The Impact of Changing Salinity on Aquatic Ecosystems:

Why the Last Page only Tells Part of the Story.

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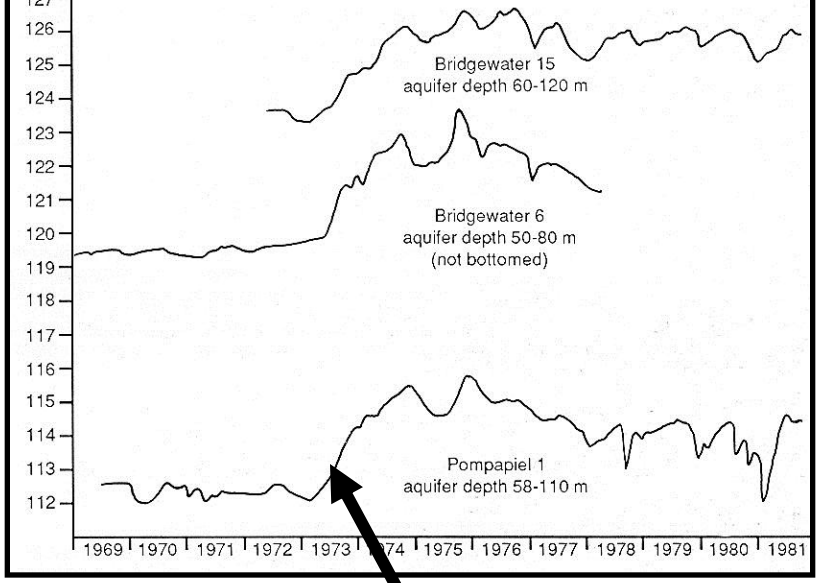
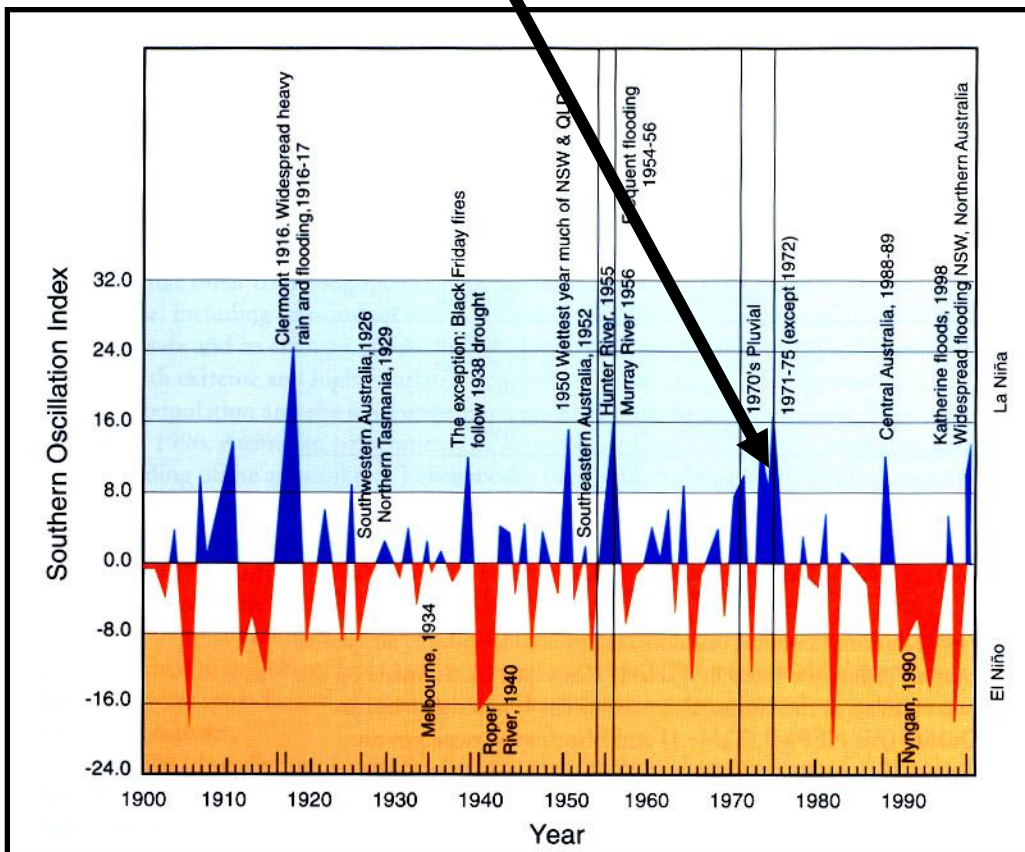
Average long term rise of 25 cm/yr

Actually increases stepwise with La Nina events e.g. 1973-75

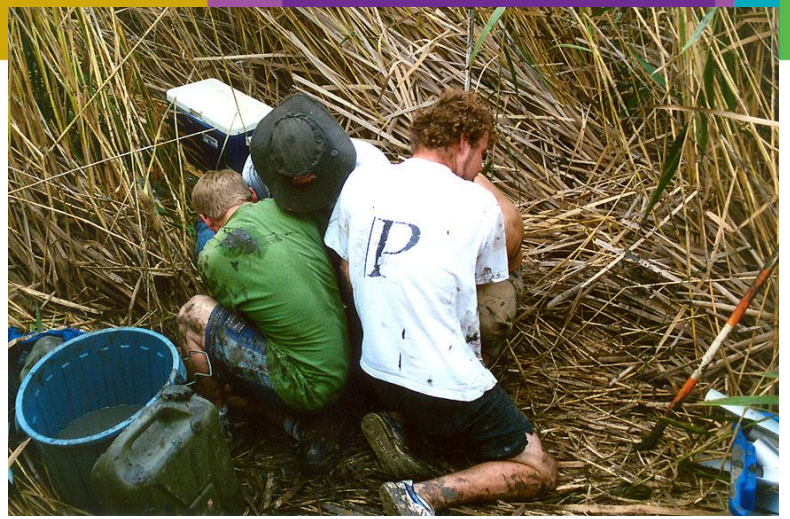
Rapid expansion of salinised land

Water Table Rise





A Longer History Lesson



- Environmental History relies on document, data and memory
- Paleoecology on preservation

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Wetland Sediments

- archive records of the past
- Gain evidence from sediments (chemical, physical)
- and fossil biota (e.g. pollen)
- Dated with ^{210}Pb, ^{137}Cs, ^{14}C, OSL & exotic pollen (e.g. *Pinus*)

