Quantifying components of the aquatic organic carbon cycle of a humic lake: a case study from the Burrishoole catchment, Co. Mayo.

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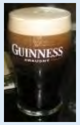
Marine Institute
Foras na Mara

institiúid teicneolaíochta dhún dealgan
DUNDALK
INSTITUTE OF TECHNOLOGY

Quantifying components of the aquatic organic carbon cycle of a humic lake: a case study from the Burrishoole catchment, Co. Mayo.

- **Background to Burrishoole**
- **Dissolved Carbon**
- **Carbon Dioxide**
- **Methane**

Salmon Research Trust of Ireland
Mission Statement - 1955



To carry out fundamental research into the factors which govern the development of stocks of salmon and sea trout.

Including whether “like breeds like – salmon sea age”

Funding

Guinness/National — Own/National — Own/National/EU →

‘58 ‘69 ‘83 ‘89 ‘96 ‘98 ‘00 ‘02 ‘04 ‘06 ‘08 ‘10 ’16/17

Projects

Wild Fish/Aquaculture

LIFE REFLECT LIFE II

CLIME SLIME

SSTI Climate INSIGHT RESCALE ILLUMINATE

Cullens CLUSTERS

Key Infrastructure

Trap Met Eireann Station

Trap

Trap

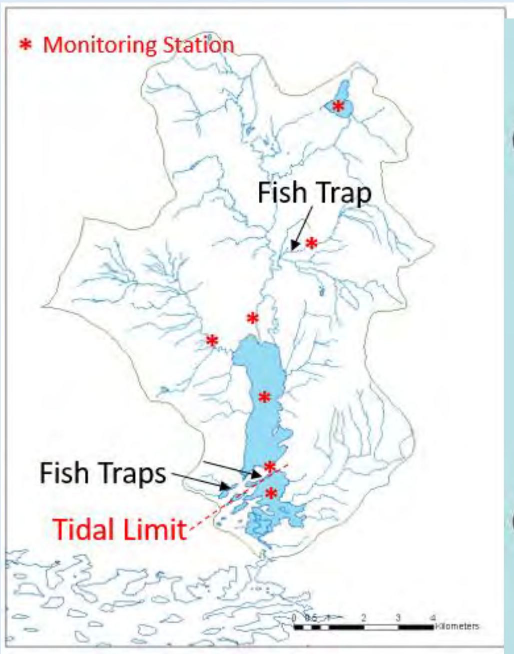
Feeagh Station 3xRiver Stations Rainfall, Water level & temp

Met Eireann Station

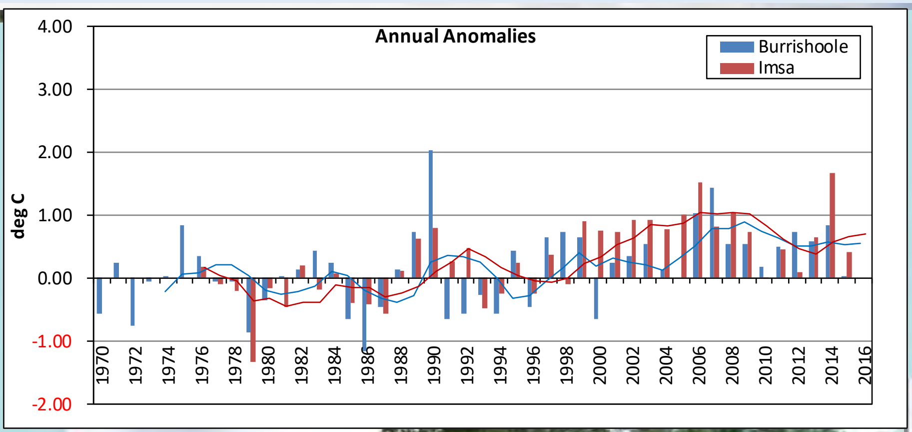
Furnace Station

Tidal Gauge

Burrishoole
Long Term Ecological Research observatory (LTER)

