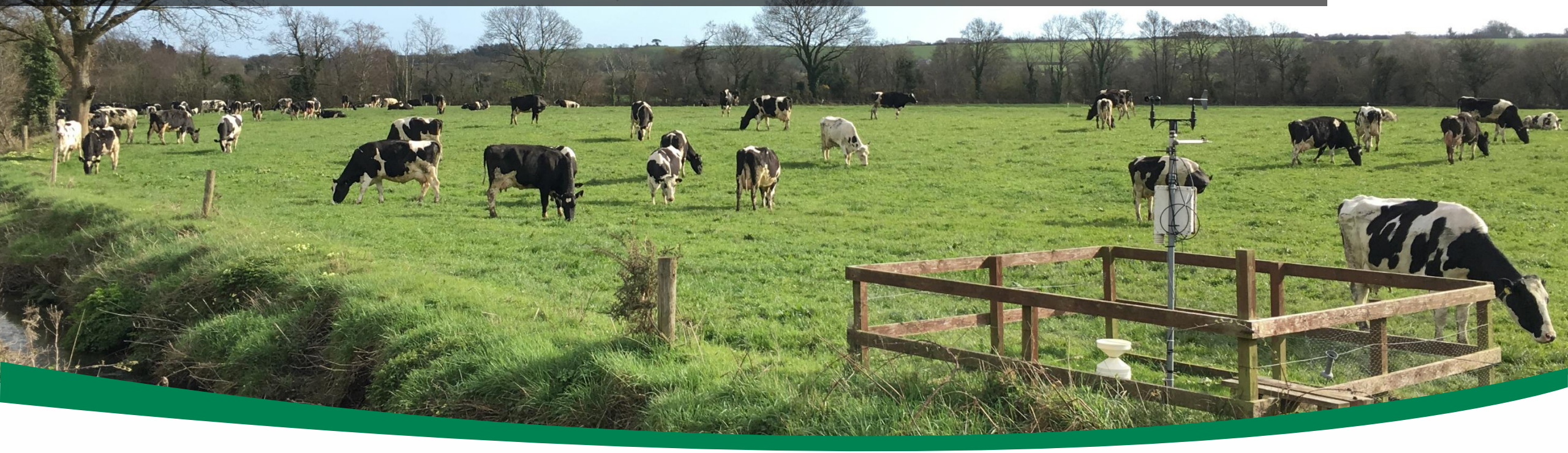
Scale of N Leaching - What, Where & When

Edward Burgess

Teagasc's Agricultural Catchments Programme



AGRICULTURAL CATCHMENTS PROGRAMME

Teagasc
Agriculture and Food Development Authority

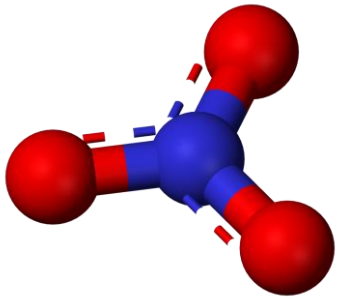
An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

What Units are we using?

MPG vs litres/100km

Nitrate (NO_3^-)

- 50 mg/l
- 37.5
- 11.5
- 8
- 4



N

- 11.3 mg/l Drinking MAC
- 8.5 (75% of MAC – avg.)
- 2.6 Marine Ecological Standard
- 1.8 EPA indicator River – good
- 0.9 EPA indicator River - high

