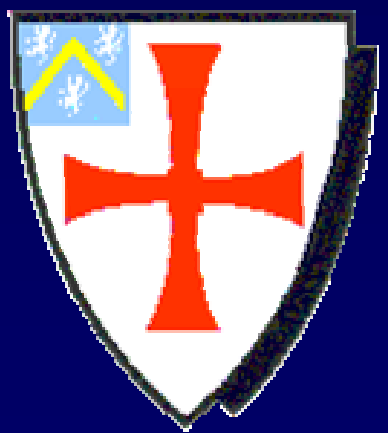
Carbon in the Uplands

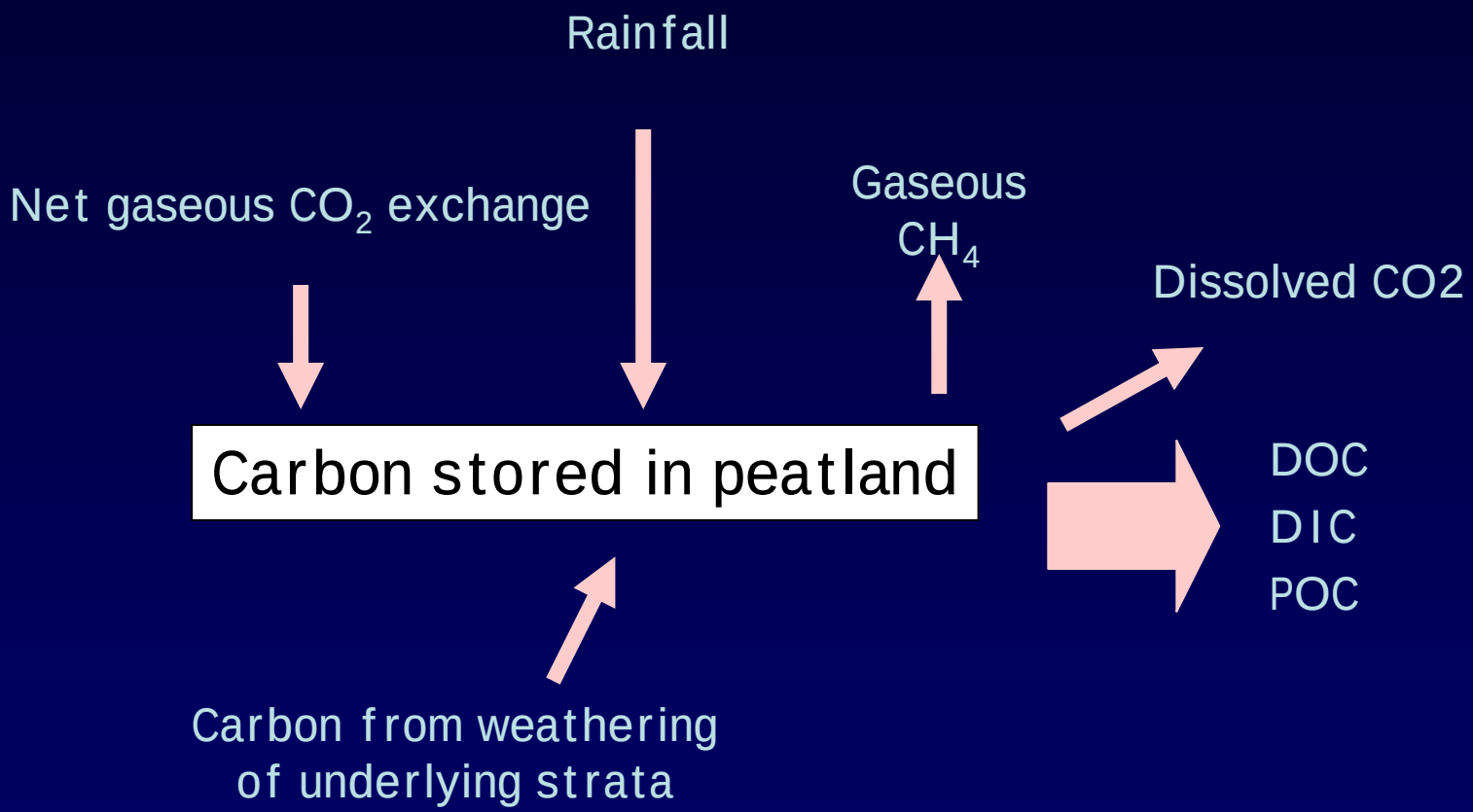
Fred Worrall
Dept of Geological Sciences,
University of Durham



Why be interested in Carbon?