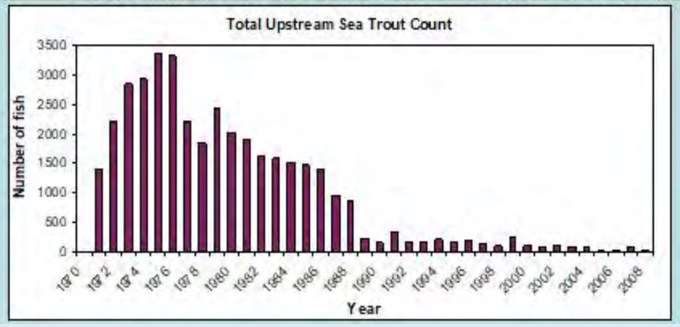


Changing Climate



Changing Environment

Changing Fish Stocks



Two Research Projects

EPA *ILLUMINATE*

SSTI *RESCALE*

Review and Simulate Climate and Catchment Responses at Burrishoole

Past

Present

Future

Palaeolimnology

Current sampling

Historical data

Forecast modelling

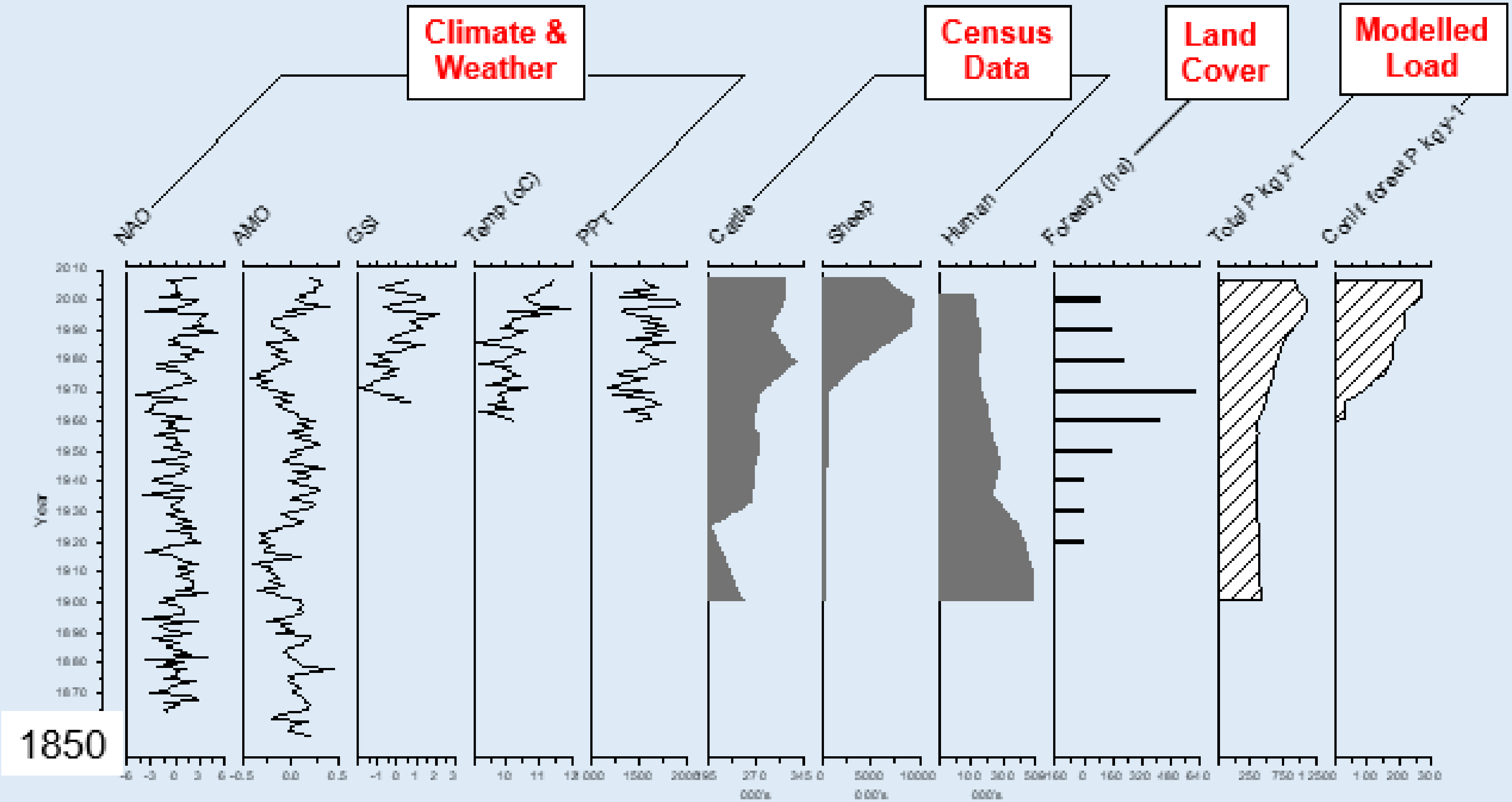
Hindcast modelling

Contributions from: University of Limerick, Trinity College, Dundalk IT, University of Maynooth

Catchment Pressures

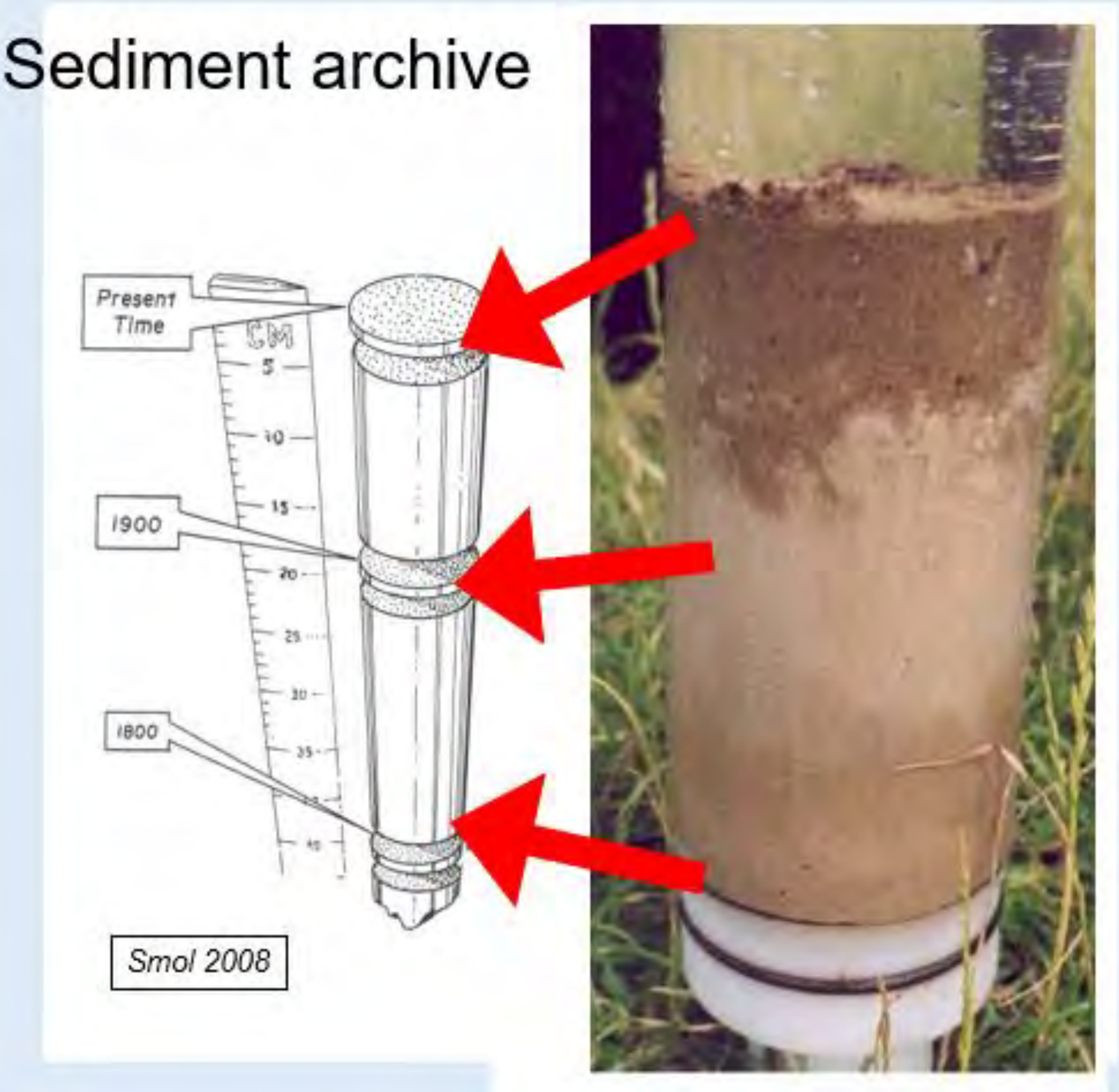
A 5-fold increase in the amount of peat lost through disturbance has been estimated for the Burrishoole catchment

(Salmon Research Agency 1994)



Jennings et al (unpublished)
Dalton *et al.* (2010)

