Lake bedtime stories: the value of sediment records for lake restoration

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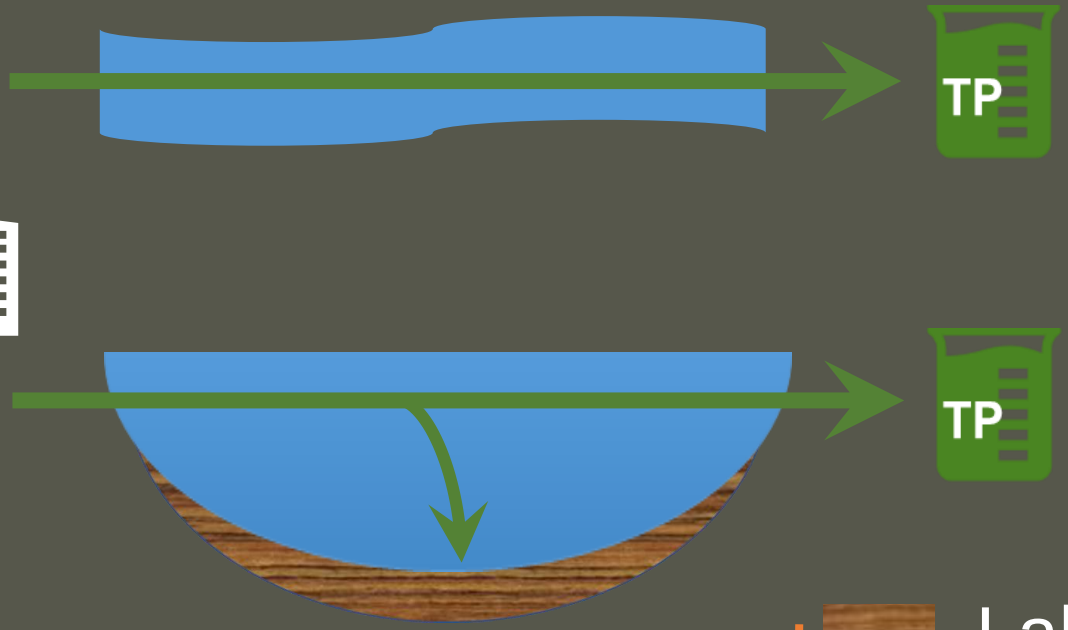
Why phosphorus?

Why lake sediments?



Monitoring of both rivers and lakes can tell us about current** TP concentrations and catchment P exports

Lakes also have a “memory” of historic TP and catchment P exports in the form of the sediment record