- UK peat is the country's largest terrestrial carbon store
  - More carbon stored than the forests of Britain and France combined
- UK peat is a major water source in Northern Britain
  - Water colour is major water quality limitation
- Are UK uplands a sink or source of carbon?

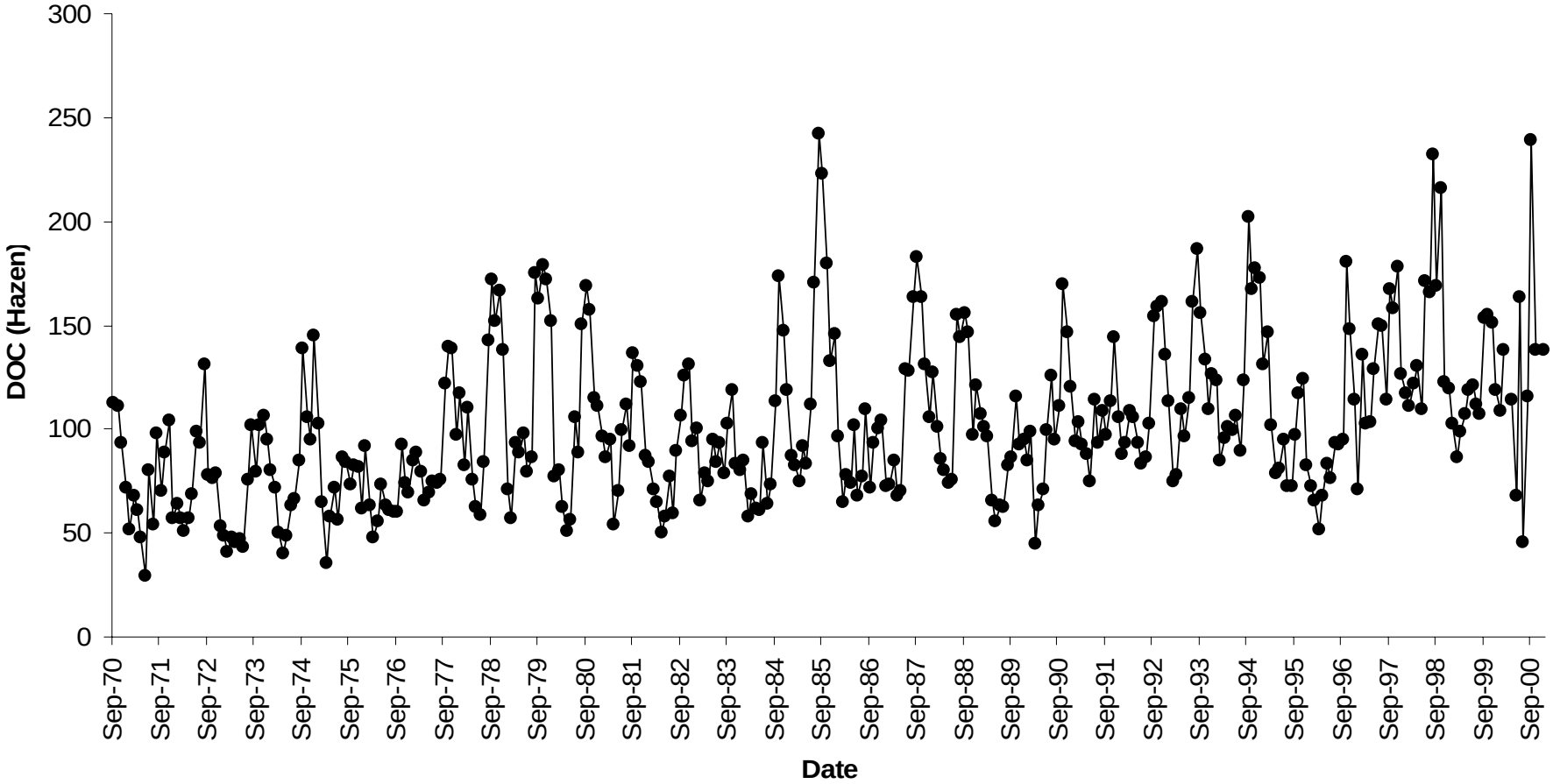
Carbon uptake and release pathways for Moor House