Different Types of Water

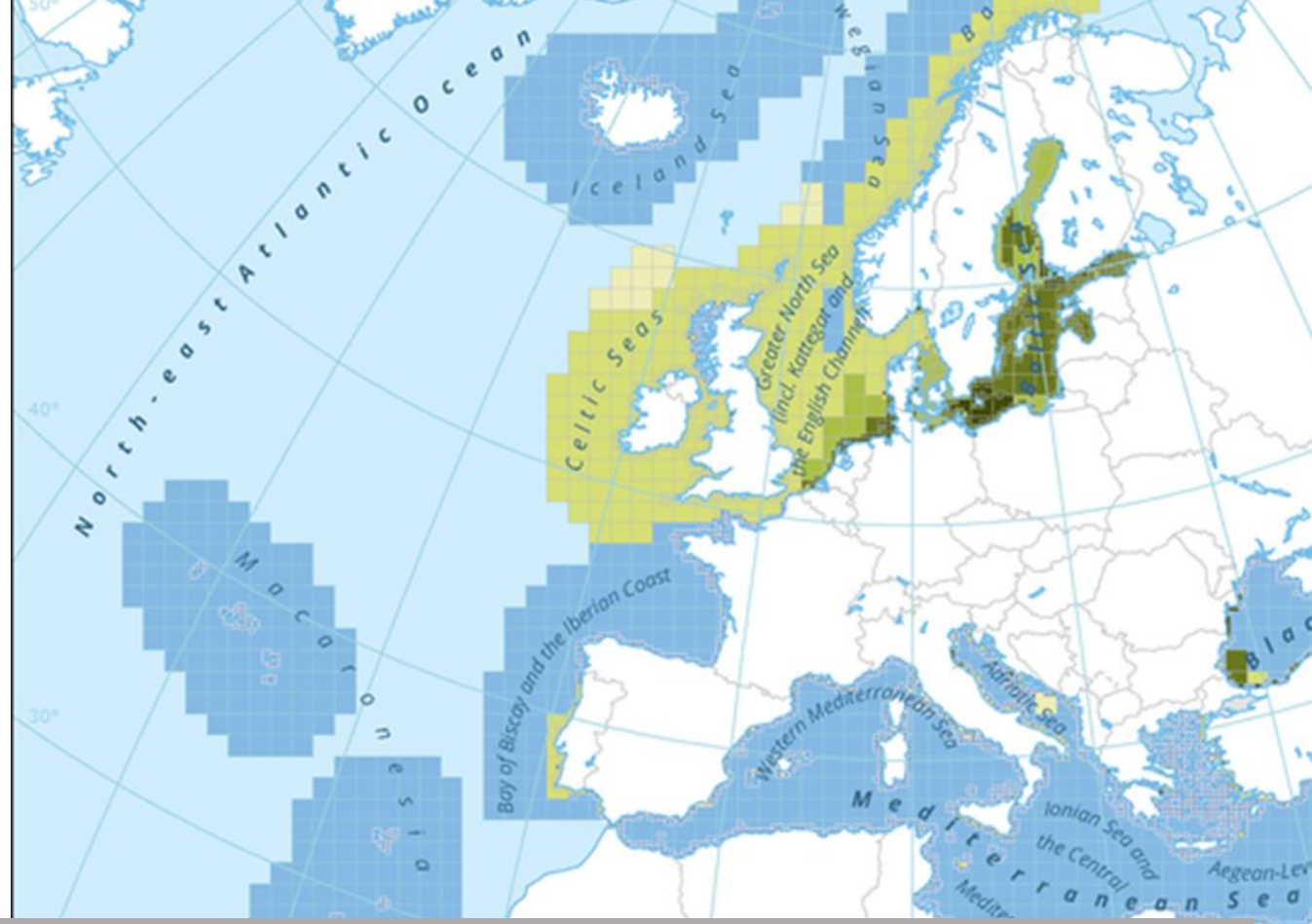
- Soil water - Leaving the root zone – Suction cups / Lysimeters
- Ground water – Below the Water Table – Well sampling
- River water - Auto & grab samples and discharge (volume)
- Estuarine - Discharge from River into the Sea – how salty ?
- Coastal - Nitrate Concentration, Eutrophication & Impact

Nutrient Load (Kg.) (Delivery) vs. Concentration (mg/l) (Impact)


0
50
100km
Algal bloom
SWEDEN
North Sea
POLAND
UK
GERMANY
LATVIA
BALTIC SEA
SWEDEN
LITHUANIA
Algal bloom
RUSSIA
POLAND
SOURCE: ESA, 11 JULY