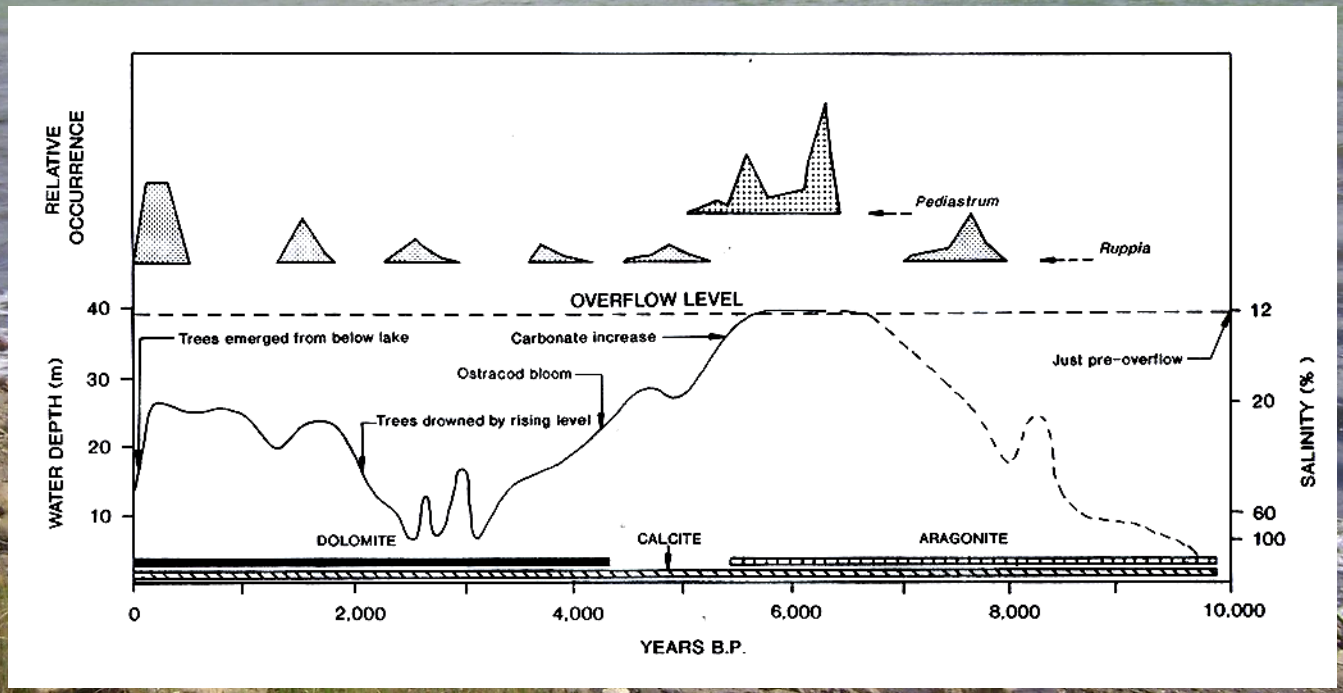
Sites of sediment records

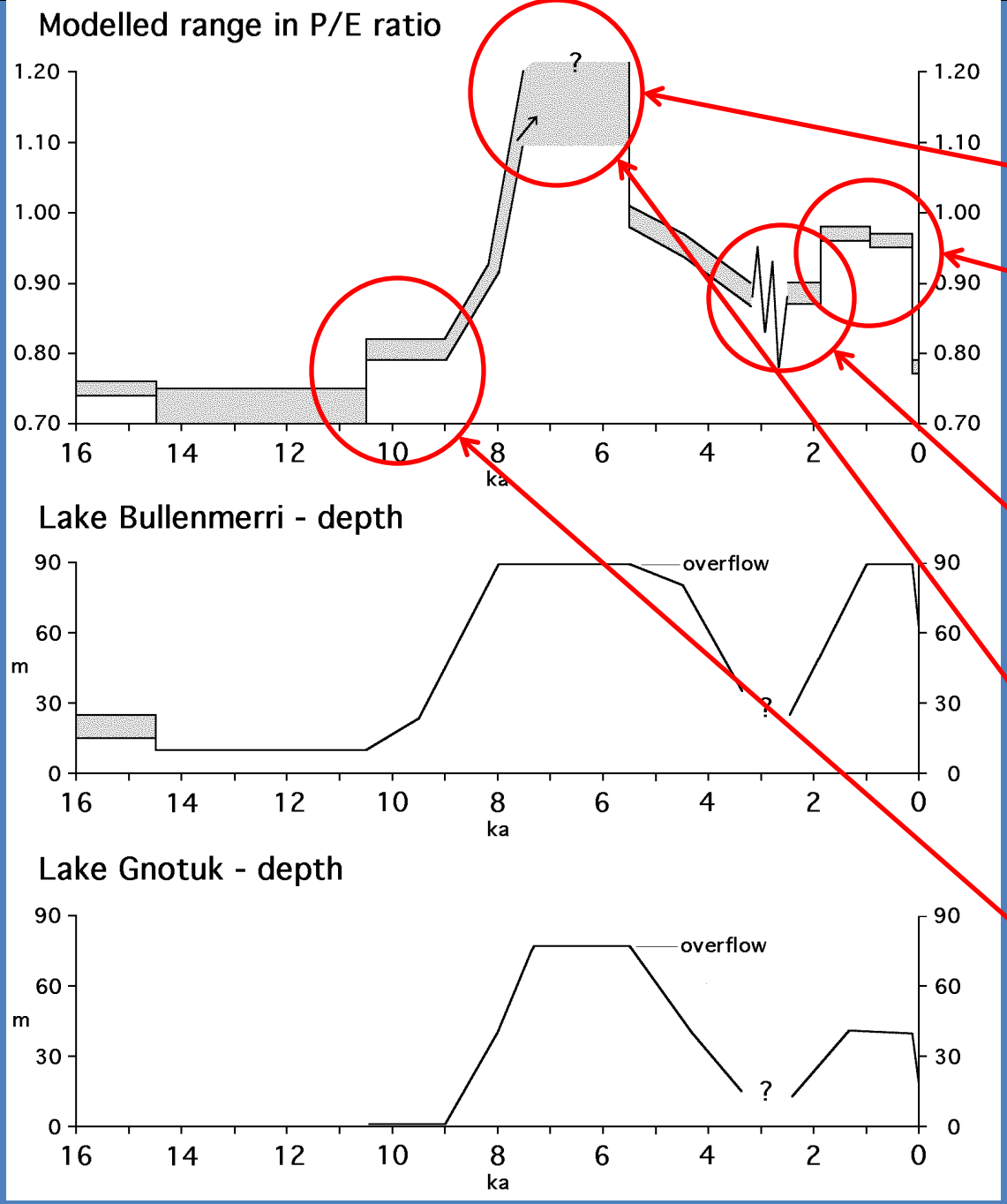
The Deep Past

Rain Gauge Lakes
– western Victoria

Lake Keilambete; overflowed 6000 yr BP; 8 m today

1859 shoreline





Initiation of ENSO

Lake refilling

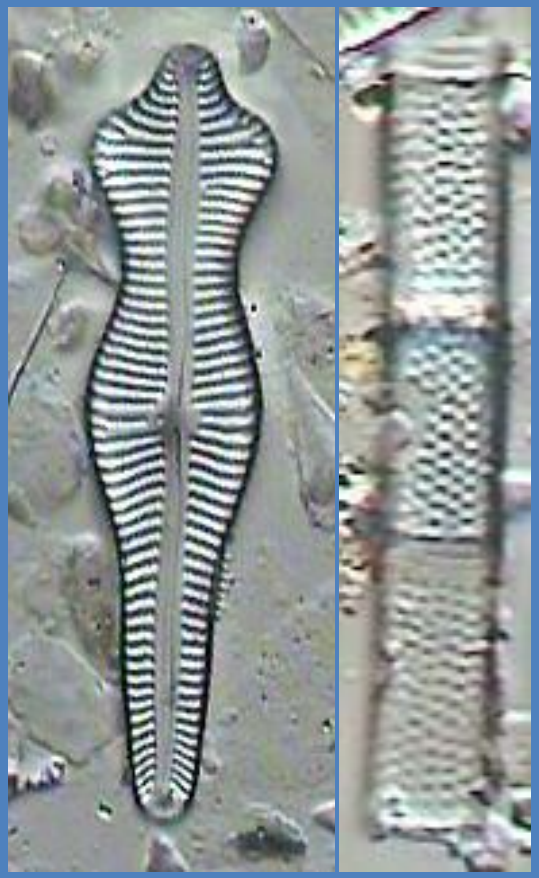
Major periodic instability

Major fluvial stage

Postglacial moisture

Source: Roger Jones

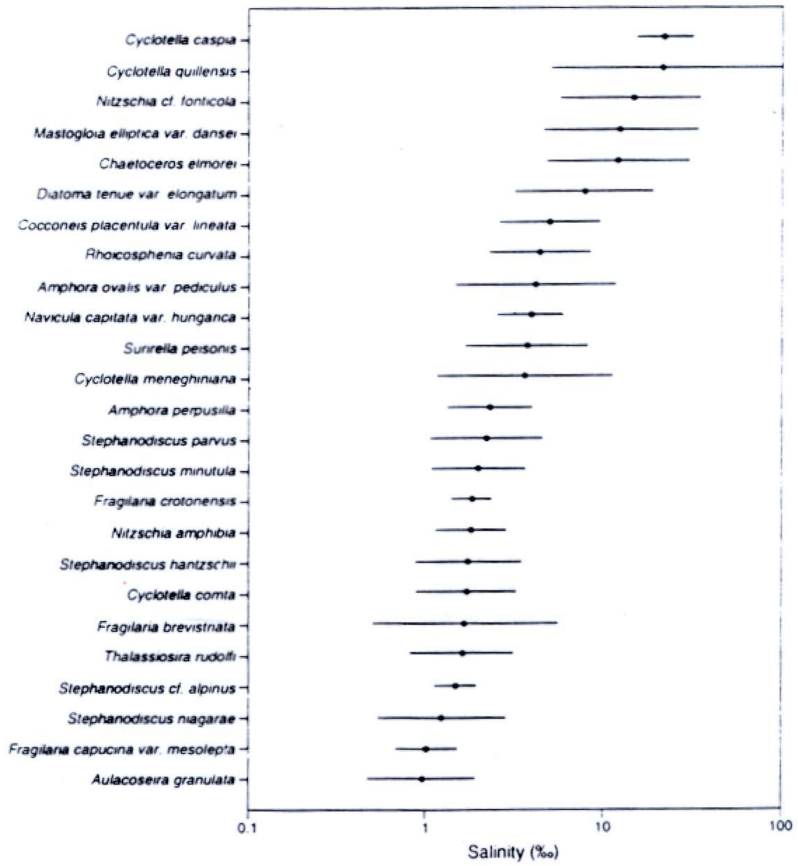
Diatoms

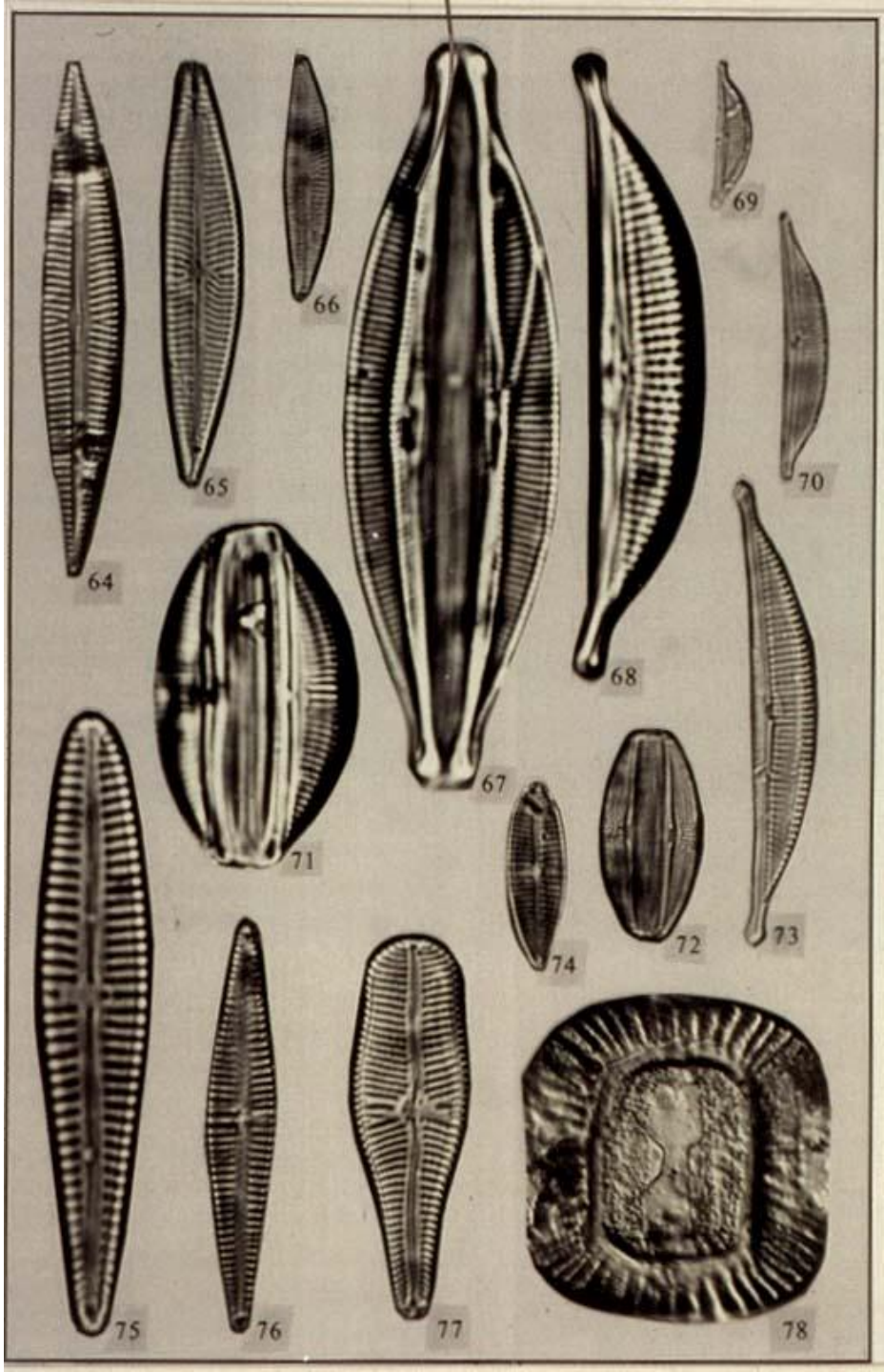


- One of the best indicators of wetland change are diatoms
- they are:
  - abundant
  - diverse
  - relate to water chemistry (esp. salinity)
  - Preserve as fossils