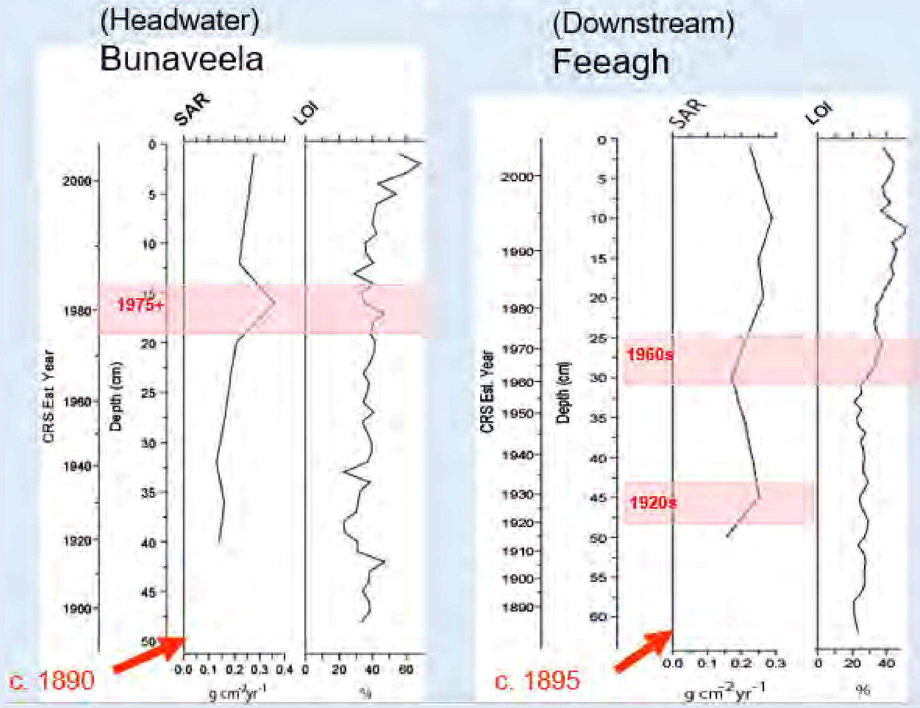
Paleolimnology – Sediment Core



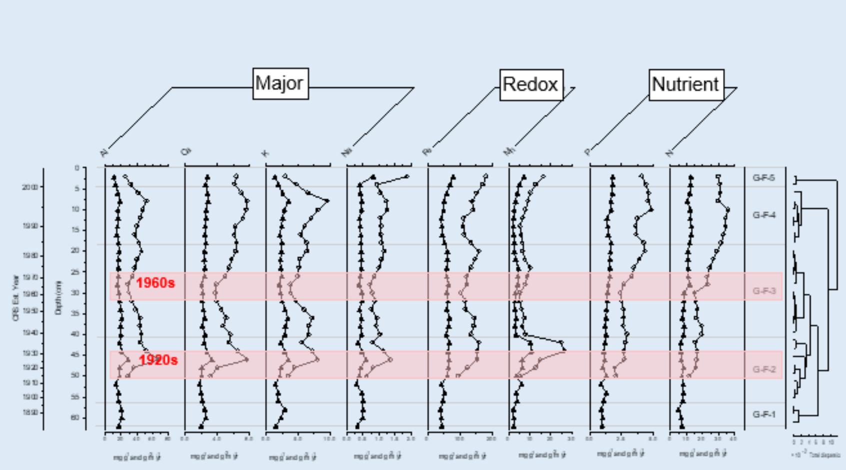
Feeagh – 1890

Furnace - ?3500 years

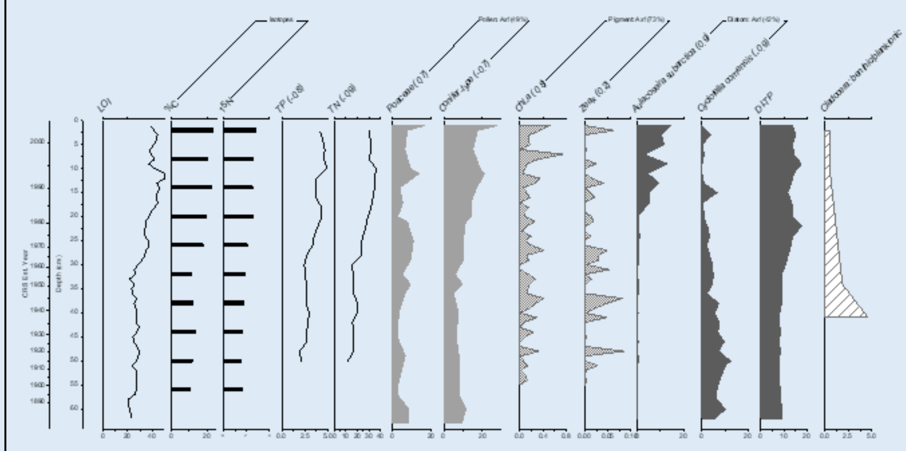
Sediment Accumulation Rate and Loss on Ignition Rate

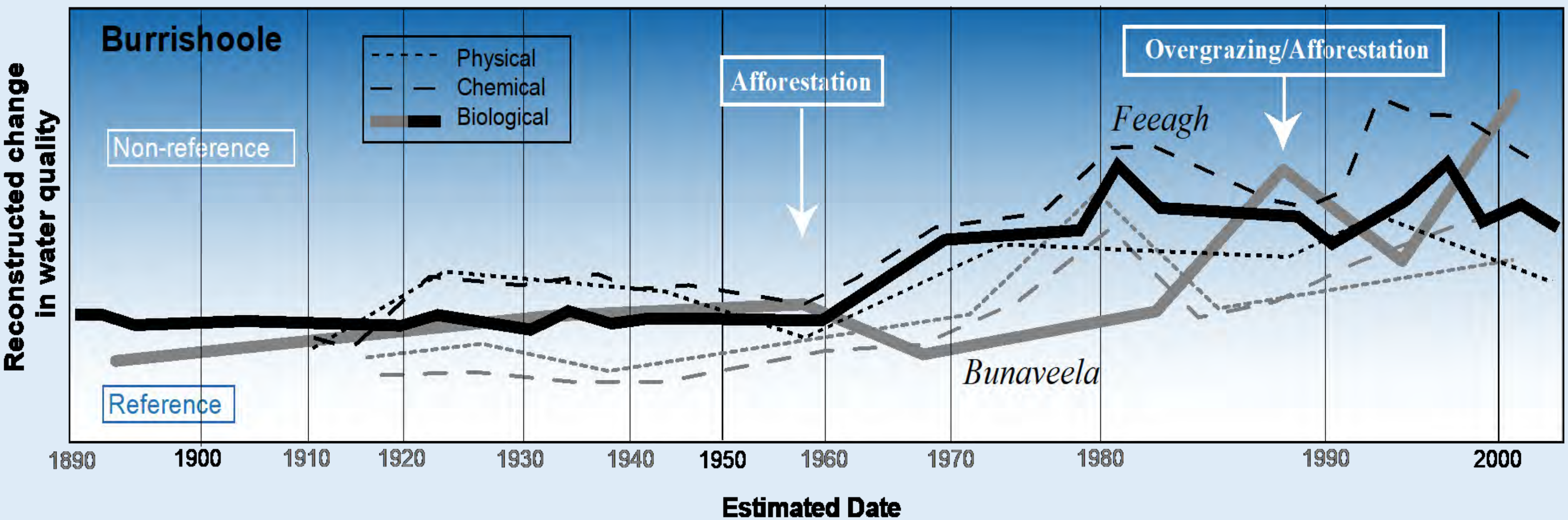


Geochemistry – Feeagh (Downstream)



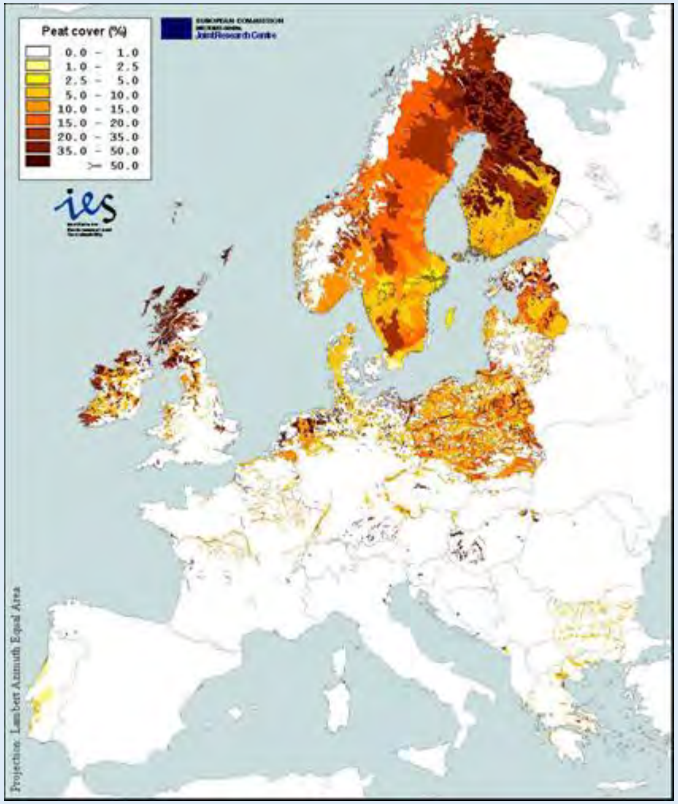
Multiproxy – Feeagh (Downstream)