Ecological Impact

- N ➢ mostly in salty water
- Estuaries & the sea
- WFD & Nitrates Directive



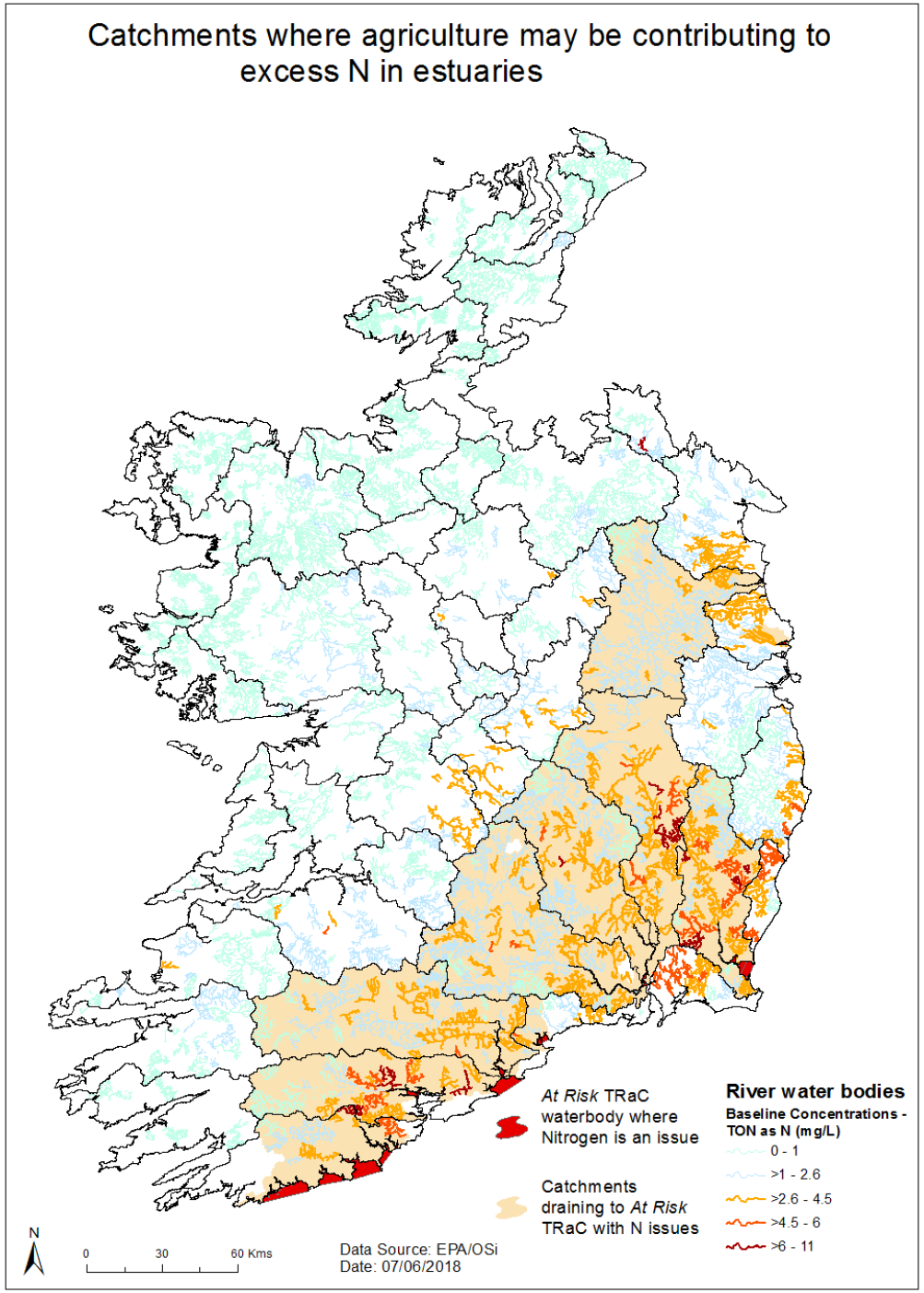
For Good Ecological Status → 2.6 mg/l N in waters that discharge from rivers into estuaries

(High Status EQS = 1 mg/l as N)