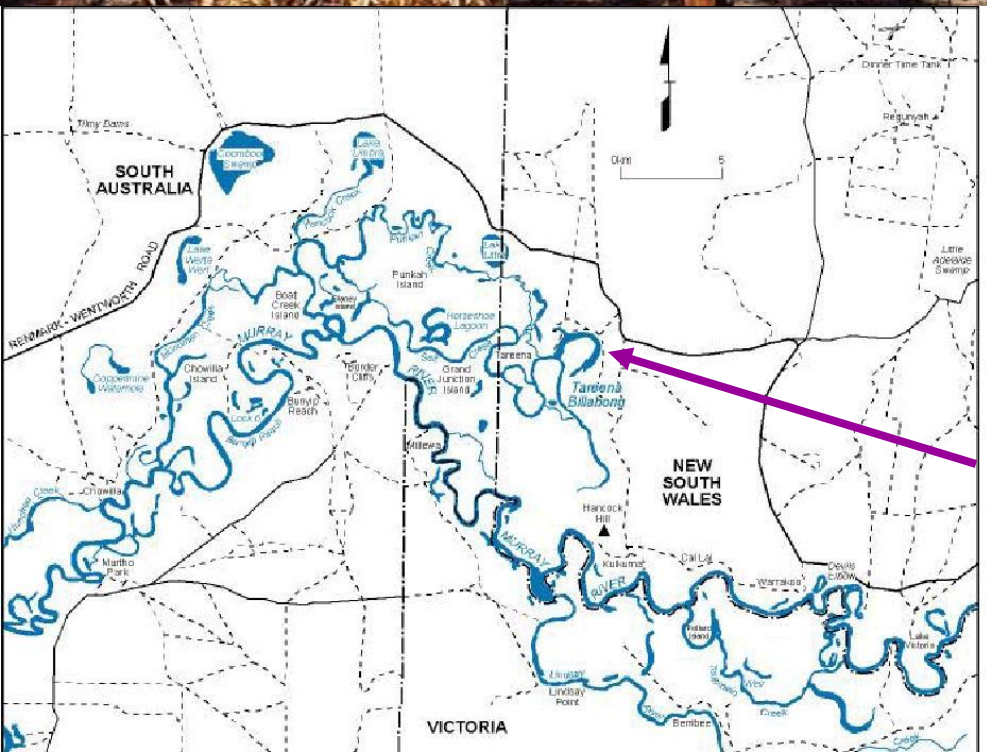
Salinity Response

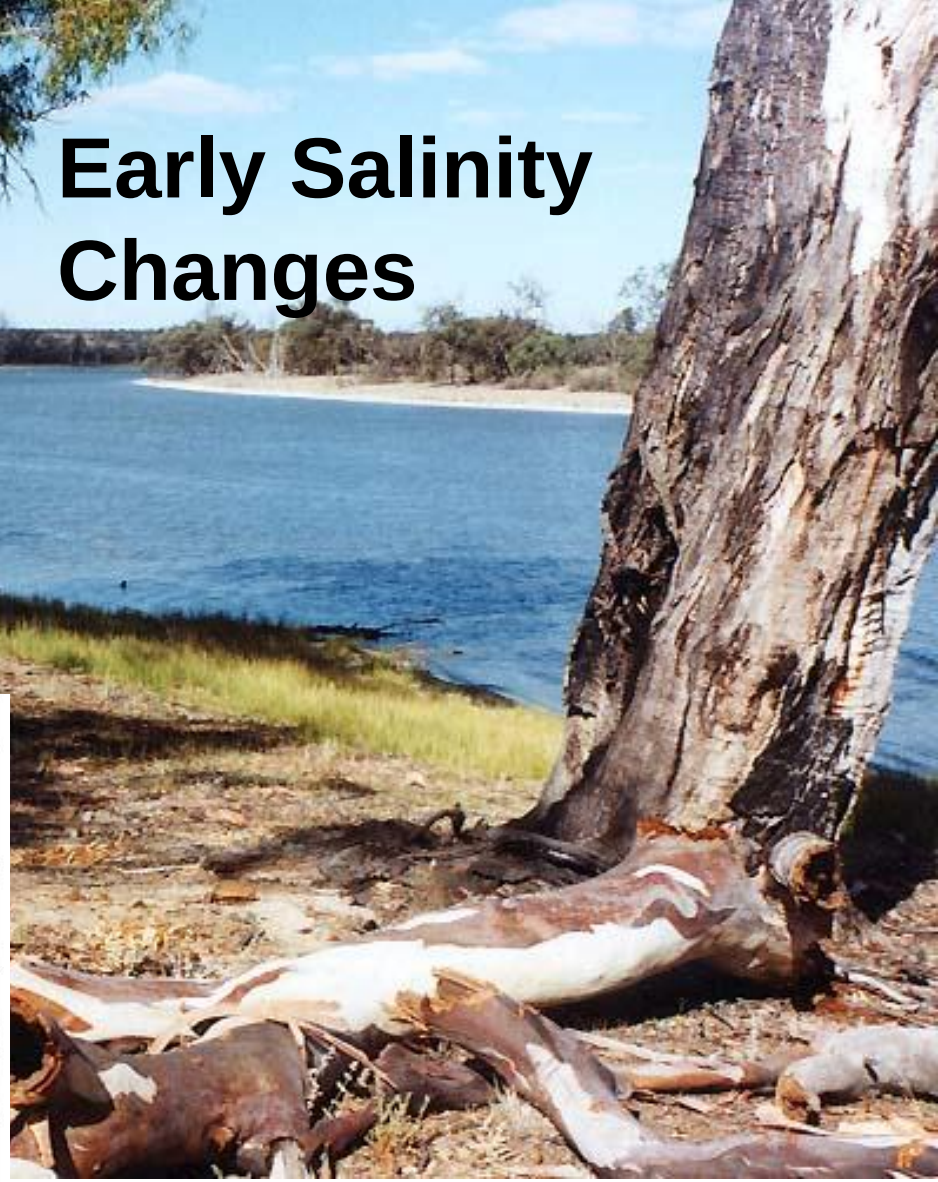
- **Can tolerate >200 g/l**
- **Some with narrow range**
- **Some broadly tolerant**





Early Salinity Changes

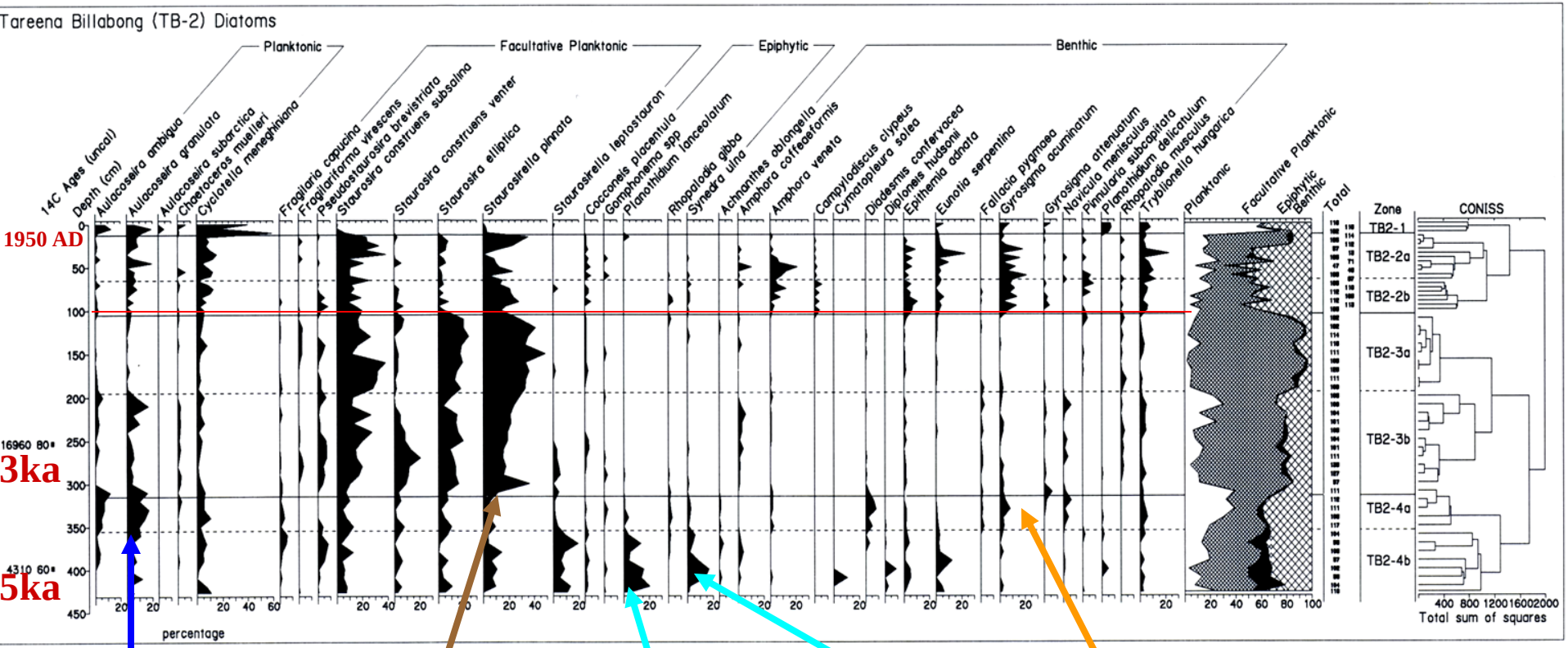




- Tareena Billabong: 5 km north of Murray R on Chowilla floodplain
- Fed by distributary ‘Salt Ck’