Burrishoole
Physical
Chemical
Biological
Non-reference
Reference
Afforestation
Overgrazing/Afforestation
Feeagh
Bunaveela
Reconstructed change in water quality
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Estimated Date

CARBON



Peat cover in Europe: Monterella et al. 2006

20.6% of Ireland is peat

(Connolly and Holden., 2009)

75% of the national soil C

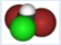
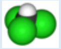
(Renou-Wilson et al. 2011)

Dissolved Organic Carbon

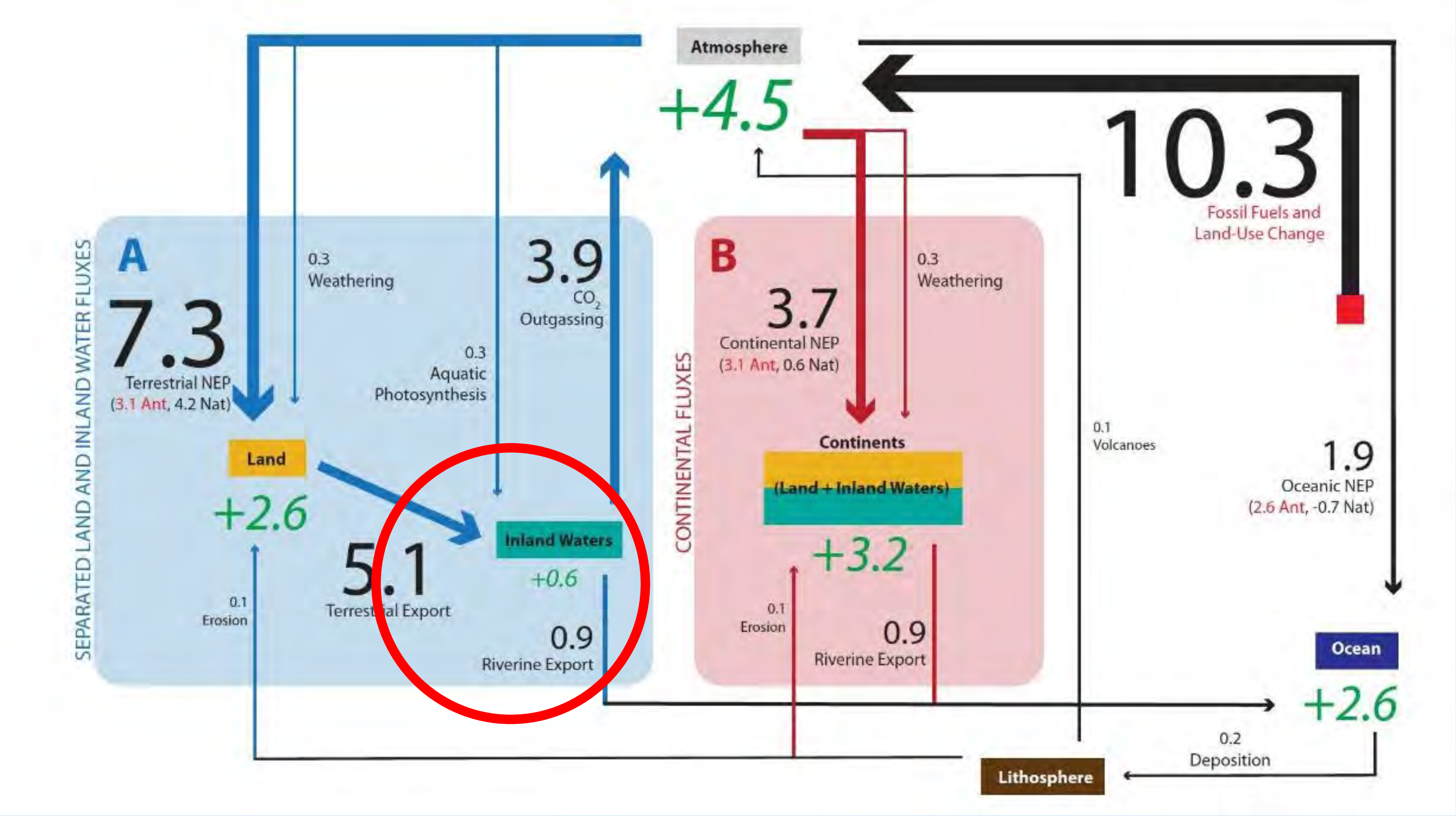
- **High DOC concentrations in streams draining peat soils**

- **Major carbon source in downstream systems**

- **Issues for water treatment**
  DOC + chlorination = THMs

  e.g. $CHCl_3$ 
  e.g. $CHBr_2Cl$ 

major health implications



Drake, T. W., Raymond, P. A. and Spencer, R. G. M. (2017), Terrestrial carbon inputs to inland waters: A current synthesis of estimates and uncertainty. Limnol. Oceanogr. doi:10.1002/lol2.10055


Rough River ARMS


Glenamong River ARMS


Black River ARMS


Lough Feeagh AWQMS


Lough Furnace AWQMS

High Frequency Monitoring of Carbon

- The carbon cycle has numerous global interconnections with, and implications for; water, soil, land management, ecology, climate and energy.

- Recent increases observed in dissolved organic matter (DOM) concentrations in streams, rivers and lakes in catchments draining peatlands in Europe.