** the earliest continuous monitored TP records in the UK date from ~1960-1970

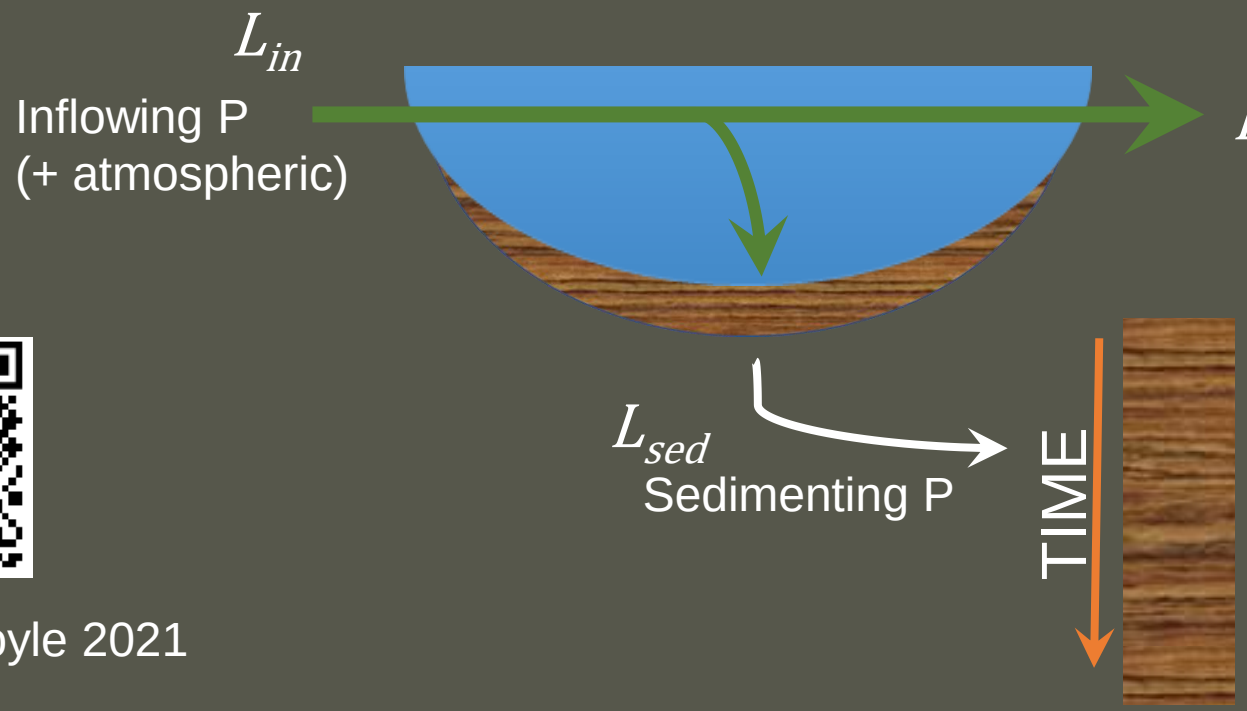
Historic lake water TP records from sediment cores

If we consider the P in the lake as a mass balance then:

$$L_{in} = L_{sed} + L_{out}$$

We can calculate sediment-inferred lake water TP (SI-TP) using:

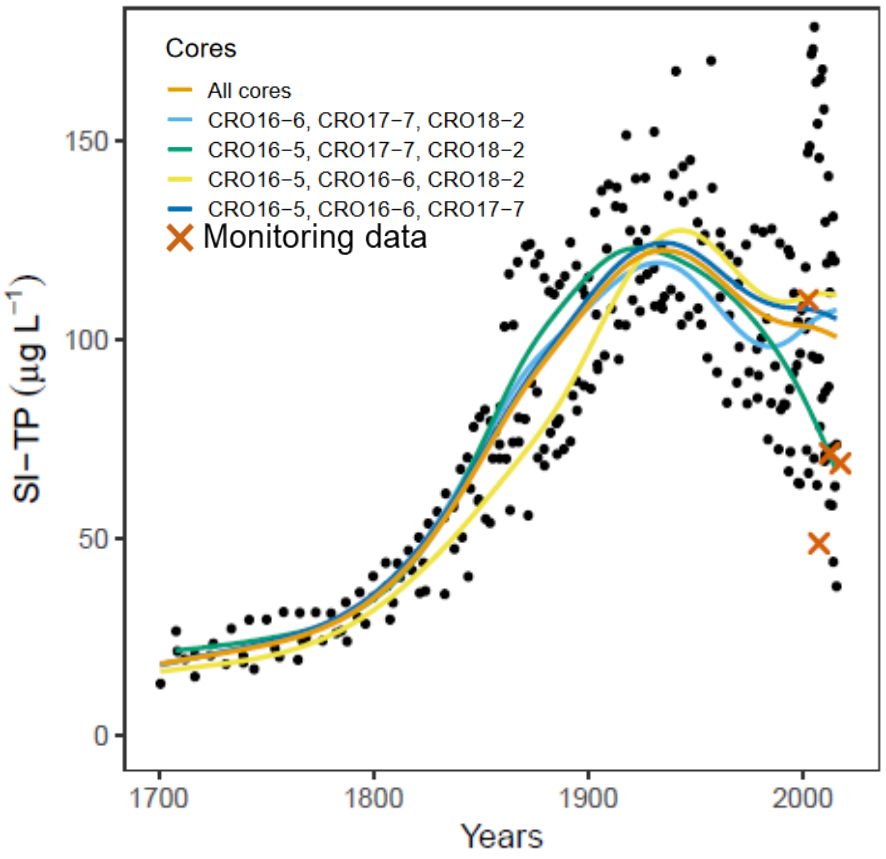
$$SI\text{–}TP = \frac{L_{sed}}{R_P q_s}(1 - R_P)$$