Pre-European Change

- Variable
- Controlled by climate?
- Long Stability

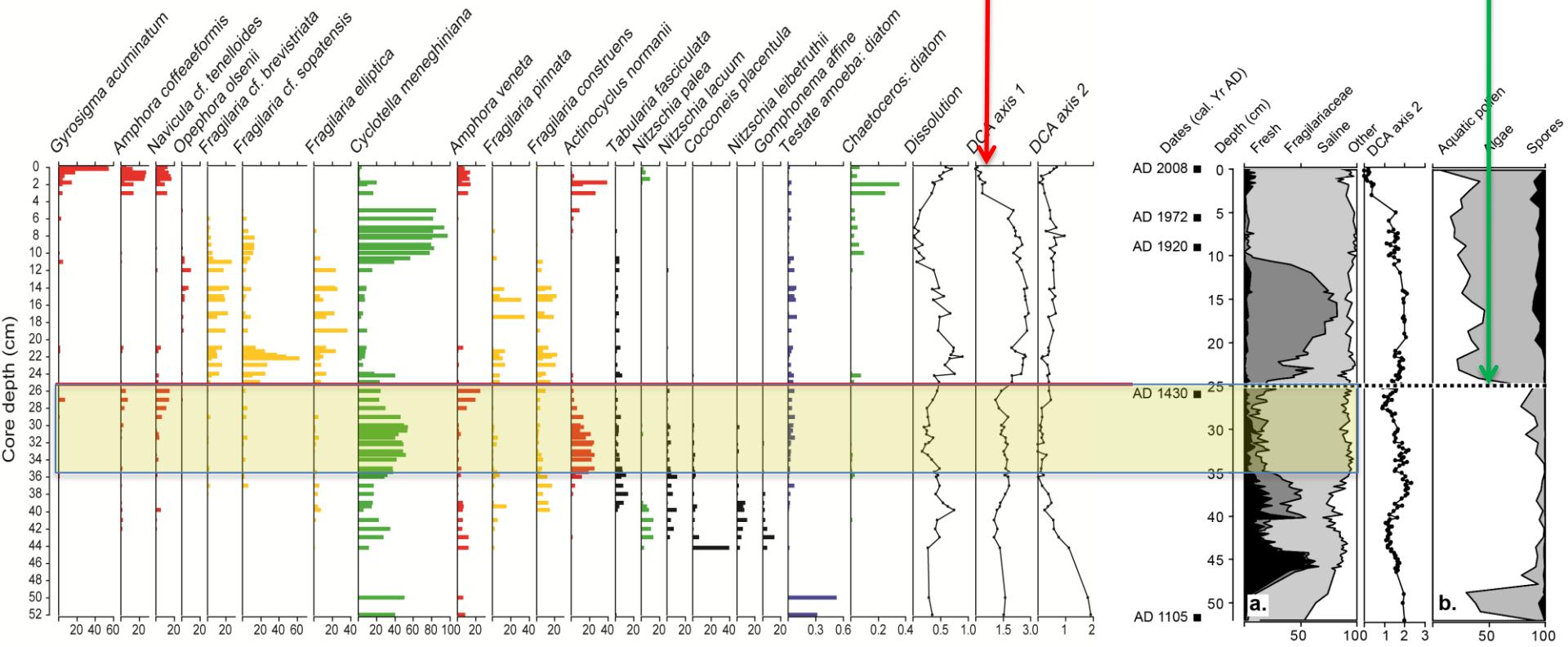


Gell *et al.*, 2005, Marine & Freshw. Res.

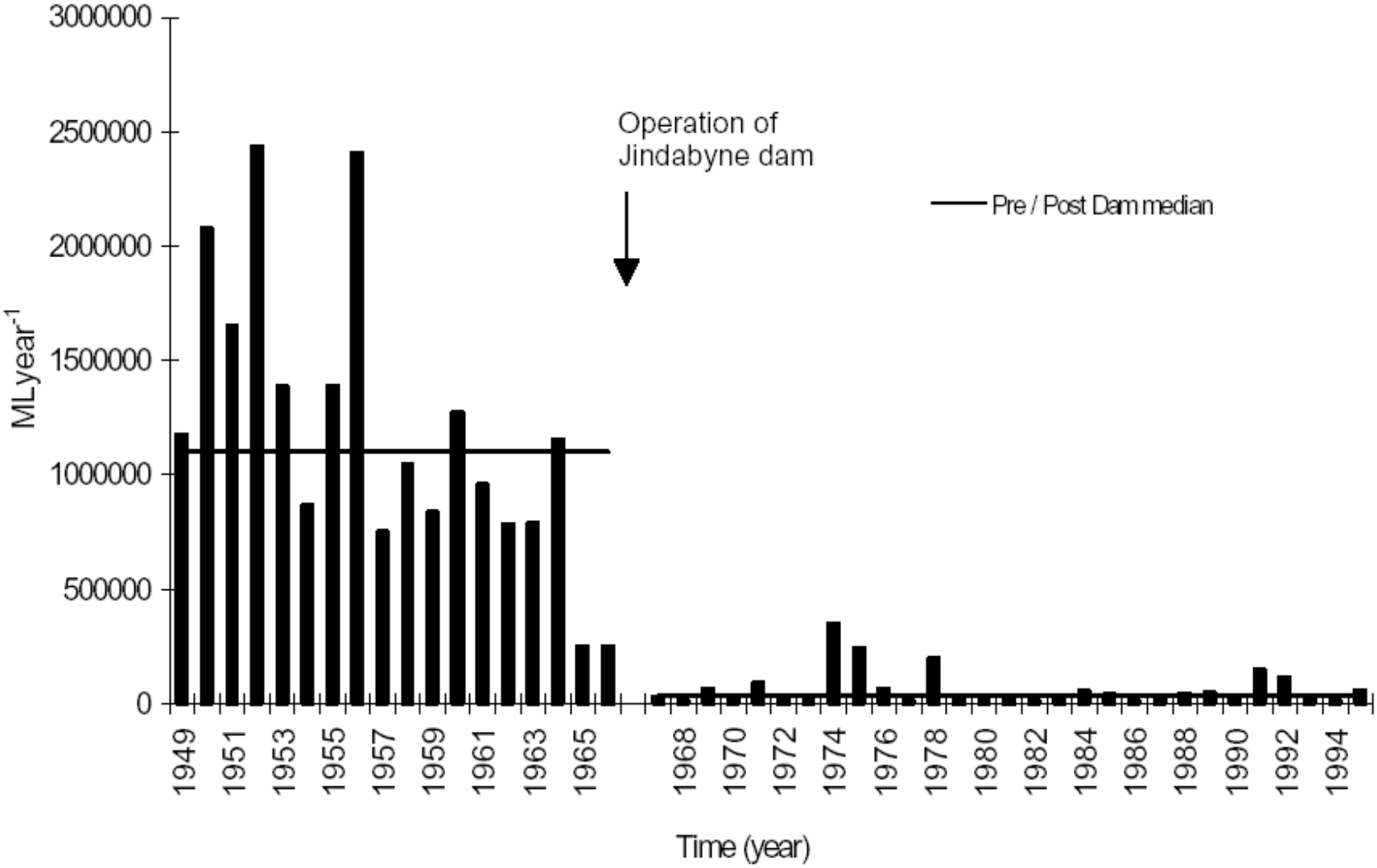
Recent Drought and Wetland Change

Lake Colac

- Pre European saline (drought) event – 1500s?
- Increased lake margin input & turbidity (?)
- State switch from macrophytes (myriophyllum spp) to algal dominance.
- 0-4 cm: saline; outside historical range



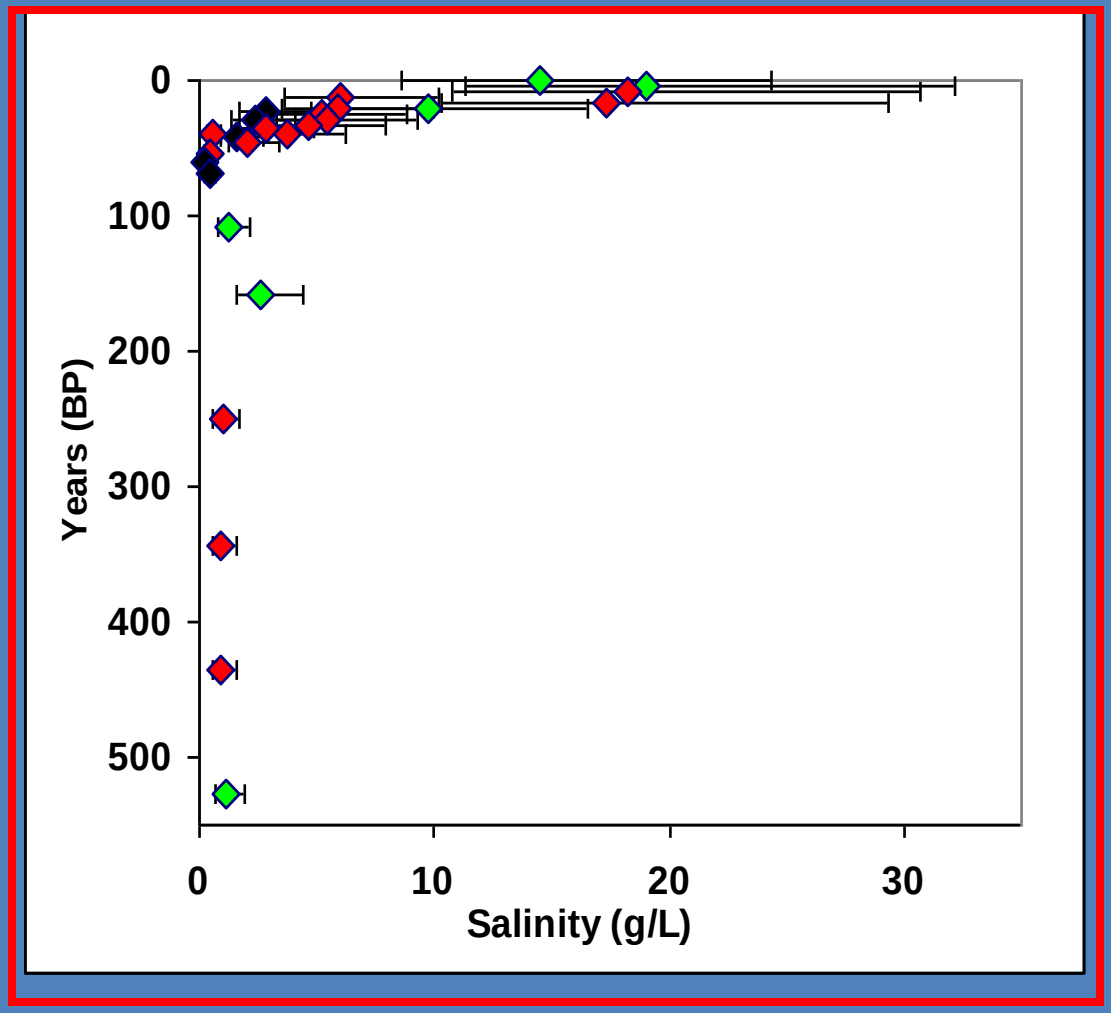
Interbasin Transfer: Snowy River

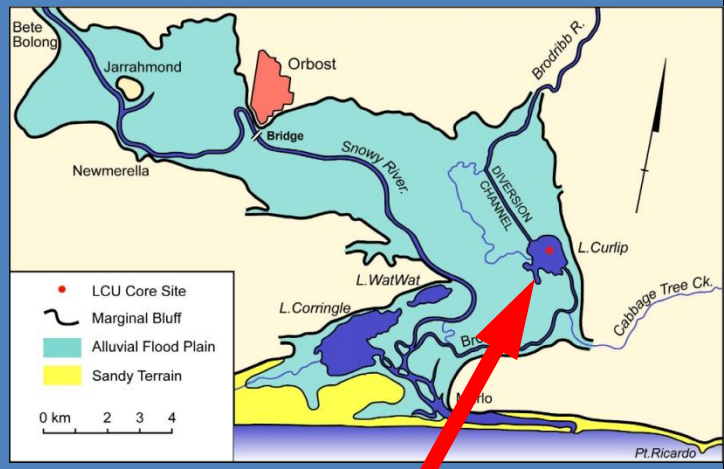


Impact on Estuary:

Pre-European dystrophic waters; fresh

50-fold Increase in wetland salinity





MacGregor *et al.*, 2005. Riv. Res & Applns.