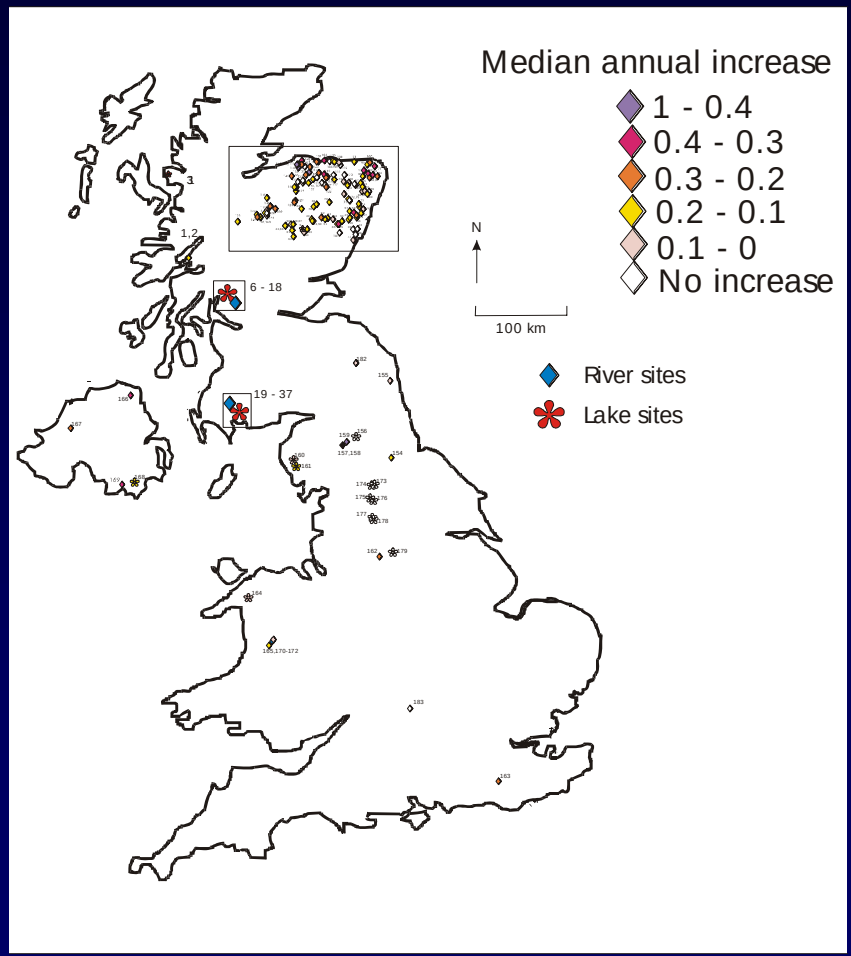
Carbon flux from Moor House

Input/Output route	Areal input/export rate ($gC/m^2/yr$)	Range ($gC/m^2/yr$)
Rainfall DIC	1.1	
Rainfall DOC	3.1	
CO_2	54.2	40.2 – 68.2
CH_4	-7.1	-1.5 – -11.3
DOC	-9.4	-9.4 - -15
POC	-19.9	4.2 - -31.7
Dissolved CO_2	-3.8	-2 - -3.8
DIC	-5.9	-4.1 - -5.9
Weathering DIC	1.8	0 – 1.8
Total	**14.1**	**14.5 $\pm$ 1.0**

The graph that started it all



Trends in Fluvial carbon



- 183 stream and lake sites from across the UK
- Catchment size from 400m^2 to 2120 km^2
- Covers period 1961 - 2001
- 86% of sites show significant increase
- No sites show a significant decrease

Cause of upward trend

- Change in flow
- Increasing summer temperature
  - Increased enzyme activity
  - Increased drawdown of water table
  - Increased faunal activity
- Enzyme latch/increased summer drought
- Change in chemistry
  - Acidification
  - Eutrophication
- Land-use change
  - Afforerstation
  - Drainage