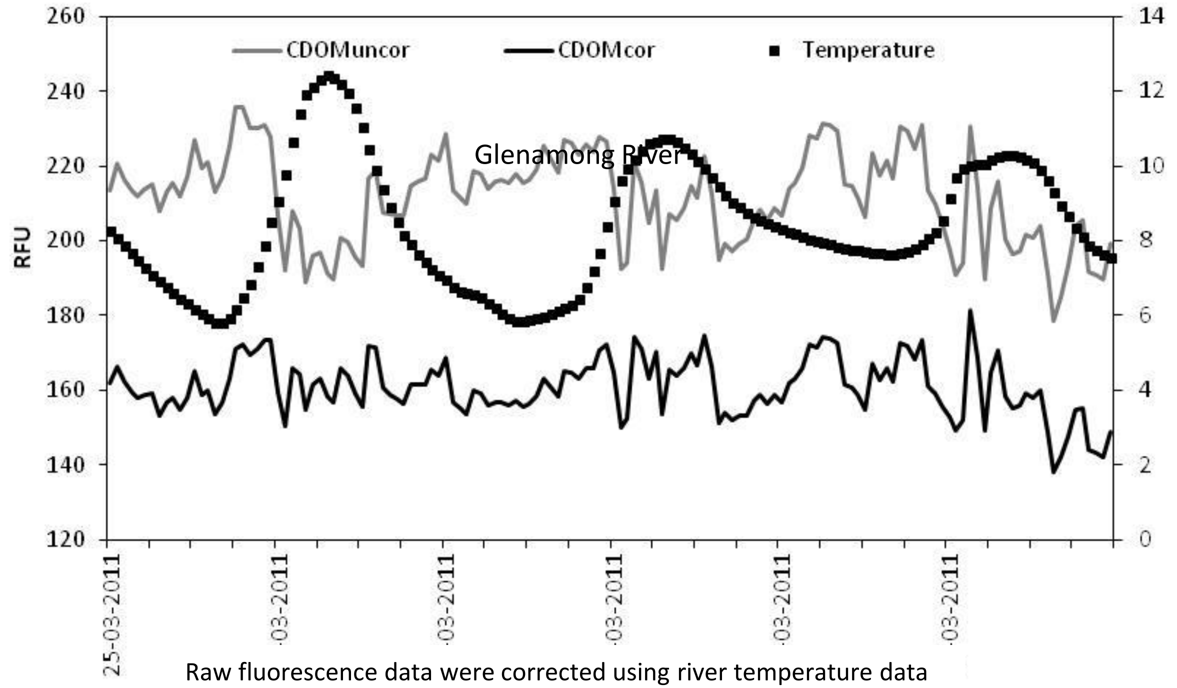
- May indicate a destabilisation of peatland carbon stores.

- Increase in carbon has major implications for aquatic ecosystems and drinking water resources.

The dissolved fraction of organic carbon is most commonly studied. The 'dissolved' = compounds below 0.45µm

Dissolved Organic Carbon (DOC)

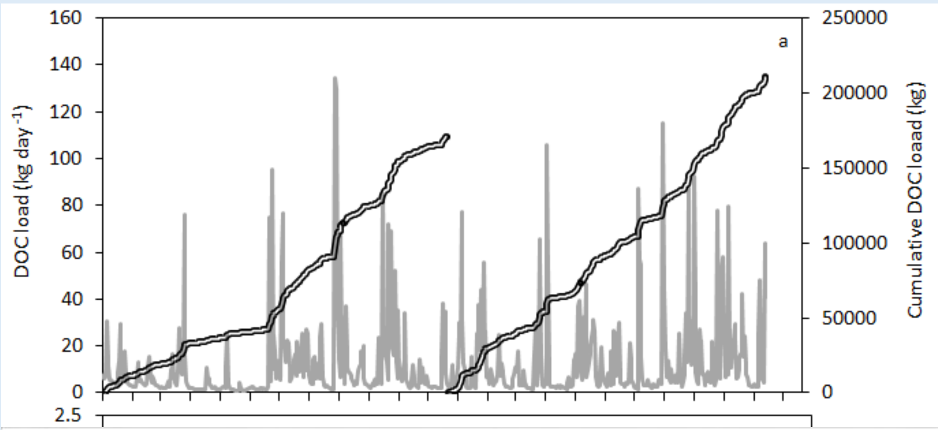
Instrument specific corrections: e.g. Temperature quenching of CDOM

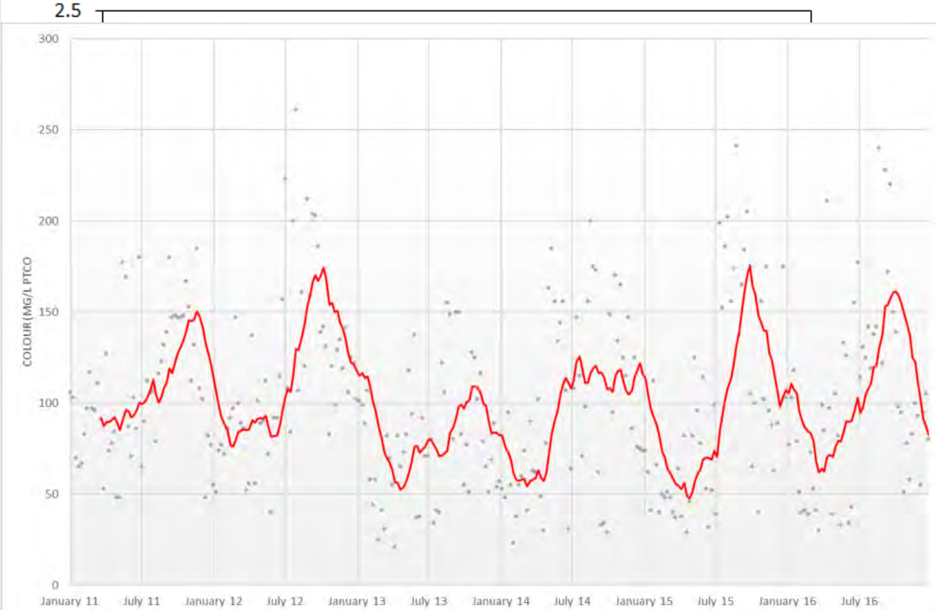


Raw fluorescence data were corrected using river temperature data

Ryder *et al.* 2012: L&O Methods.
Ryder *et al*. 2015: L&O Methods.

High Frequency Monitoring of Allochthonous Carbon





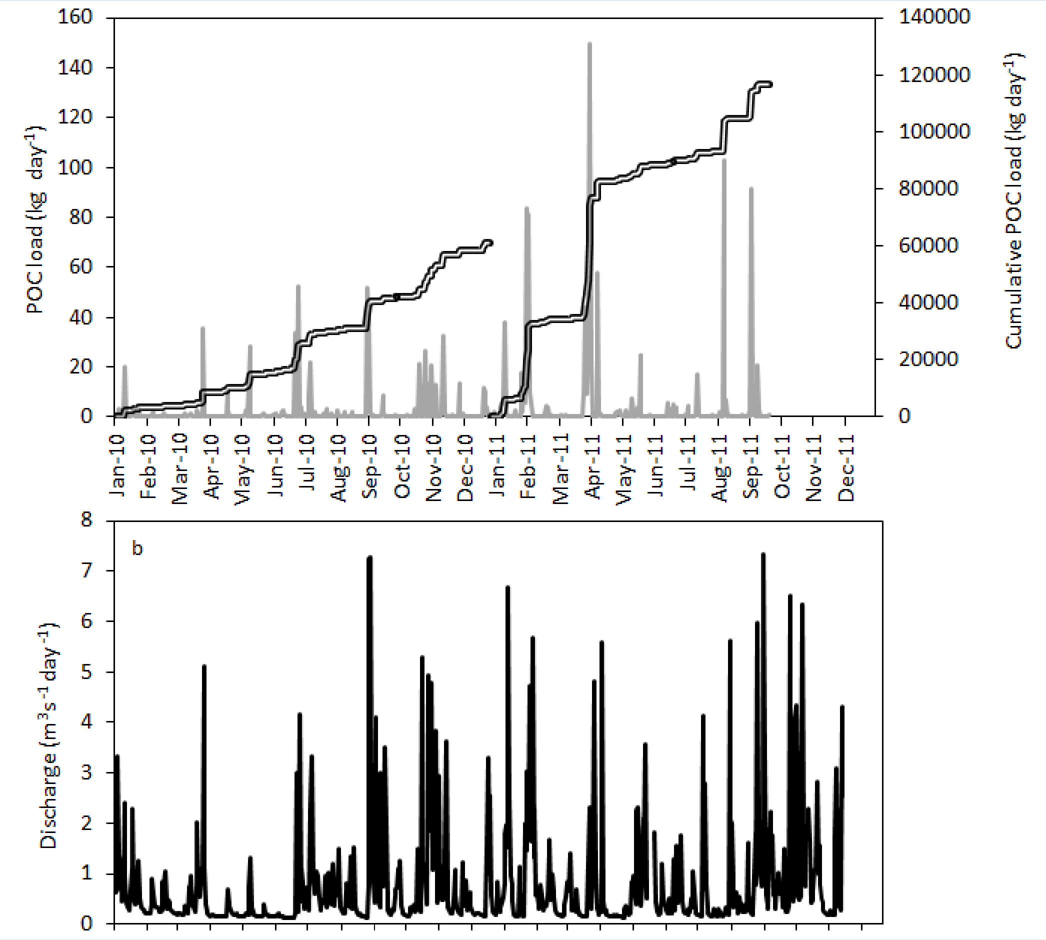
Annual loads of DOC export
9.8 t DOC km^2 year^{-1} - 2010
12.6 t DOC km^2 year^{-1} - 2011