The Coorong

- Back barrier lagoon
- adjacent to a complex estuary
- at the mouth of the River Murray, South Australia.
- Weirs established 1940

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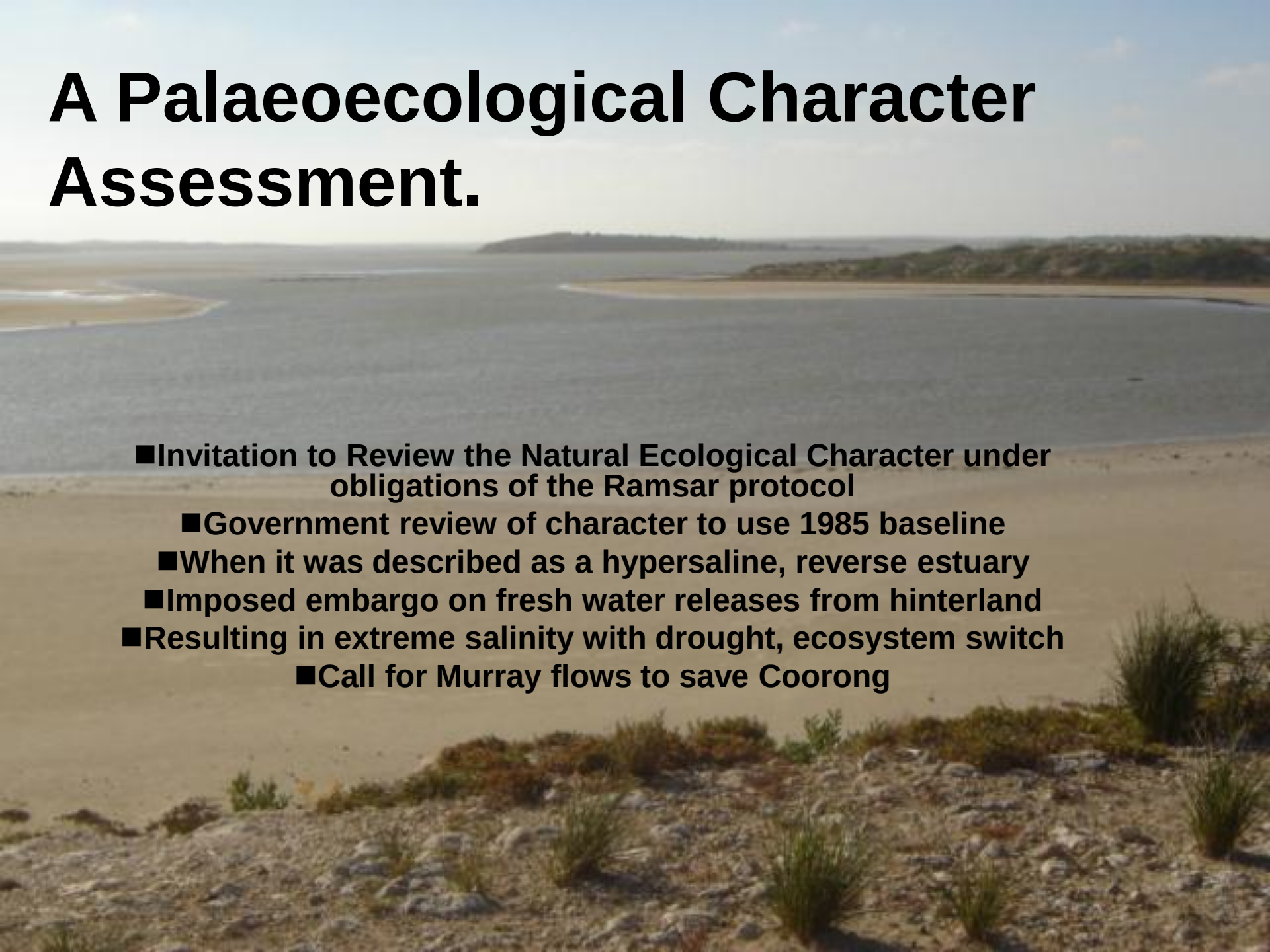
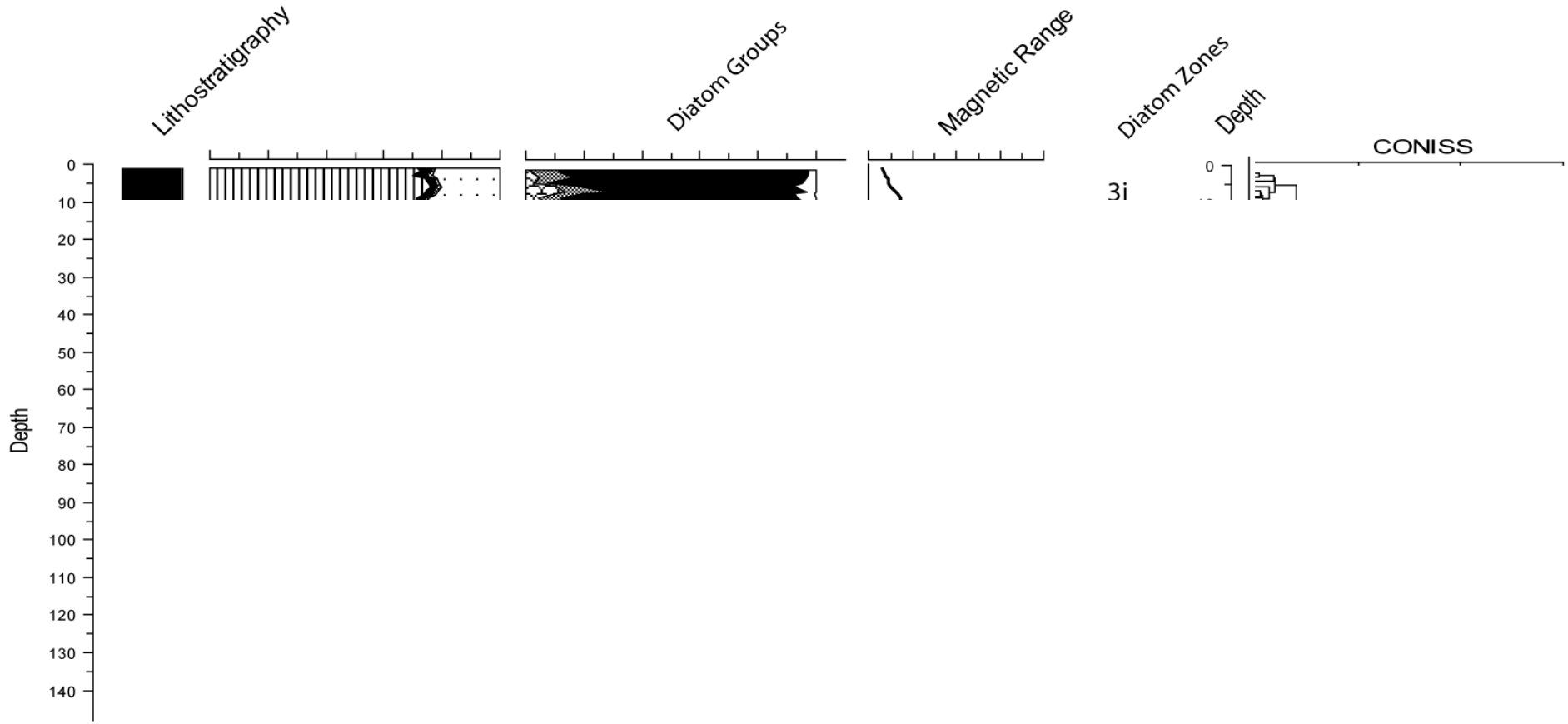
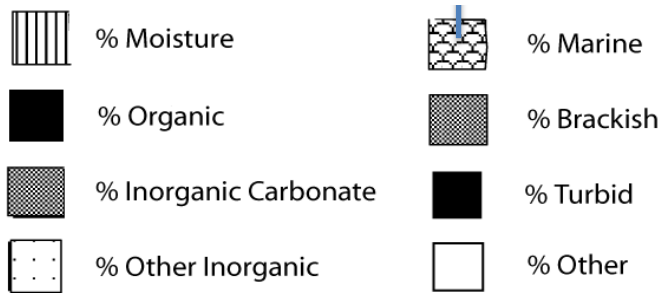
A Palaeoecological Character Assessment.



- Invitation to Review the Natural Ecological Character under obligations of the Ramsar protocol
- Government review of character to use 1985 baseline
- When it was described as a hypersaline, reverse estuary
- Imposed embargo on fresh water releases from hinterland
- Resulting in extreme salinity with drought, ecosystem switch
- Call for Murray flows to save Coorong

- **In 1985 a wetland dominated by turbid & saline diatoms**
- **For 6000 years before 1985 a stable, marine system**