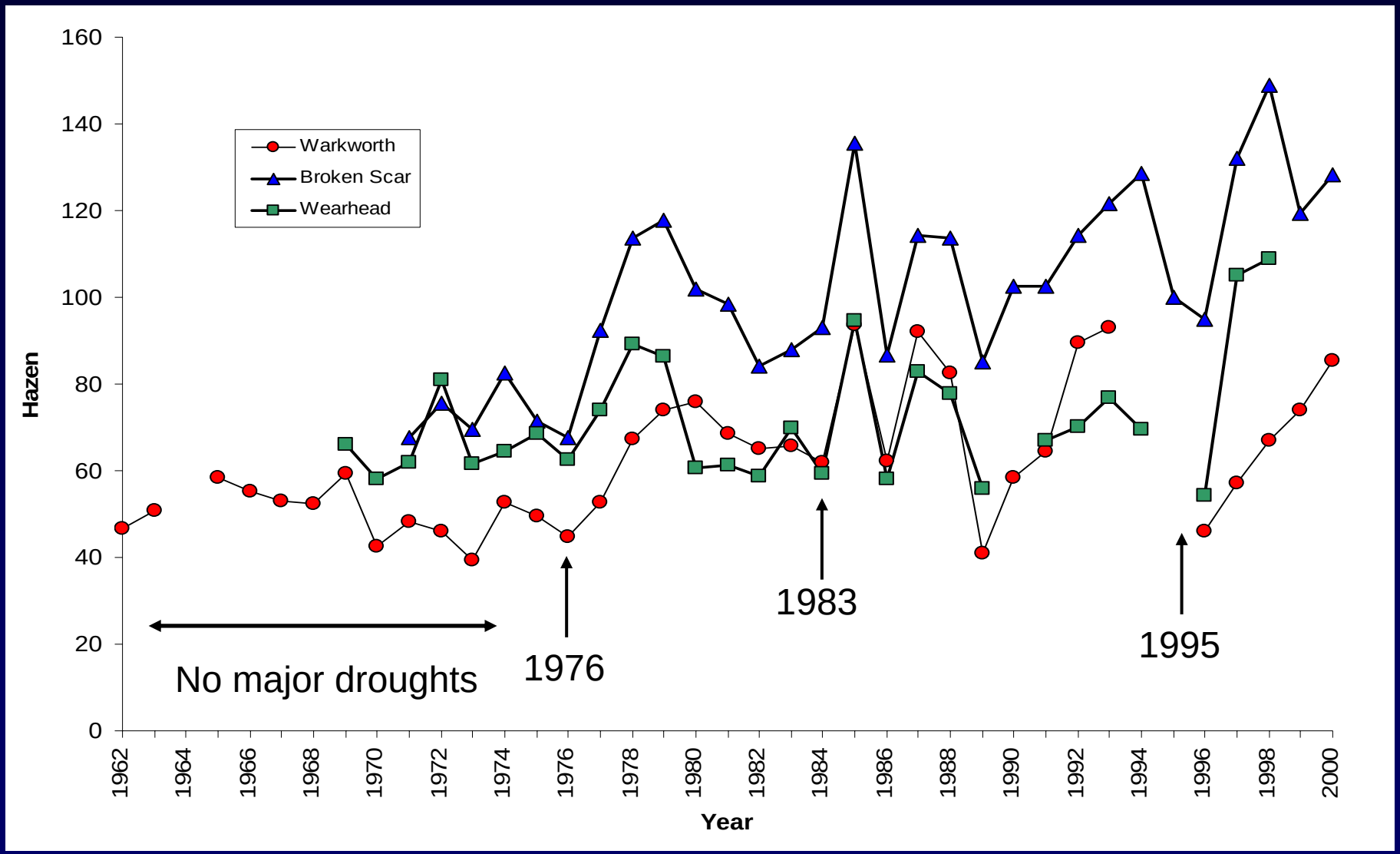
What causes increase?

- Discharge → No
- Temperature → Insufficient
- Acidification → Not widespread
- Land-use change → Not widespread
- Eutrophication → Lack of evidence
- Enzyme latch → Only thing left?

What is an enzyme latch?

- The de-repression of anaerobic degradation by a drop in water table
- Anaerobic degradation is switched on but not switched off by fall in water table
- Enhanced DOC production should be related to severe droughts