Significant drivers of variability in **DOC** concentration:

- Soil temperature
- stream discharge
- drought conditions

Ryder *et al*. 2014: Science of the Total Environment.

High Frequency Monitoring of Allochthonous Carbon



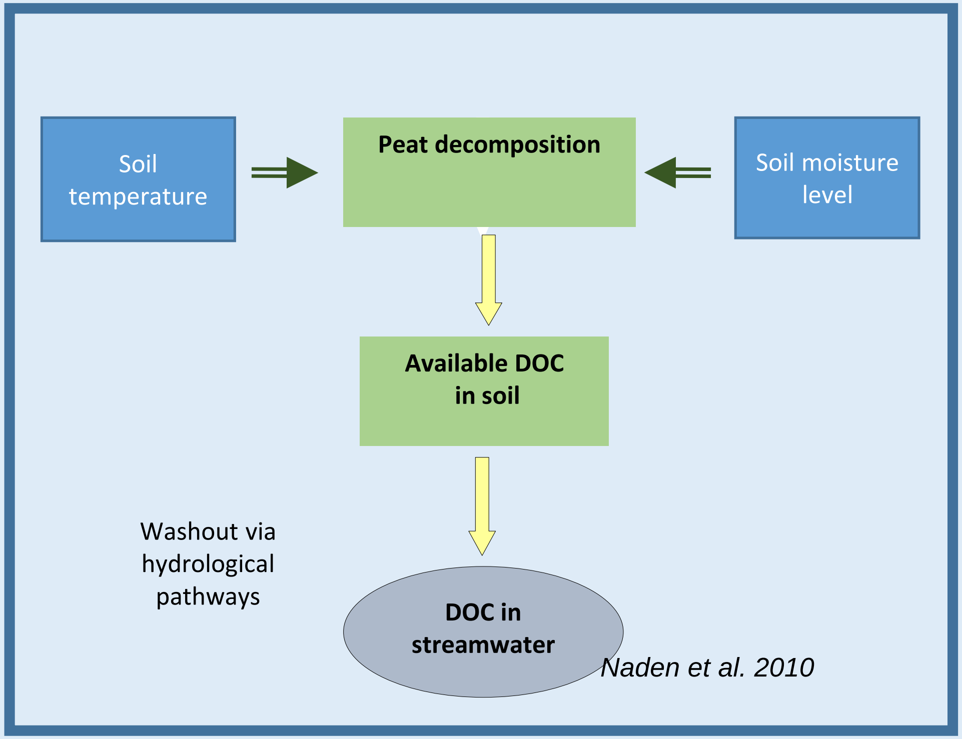
Annual loads of POC export was 6.2 t POC km^{-2} $year^{-1}$

Significant drivers of variability in **POC** concentration:

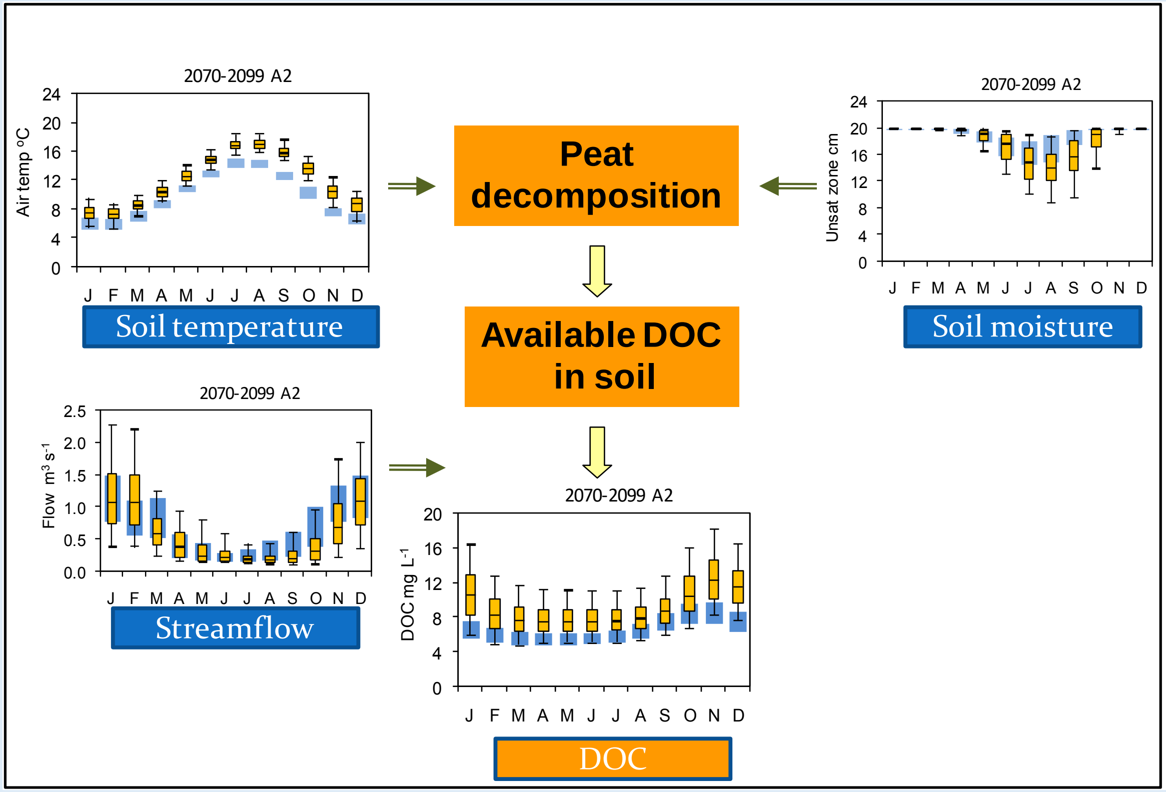
- Soil temperature
- stream discharge
- rainfall levels