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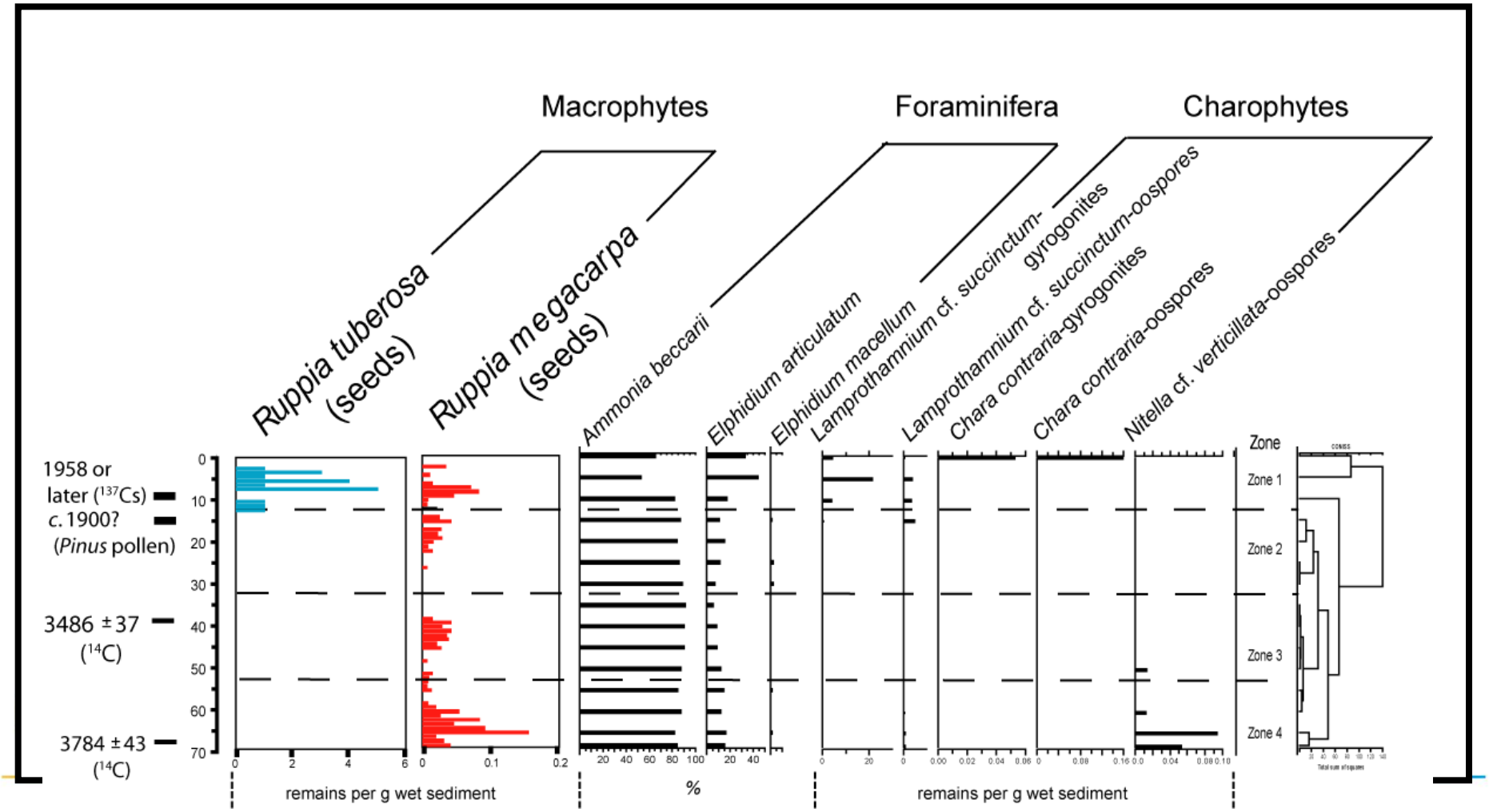
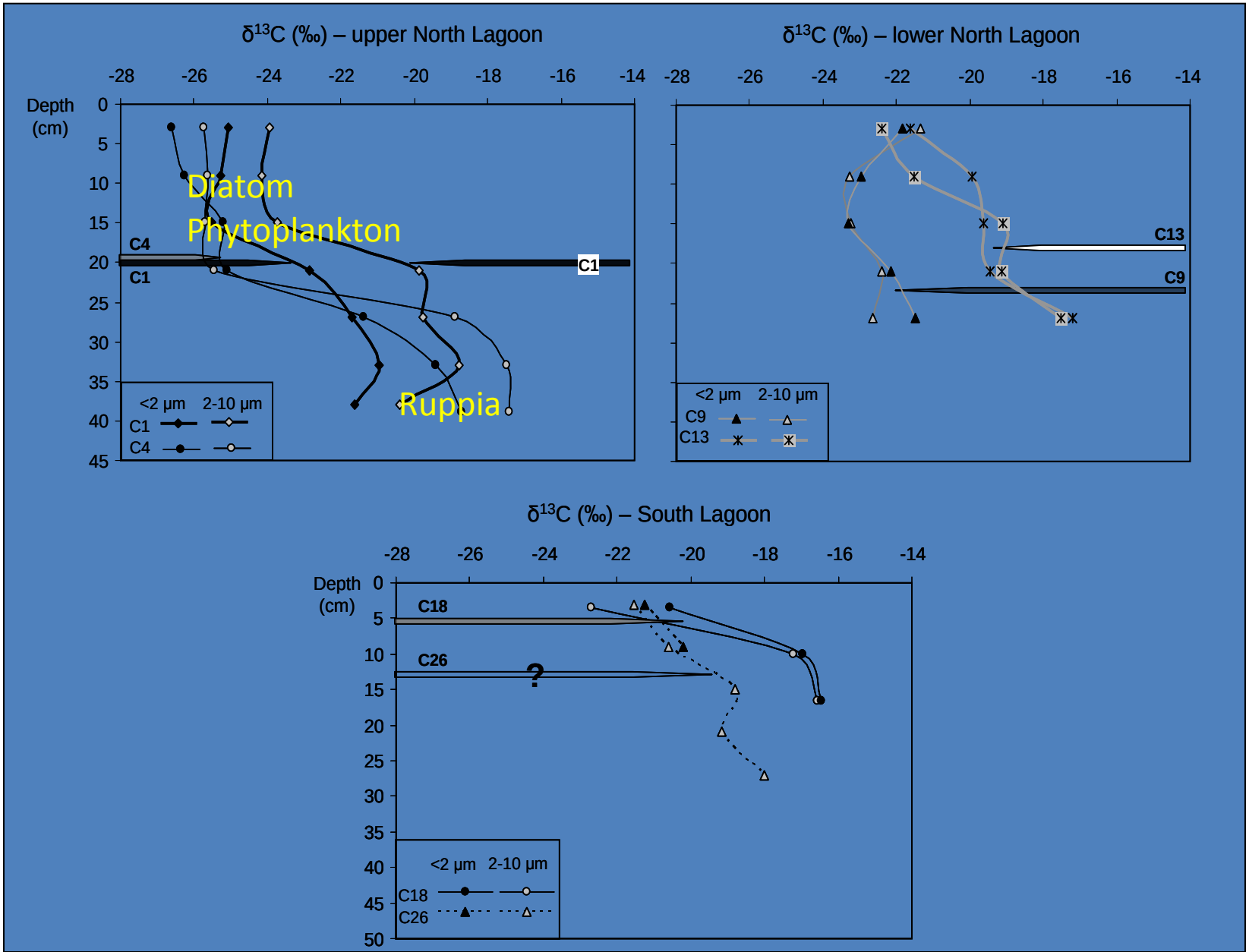
Historical Condition

South Lagoon: macrofossils



Carbon Isotope Record

Krull et al., Biogeochemistry

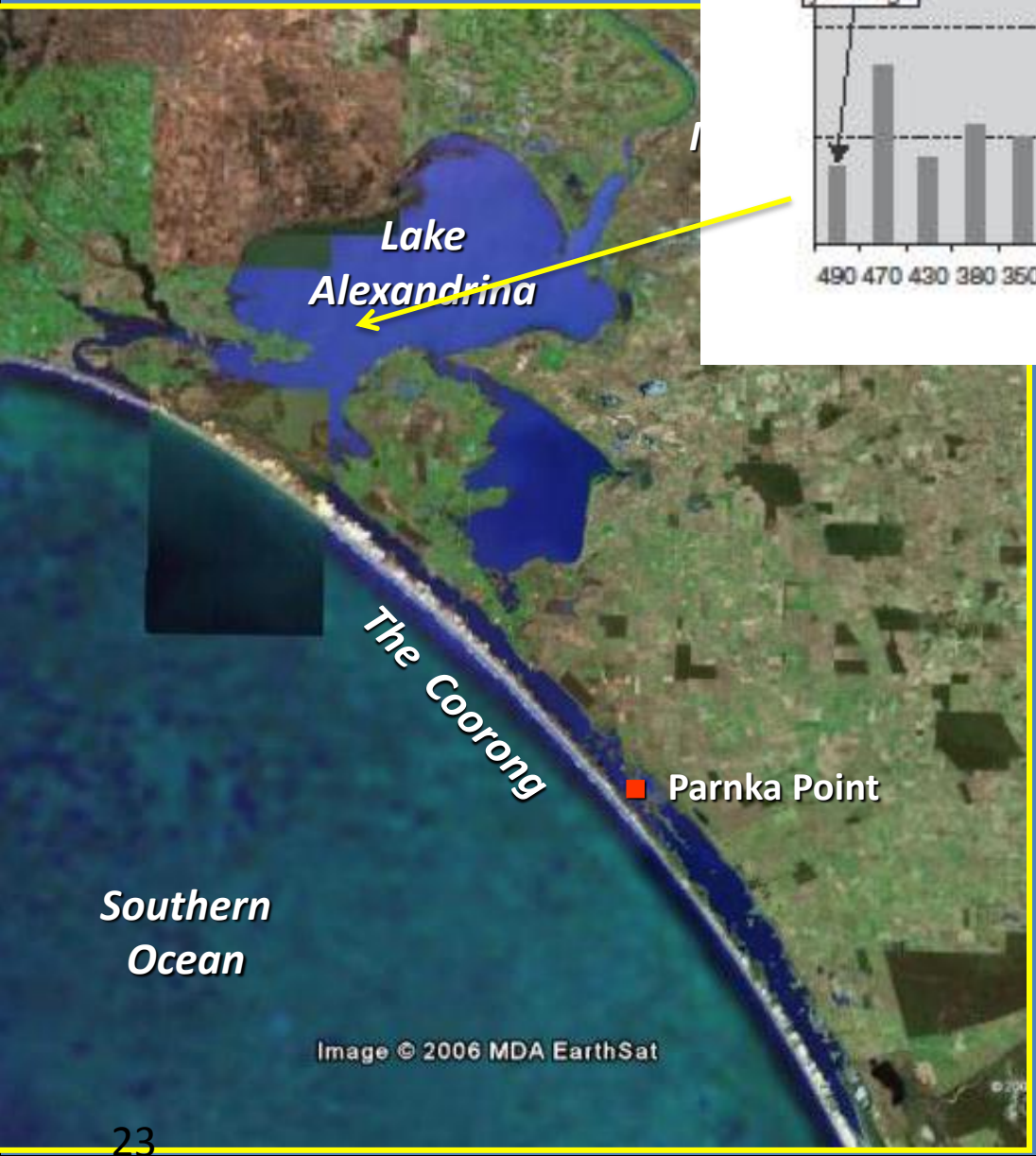


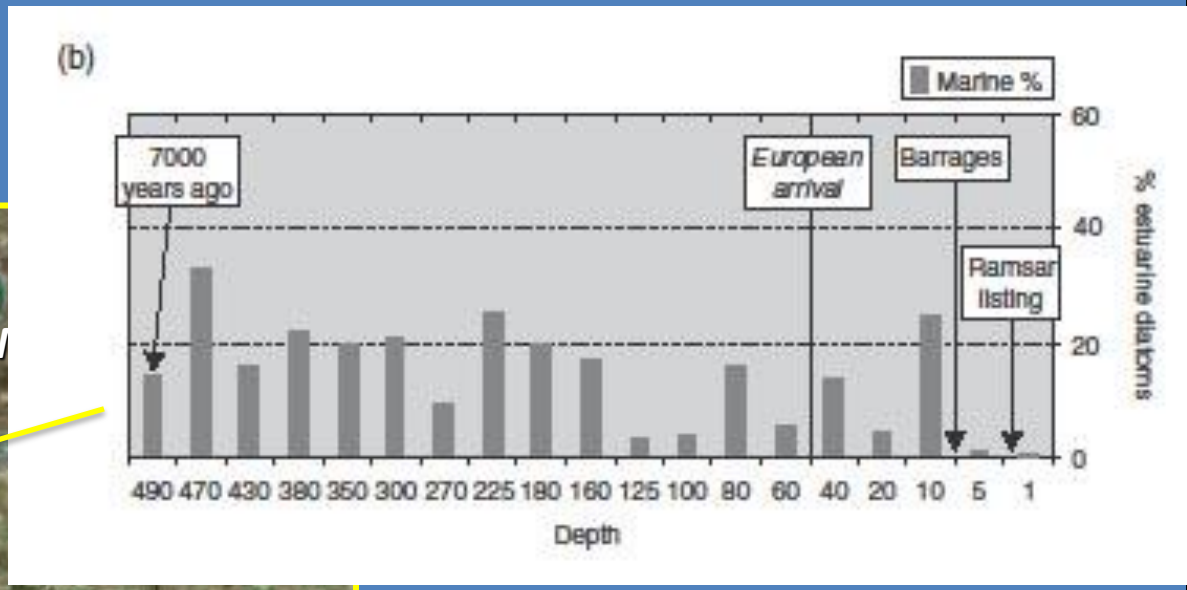
The Modern Coorong

- **The modern Coorong is**
  - hypersaline,
  - turbid
  - closed
- **The old Coorong**
  - Was variable
  - Received clear water from the ocean
  - Received water from the USE
- **Implications**
  - Not a reverse estuary
  - Candidate for Montreux List of degraded wetlands
  - River flows not the natural solution
  - Contested view of condition, and of solution