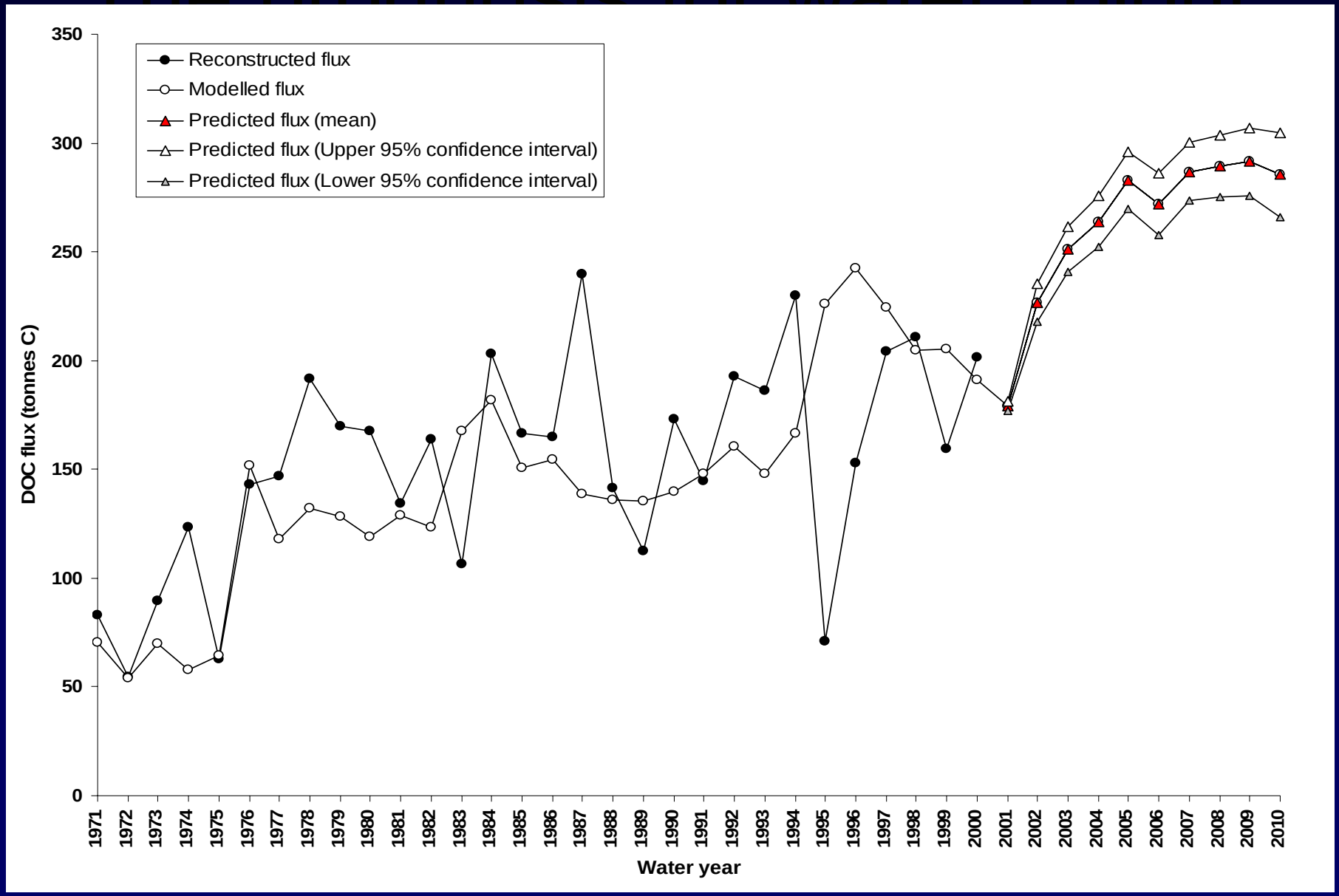
Carbon flux from Northumbrian catchments



The prognosis for Water Colour?

- Constructing a “business as usual” model
- What will happen to water colour if nothing is done
- Model
  - based on data from Moor House
  - estimates annual DOC flux
  - includes effects of temp., rainfall & enzyme latch
  - predicts flux to 2010

The future of DOC flux at Moor House



What does this trend mean?

- Flux at Broken Scar
  - Average flux 1995-2000 = 4.08 Kt
  - Predicted for 2010 = 6.95 Kt
- Colour at Broken Scar
  - Average colour 1995 – 2000 = 107 ± 32 Hazen
  - Predicted for 2010 = 151 ± 46 Hazen
- Upland peat will be a net source by 2013

UK carbon fluxes

	Present UK carbon inventory	This research
River flux	+0.68 Mt C/yr	+0.86 Mt C/yr
Peats	-0.7 Mt C/yr	-0.27 Mt C/yr
Forests	-1.62 Mt C/yr	
Fossil fuels	+142 Mt C/yr	

Can the trend be reversed?

- Climate change cannot be reversed
- Susceptibility to climate change could be altered
- Land-use change reversed to preserve water table and enhance water retention
- Grip-blocking

Conclusions

- Upland peats are presently a net sink for CO_2
- The trend is toward increased losses of carbon storage
- The increased losses are driven by drought but extenuated by increasing temperature and land management
- Water table restoration maybe the only hope