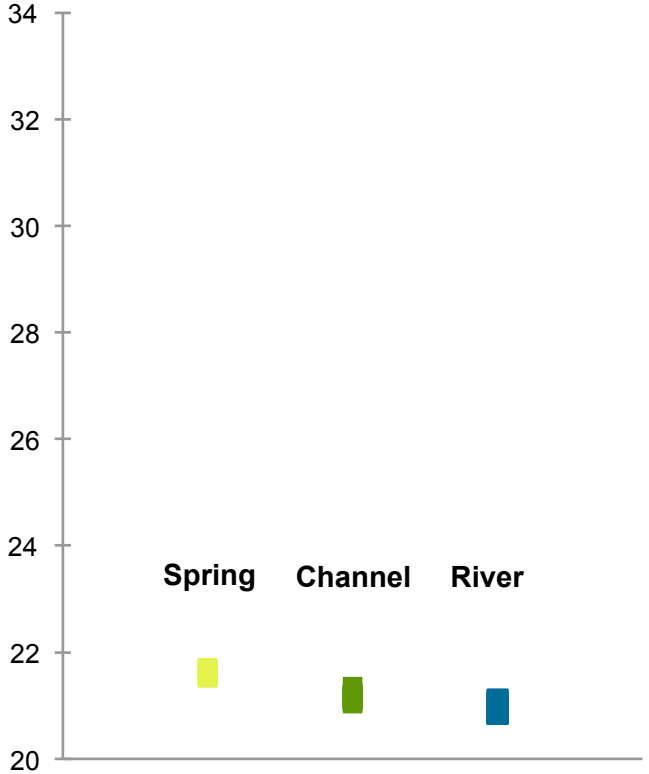


RESULTS

Tree isotopes

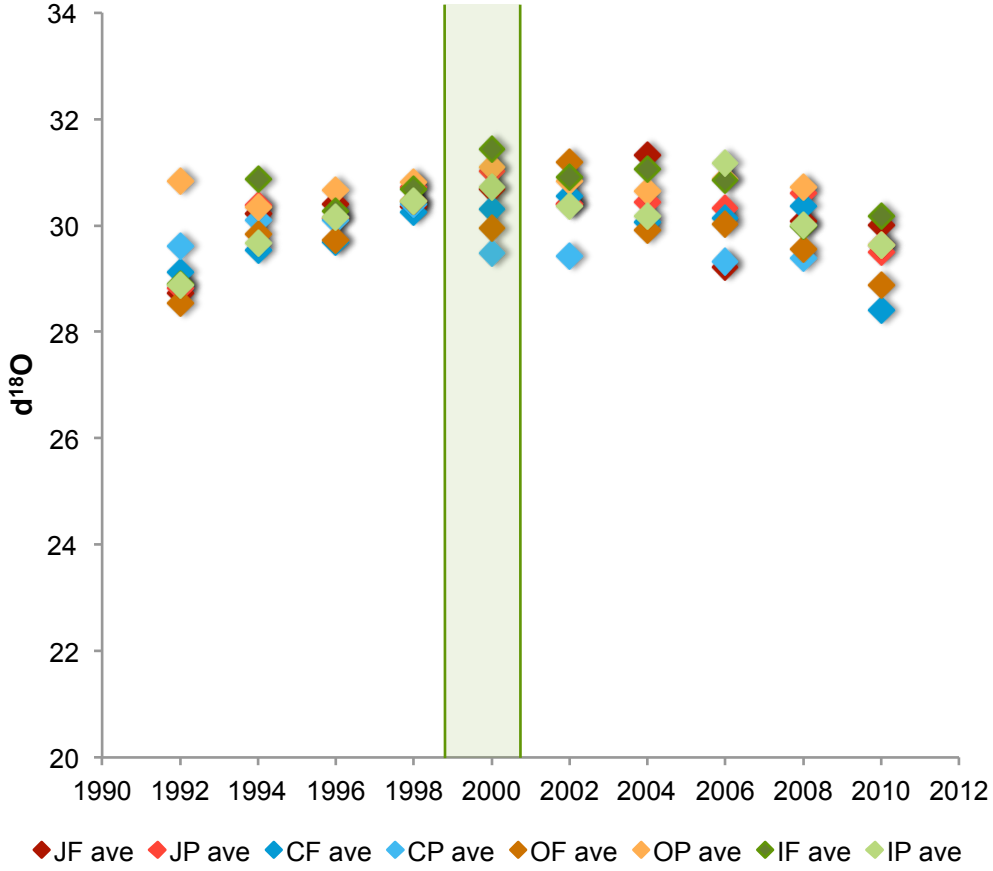


Water isotopes

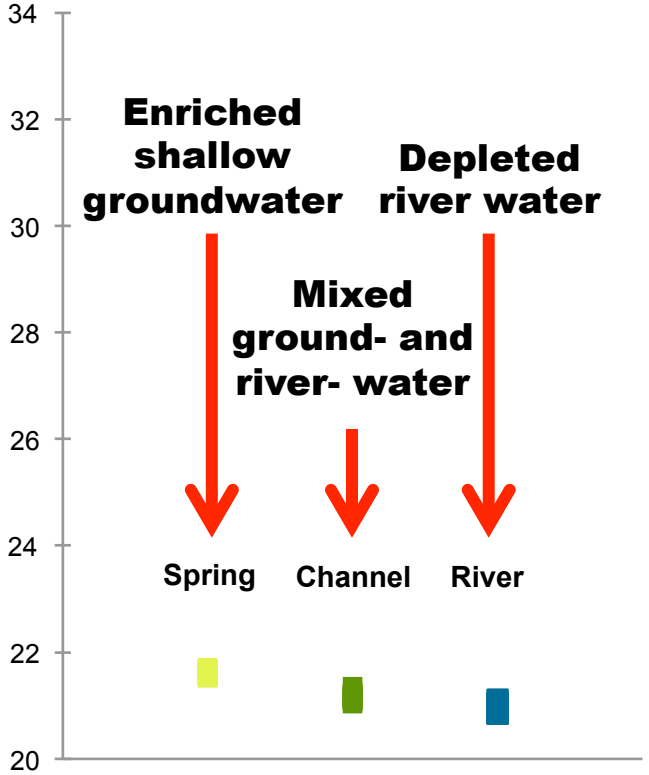


RESULTS

Tree isotopes



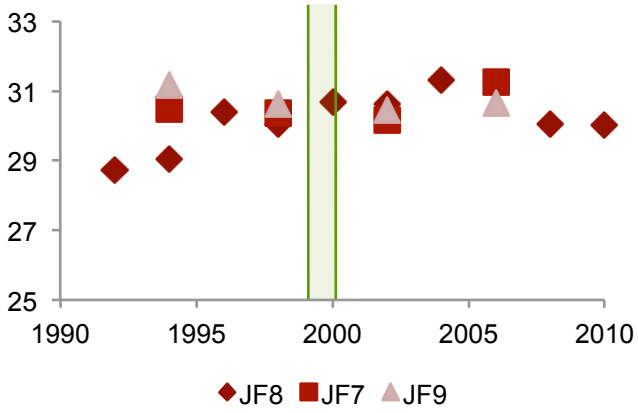
Water isotopes

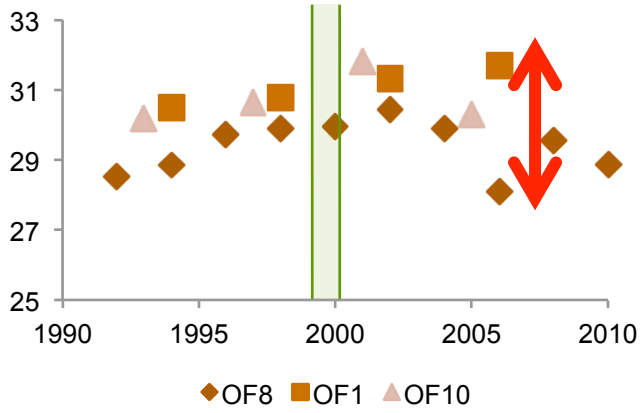


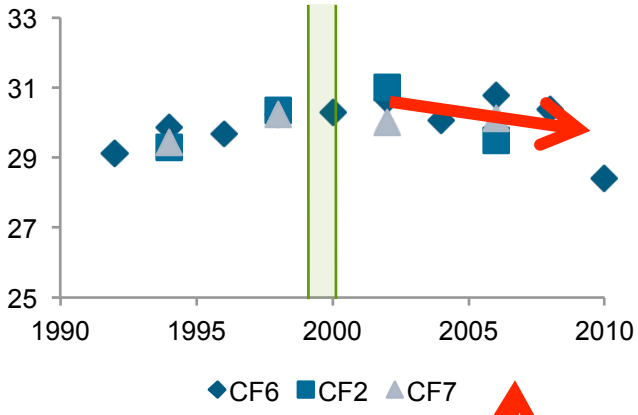
RESULTS

Isotopic ash data

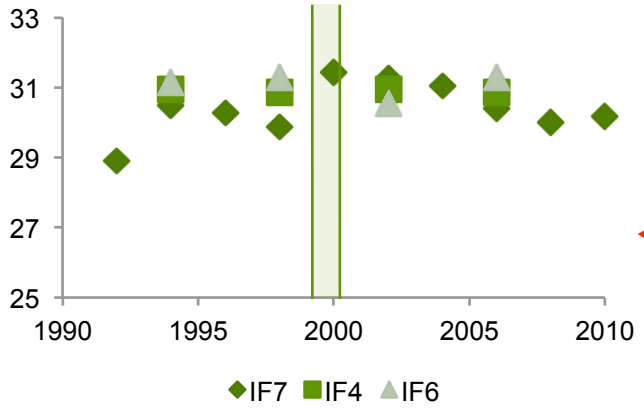
Groundwater sites







Channel-fed site

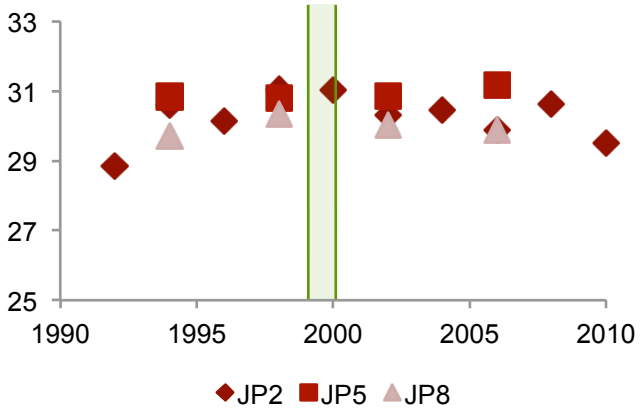


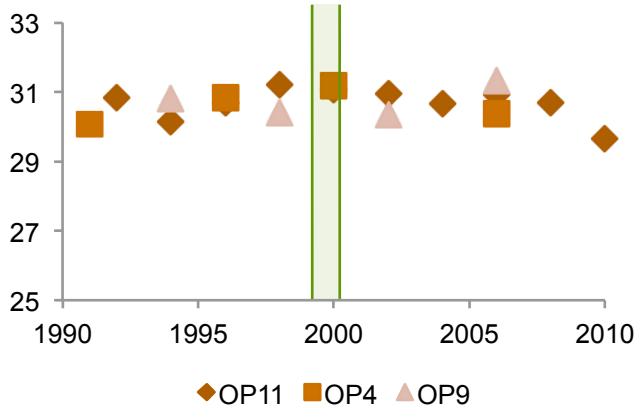
"Dry" site – precipitation-fed