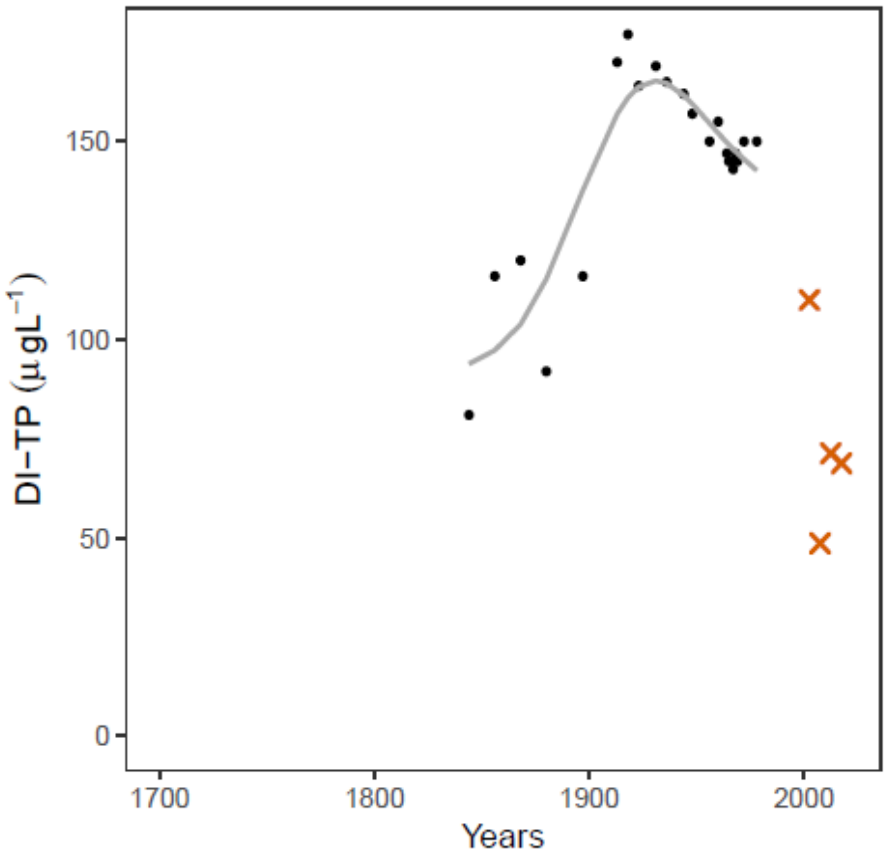


Moyle & Boyle 2021

L	P loading (area normalised P flux)	mg/m^{2}LA/yr
q_s	Areal water load (i.e. Q/LA)	m/yr
R_P	P retention coefficient (how well the sediment retains P) $R_P = \frac{L_{in} - L_{out}}{L_{in}} = \frac{L_{sed}}{L_{in}}$	-