Fluin et al., 2007, Hydrobiologia

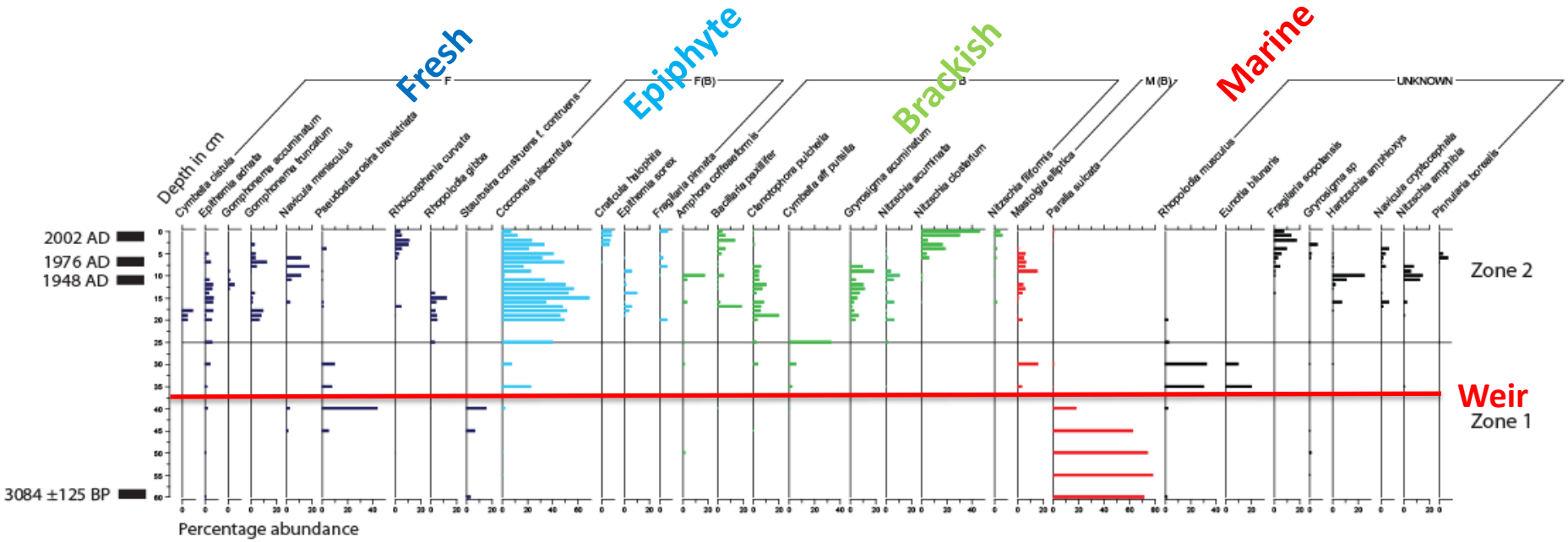
Lower Lakes





- **"There is no evidence in the 7000 year record of substantial marine incursions into Lake Alexandrina"**
  SA Govt website

Reedy Lake – Lower Barwon

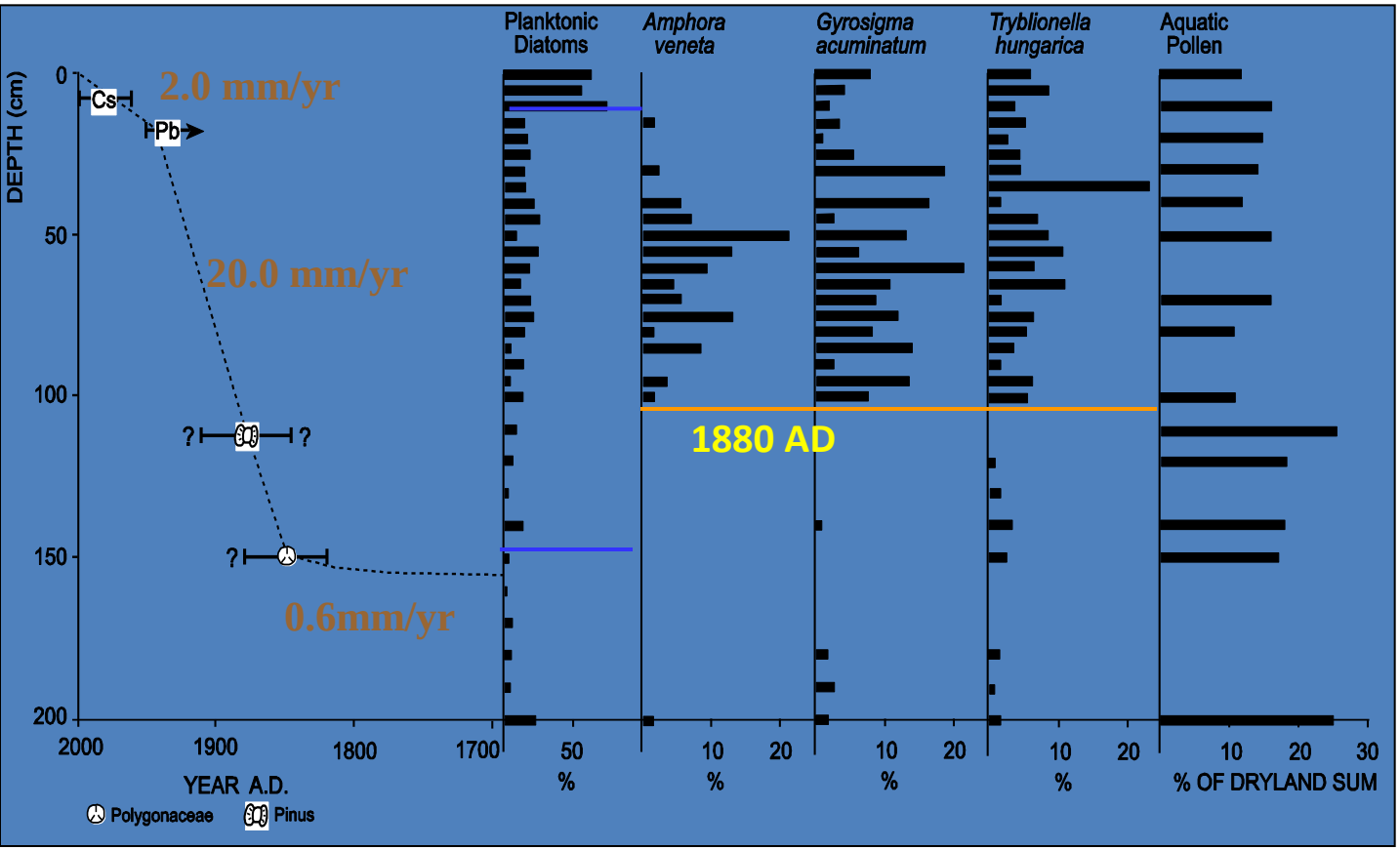


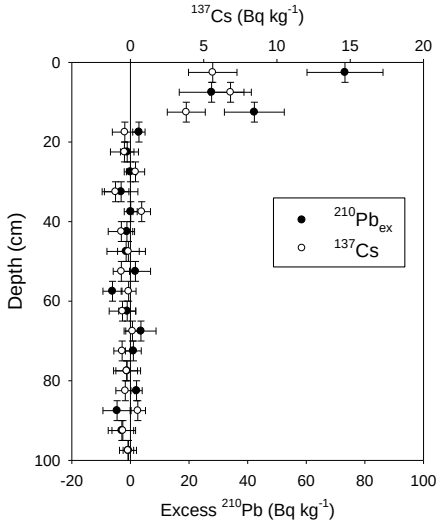
- A mirror image of Lake Alexandrina
- “Objective for environmental water management is to achieve the extent of plant communities mapped in 1983”