Ryder *et al*. 2014: Science of the Total Environment

Model of DOC export used in CLIME / RESCALE



Drivers of increase in DOC concentrations A2 scenario 2070-2099



Jennings et al., 2010; Fealy et al. 2010

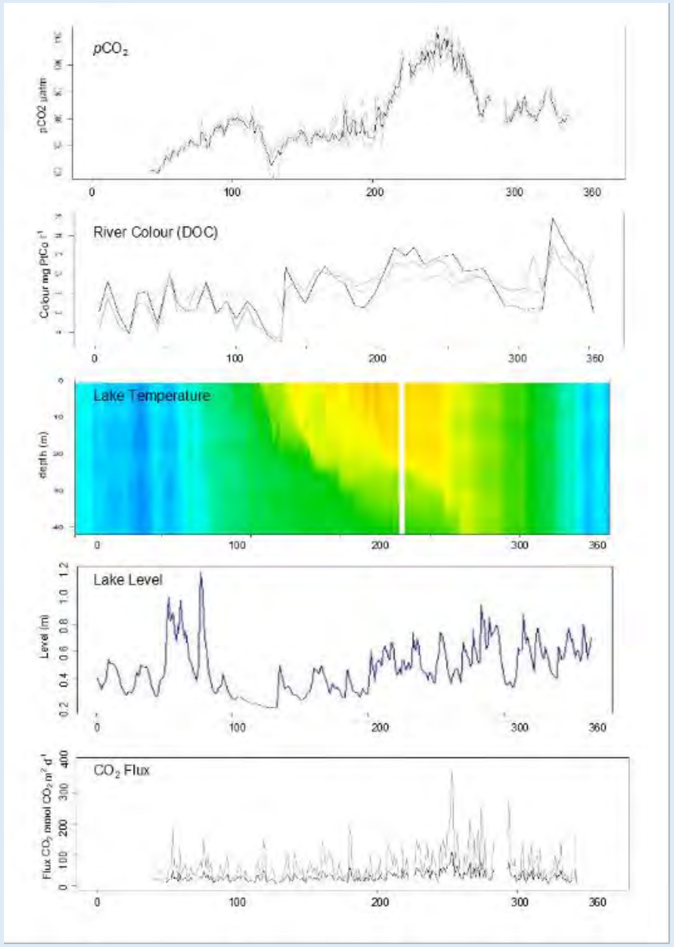
Future climate projections: increase of 15% to 36% in DOC concentrations exported from peat catchments.

The drivers of pCO_2 variability in Lough Feeagh

Brian C. Doyle, *Elvira de Eyto, Mary Dillane, Russell Poole, Valerie McCarthy, Eleanor Jennings*

The drivers of *p*CO_2 variability in Lough Feeagh

***Brian C. Doyle**, Elvira de Eyto, Mary Dillane, Russell Poole, Valerie McCarthy, Eleanor Jennings*



Aims & Objectives of the study:

- What is the temporal variability of *p*CO_2 in the lake over the study period (2017)?
- What are the key environmental drivers of this variability?
- What is the magnitude of the CO_2 flux from the lake over the study period?

Methods and Data Sources

Aquatic pCO_2 Sensor

Data Sources:

- pCO_2 data was collected from an aquatic CO_2 sensor positioned on the AWQMS, 1 meter below the lake surface.

- Other key data sources used in the analysis from the Catchment include:
  - Lake Water Temperature
  - Wind Speed
  - Rainfall
  - Solar Radiation
  - Dissolved Oxygen
  - Dissolved Organic Carbon
  - Lake Water pH

Main drivers of CH_4 in Lough Feeagh (work in progress T. Hanson)

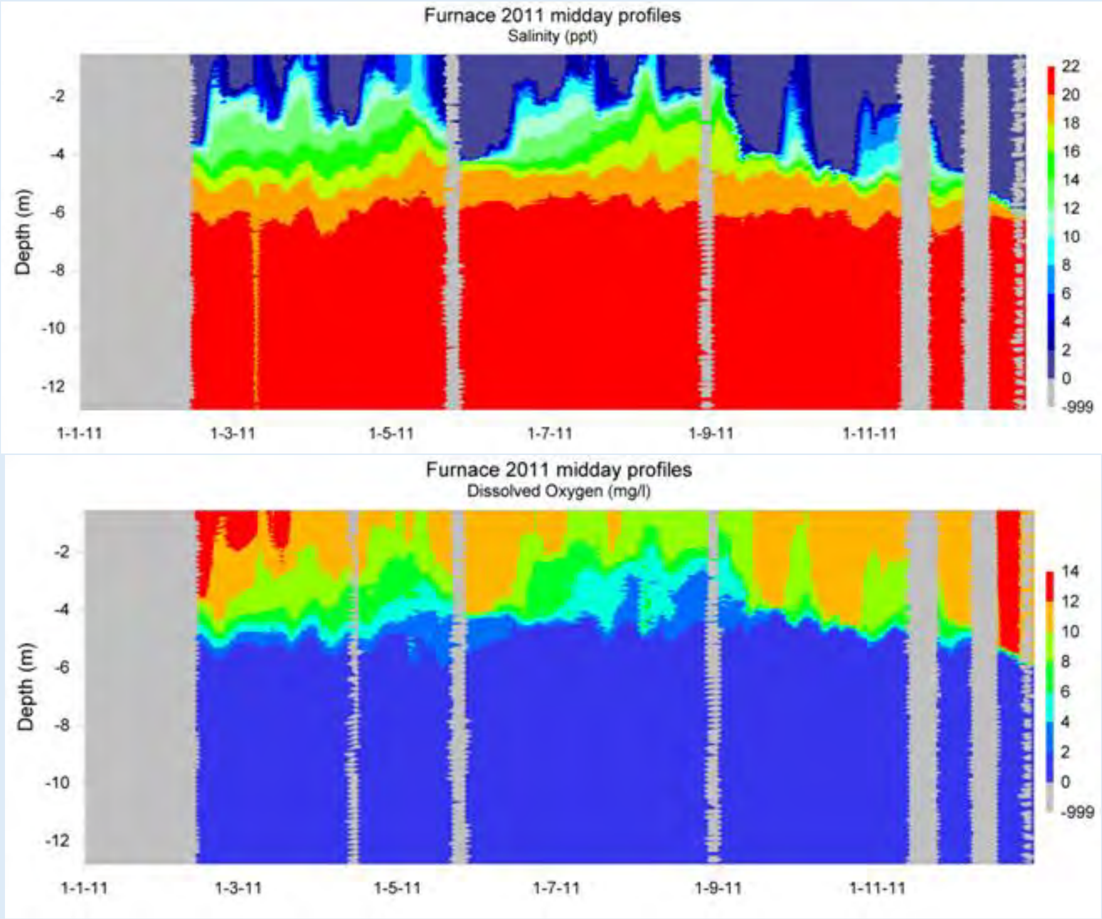
- Flowrate/precipitation appears to have strong negative effects