Historic lake water TP records from sediment cores





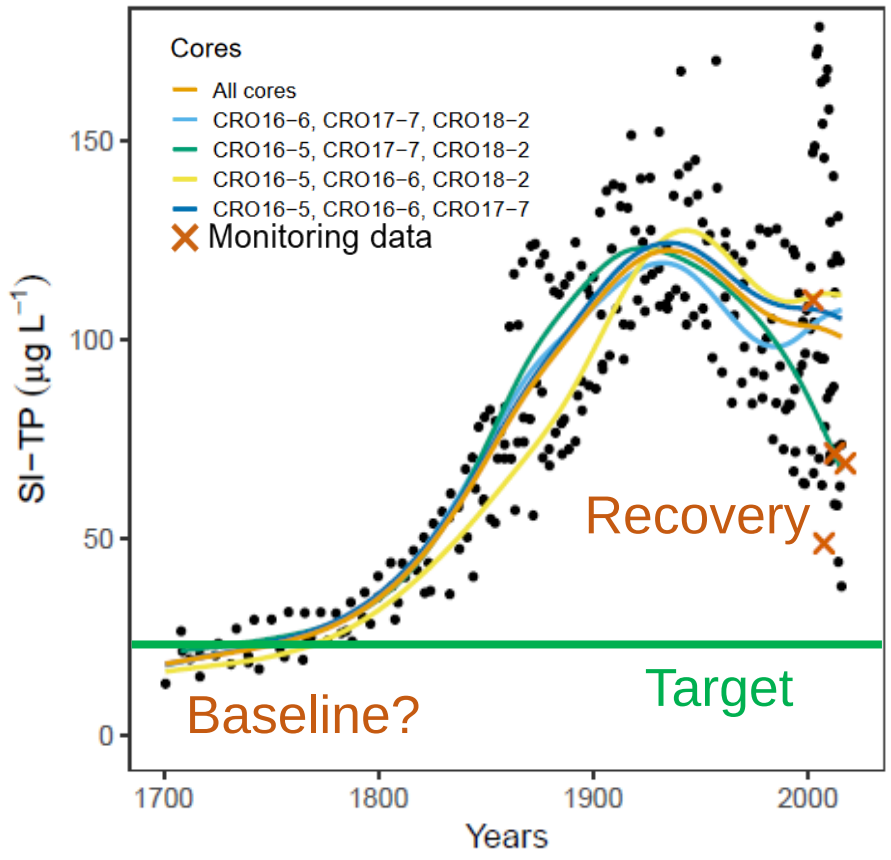
We can compare SI-TP to the existing diatom-inferred method (DI-TP)

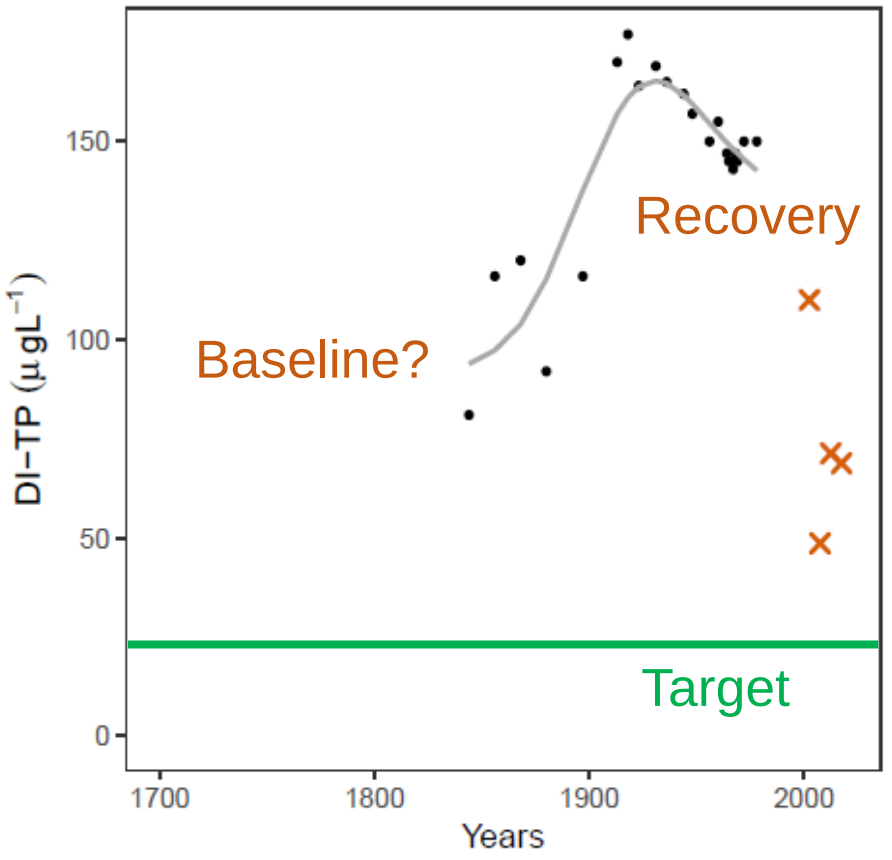
The two methods show remarkable similarity for records that are:

- Independent
- Un-tweaked

Record from Crose Mere, Shropshire

Historic lake water TP records from sediment cores





At this site diatom preservation was progressively worse down core – we get a much longer record from SI-TP and lower "baseline" TP values.