- Tareena Billabong, sw NSW
- Early increase in diatom-inferred salinity

Floodplain Lakes: Recent Changes

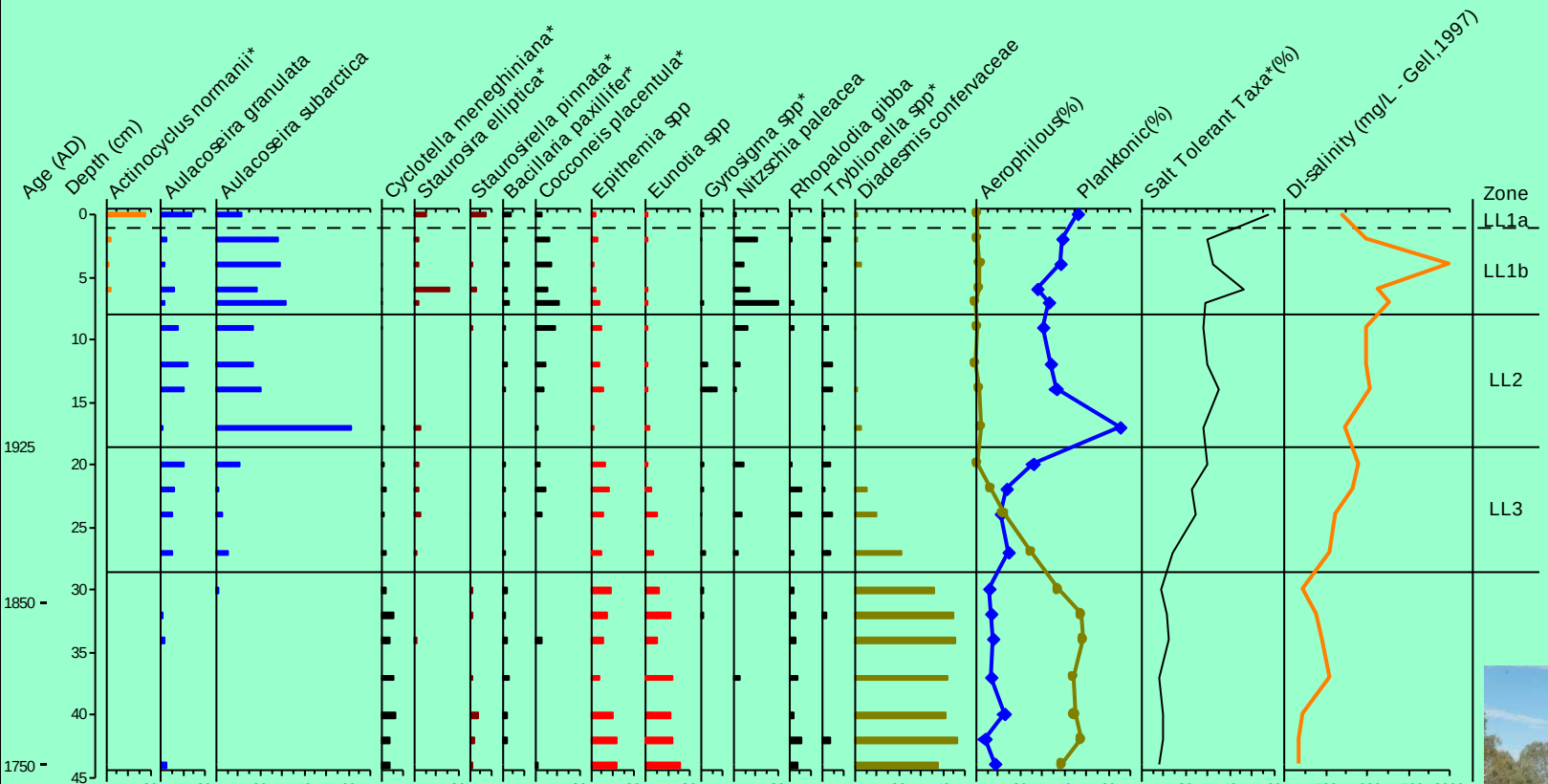
Salt tolerant taxa





Gell *et al.*, 2005, Marine & Freshw. Res.

Loch Luna – salinisation

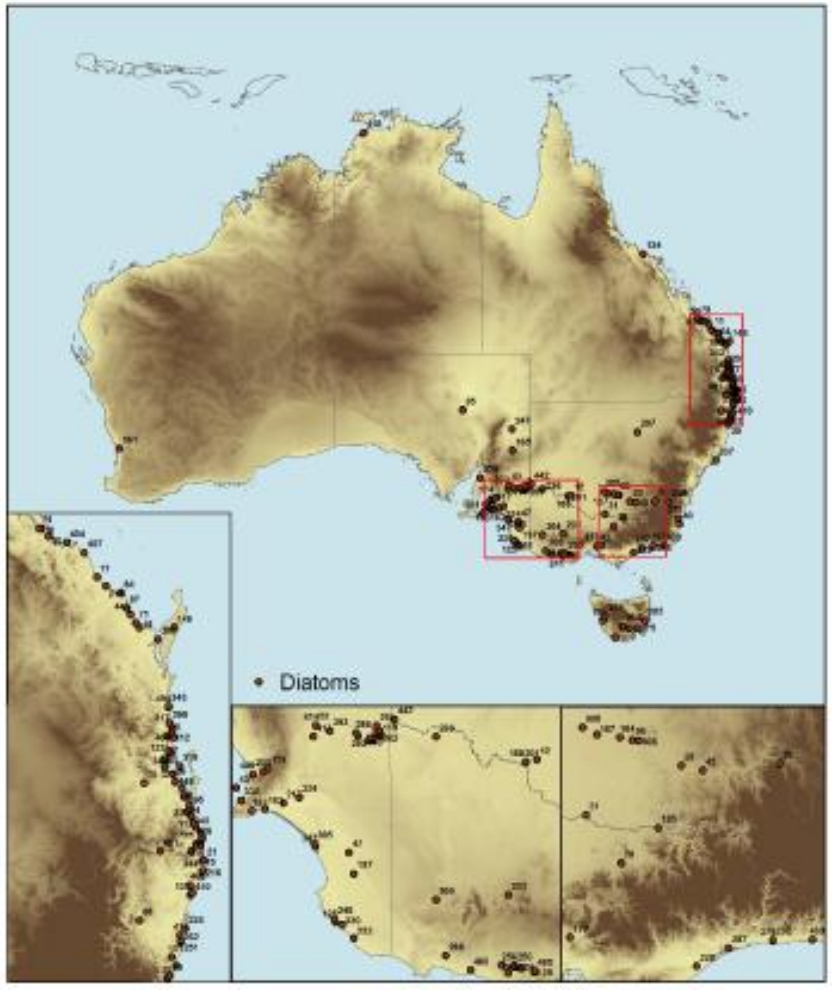


- **Shallow (clear water?) swamp initially**
- **Early increase in *Aulacoseira*; esp *A. subarctica* @ regulation**
- **Wetland salinity increase; River salinity increase (*Actinocyclus normannii*)**

Meta Data Sets

- **Widespread distribution of palaeo-sites in landscape – bias to humid margins**
- **Contribute to regional climate record, but also**
- **Regional audit of ecosystem condition and responses to non climate drivers**

Long Term Wetland Records (data contributed by Gell, Taffs, Saunders, mapped by Bickford)
http://www.aqua.org.au/Archive/OZPACS



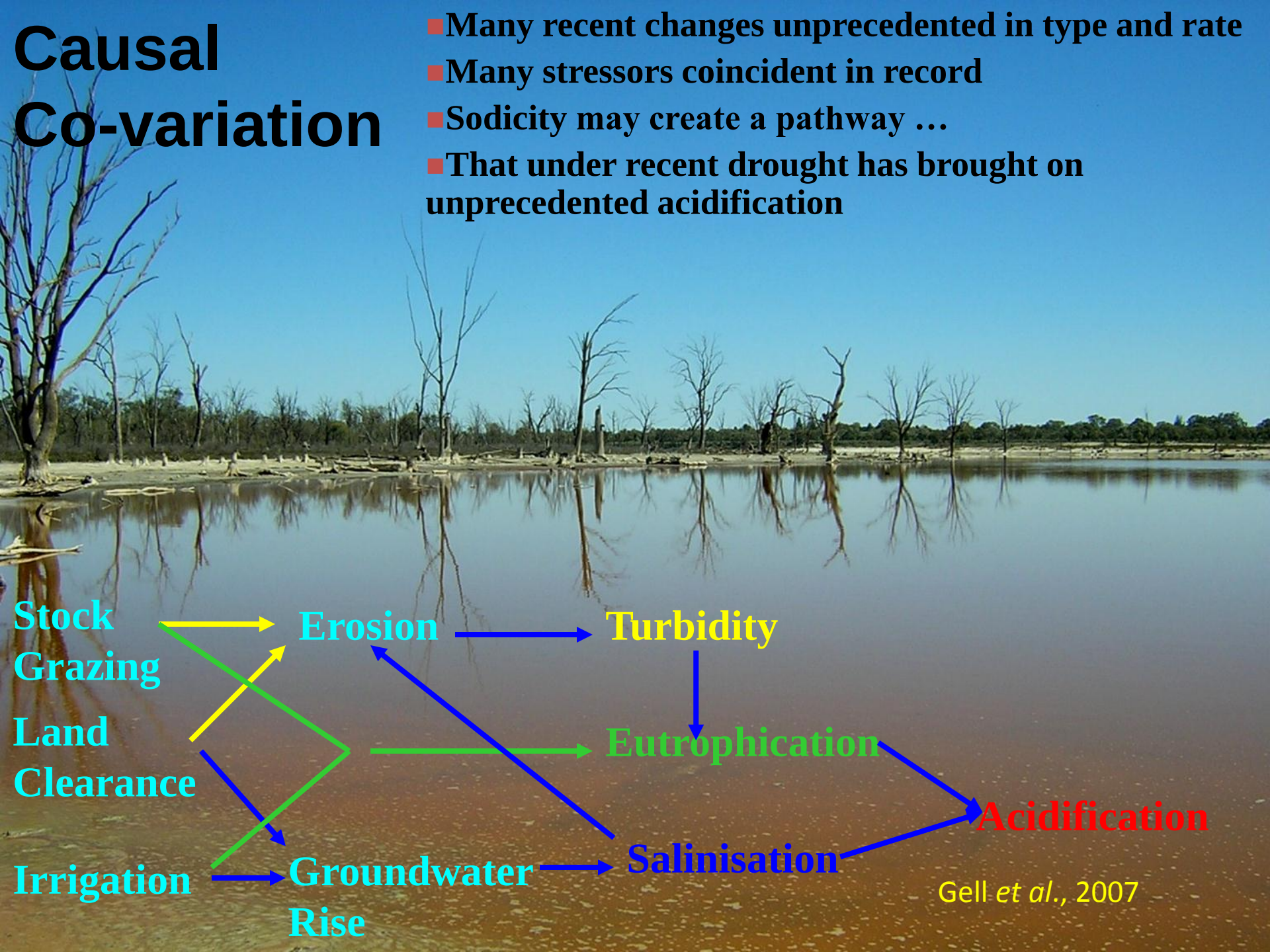
Impacts - MDB

- Salinisation
  - Tareena, Luna, Loveday, Berry Jerry, Coorong, Coonoocoocabil
- Turbidity widespread
  - Hogans, Cullulleraine, Sinclairs, Coorong, Coonoocoocabil
- High sedimentation
  - Tareena, Pikes, Ajax, Ral Ral, Swanport, Coorong,
- Eutrophication
  - ‘bidgee, Sinclairs Flat, Murroondi, Coorong, Coonoocoocabil
- Macrophyte Invasion
  - Mundic
- Acidification
  - Psyche Bend, Martin’s Bend, Loveday, Albert
- Minimal Impact
  - ???
  - Baseline flora in contrast to modern

Gell *et al*., 2006. IAHS publ. 306.

Causal Co-variation

- Many recent changes unprecedented in type and rate
- Many stressors coincident in record
- Sodicity may create a pathway …
- That under recent drought has brought on unprecedented acidification



Gell *et al.*, 2007

Conversations from the Longer Term View

- **Wetlands have experienced great variability in water balance and salinity**
- **Salinisation occurred very early in settlement**
- **Few sites are unimpacted**
- **Interactions produce unusual outcomes.**

Thank you – any questions

- **Thanks to:**
  - Australian Research Council
  - SA Dept Water, Land & Biodiversity Conservation
  - River Murray NRM Board
  - AINSE