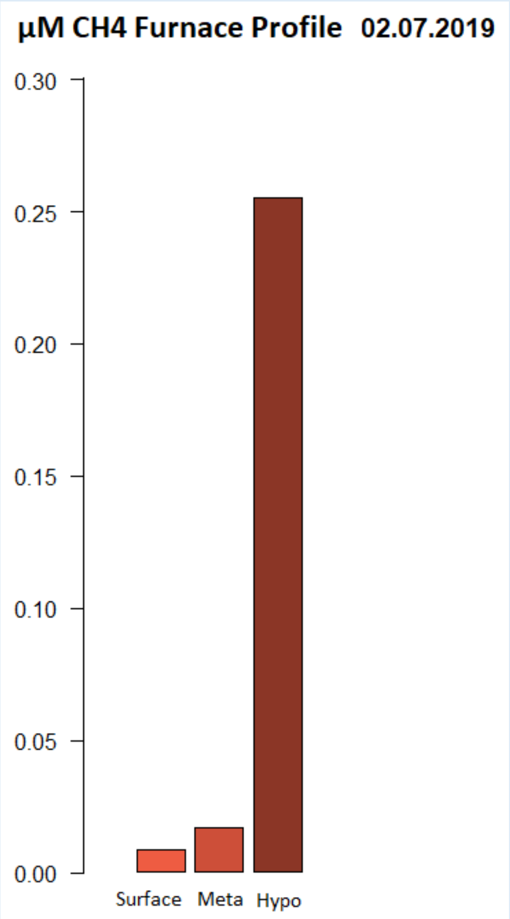
- Presence of thermocline, likely influences concentrations ìn the deeper parts of the lake.

- Oxidation also occurs in the lake, however, rates appear too low to explain rapid loss of methane from inflow area.

- Flux measurements demonstrated CH_4 flux to atmosphere (up to 48 ppm/h according to initial data analysis)

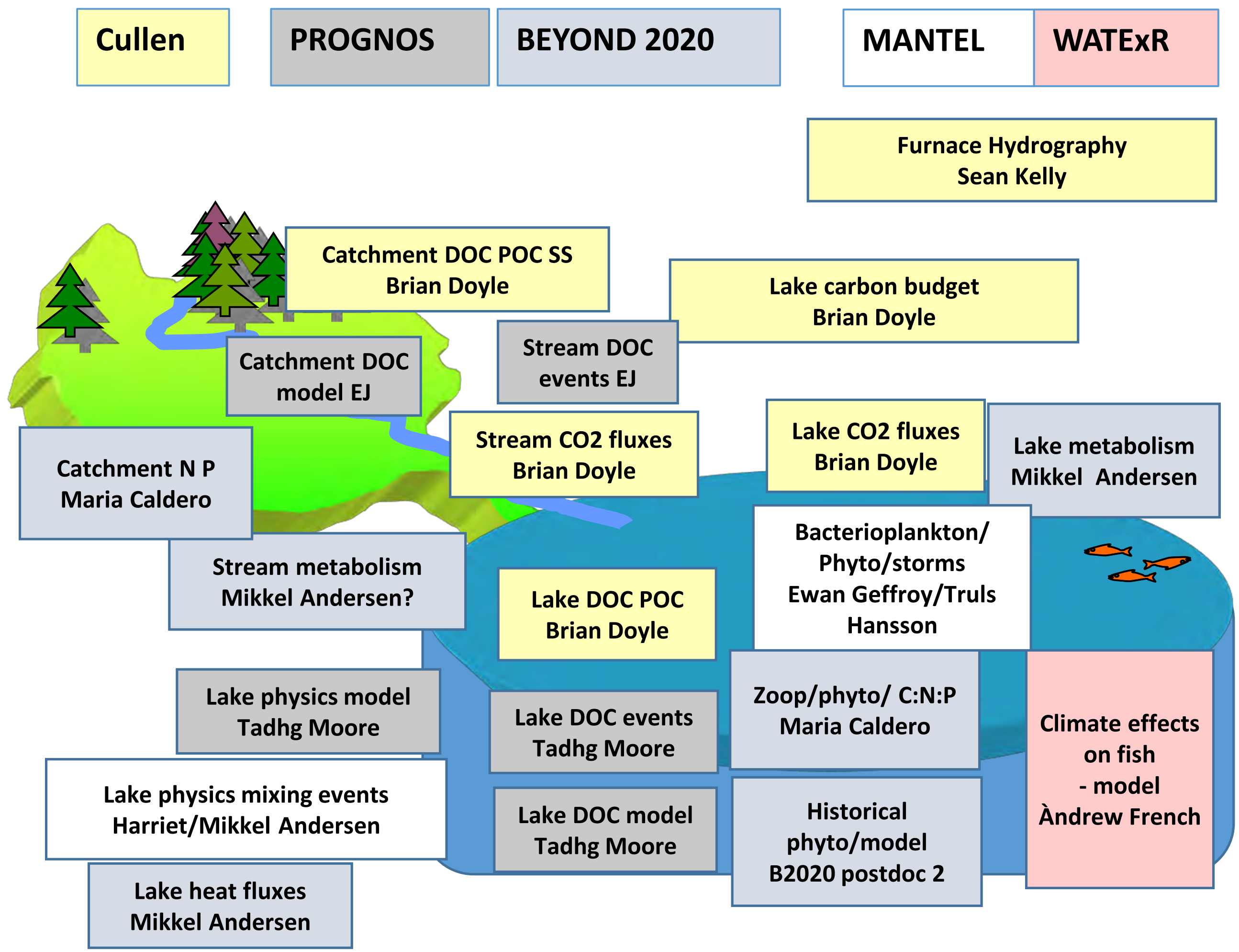
Tidal Lough Furnace CH_4 concentrations – impact of anoxia





Conclusions

- High resolution data collected since the mid 1950s, peatland dominated
- Loss of terrestrial carbon to the lake, through in-river DOC & POC
- Loss of C to the atmosphere
- DOC: 9-12t C km^{-1}. $year^{-1}$, linked to temperature and moisture
- POC: 6t C km^{-1}. $year^{-1}$, more related to floods & erosion
- Climate change expected to increase DOC by up to 36%
- Lough Feeagh, a humic lake, appears to be a net omitter of CO_2 & CH_4
  - (work in progress)
- CH_4 emissions relatively low
  - Related to incoming DOC & POC, increases with stratification and anoxia
- In Burrishoole, intensive catchment/aquatic studies: collaborations welcomed


Cullen
PROGNOS
BEYOND 2020
MANTEL
WATExR
Furnace Hydrography
Sean Kelly
Catchment DOC POC SS
Brian Doyle
Lake carbon budget
Brian Doyle
Stream DOC
events EJ
Catchment DOC
model EJ
Stream CO2 fluxes
Brian Doyle
Lake CO2 fluxes
Brian Doyle
Lake metabolism
Mikkel Andersen
Catchment N P
Maria Caldero
Bacterioplankton/
Phyto/storms
Ewan Geffroy/Truls
Hansson
Stream metabolism
Mikkel Andersen?
Lake DOC POC
Brian Doyle
Lake physics model
Tadhg Moore
Lake DOC events
Tadhg Moore
Zoop/phyto/ C:N:P
Maria Caldero
Climate effects
on fish
- model
Àndrew French
Lake physics mixing events
Harriet/Mikkel Andersen
Lake DOC model
Tadhg Moore
Historical
phyto/model
B2020 postdoc 2
Lake heat fluxes
Mikkel Andersen

Thank you for your attention

More information:

http://burrishoole.marine.ie

http://prognoswater.org

@edeeyto

@MarineInst

#burrishooleLTER