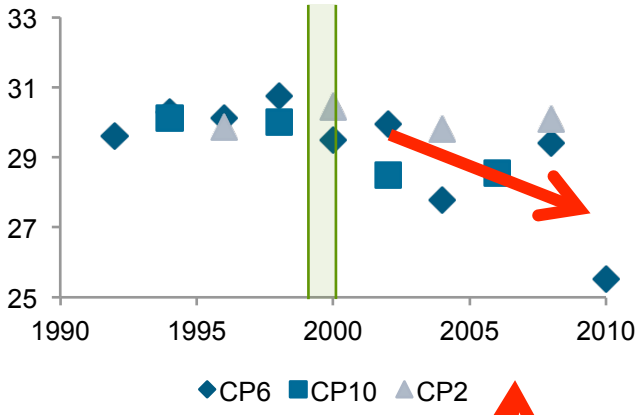
RESULTS

Isotopic poplar data

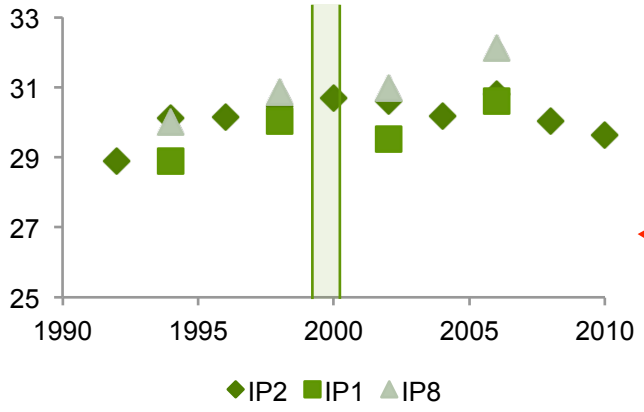
Groundwater sites







Channel-fed site



"Dry" site – precipitation-fed

CONCLUSIONS AND OBSERVED RESULTS

- **Dendrochronology**
  - Less variation within ash – more water limited than poplar
- **Isotopes: differences between species by site**
  - Groundwater sites: ash uses more sources, as expected
  - Channel site: equal sourcing by ash and poplar
  - “Dry” site: equal sourcing by ash and poplar
- **Isotopes: differences pre- and post-restoration**
  - Difficult to constrain
  - Channel site shows most significant change, but in response to river water exposure rather than raised groundwater

FUTURE WORK

- **Isotopic Analysis**
  - Broaden oxygen isotopic analysis to more of the sampled cores
  - Expand isotopic analysis to include hydrogen isotopes in order to narrow down isotopic signatures
  - Sample water directly from piezometers and from precipitation
- **Further field work?**
  - Use more specific parameters for tree selection
  - Sample older trees – see reaction to 1966 hydroelectric scheme

THANK YOU FOR LISTENING

Rosanagh Davison, 2010