But does 300 years really give a "baseline" TP concentration?

Record from Crose Mere, Shropshire

SI-TP and TP targets

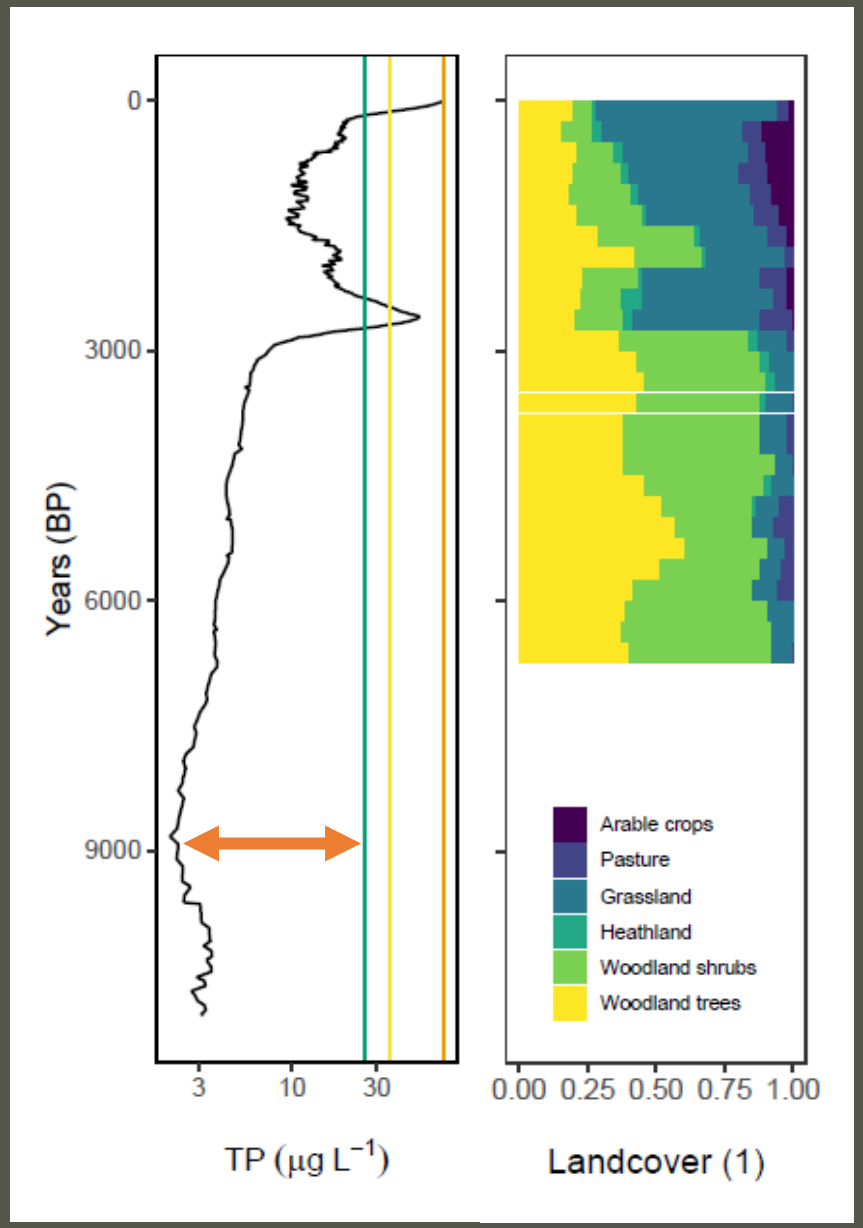
The current TP targets do not reflect a natural system

High
25 µg L^{-1}

Good
35 µg L^{-1}

Natural baseline of ~ 3 µg L^{-1}

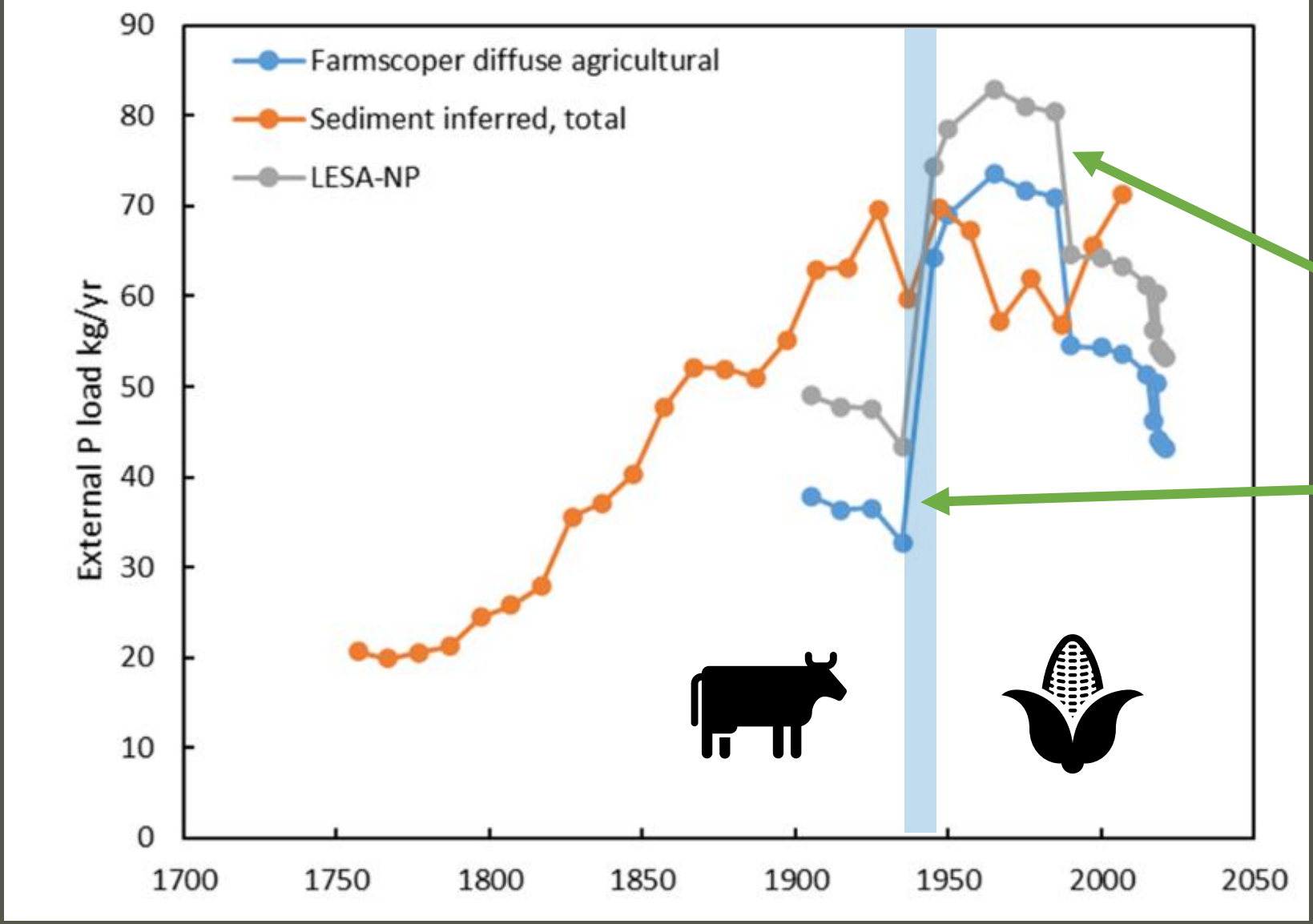
But is this realistic for a restoration TP target?



Meeting a 3 µg L^{-1} baseline would require full reforestation of the catchment.

The same would go for all lowland lakes – there would be no space for people!

Historic P loading**: Sediment record v. model output



Do the models work?

Overestimating P load

Underestimating P load

Relative stability in sediment inferred values

**Diffuse P sources only