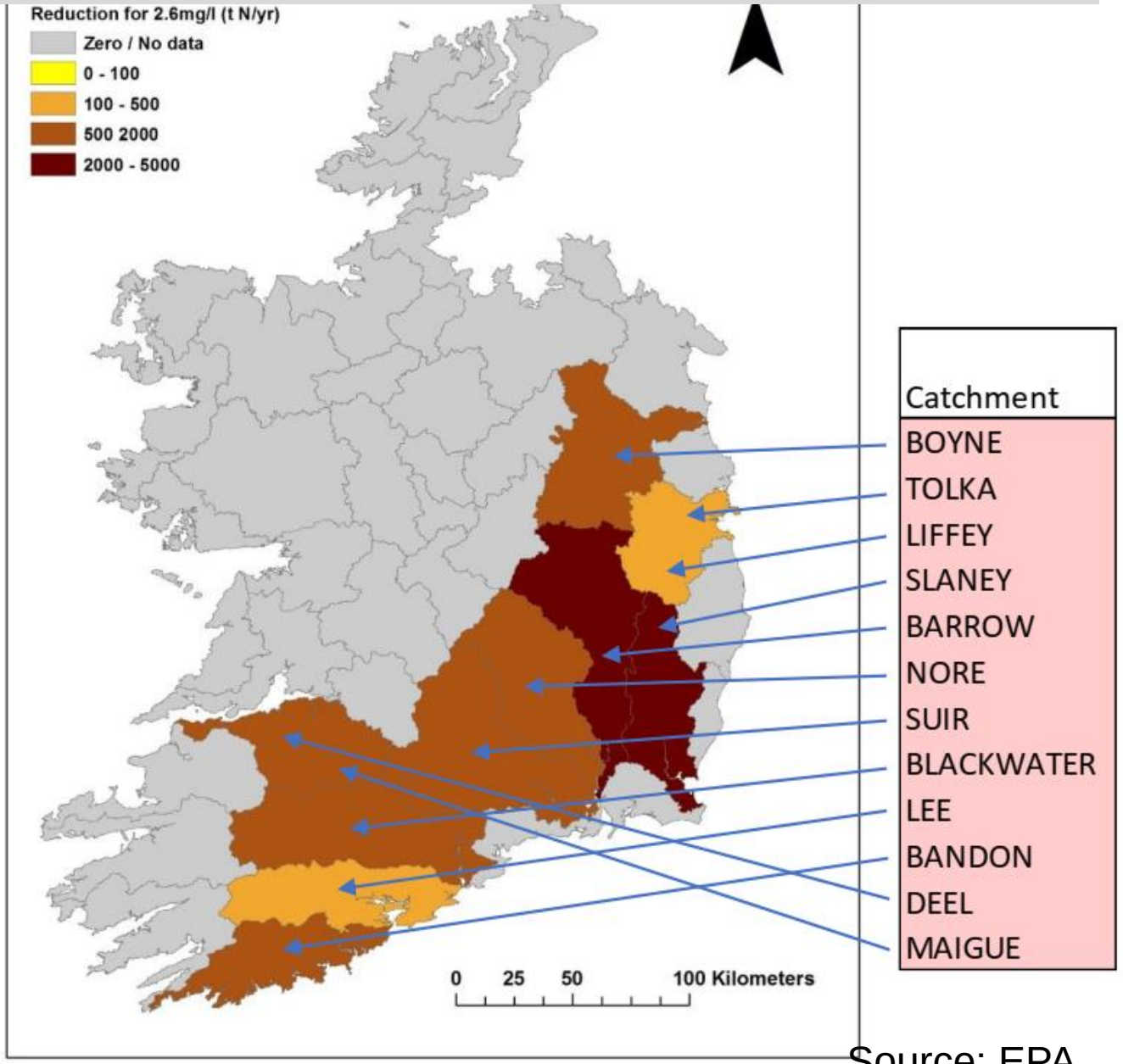
Algae Bloom on a beach on the south coast of Ireland

Source: EPA

S O’Boyle photograph



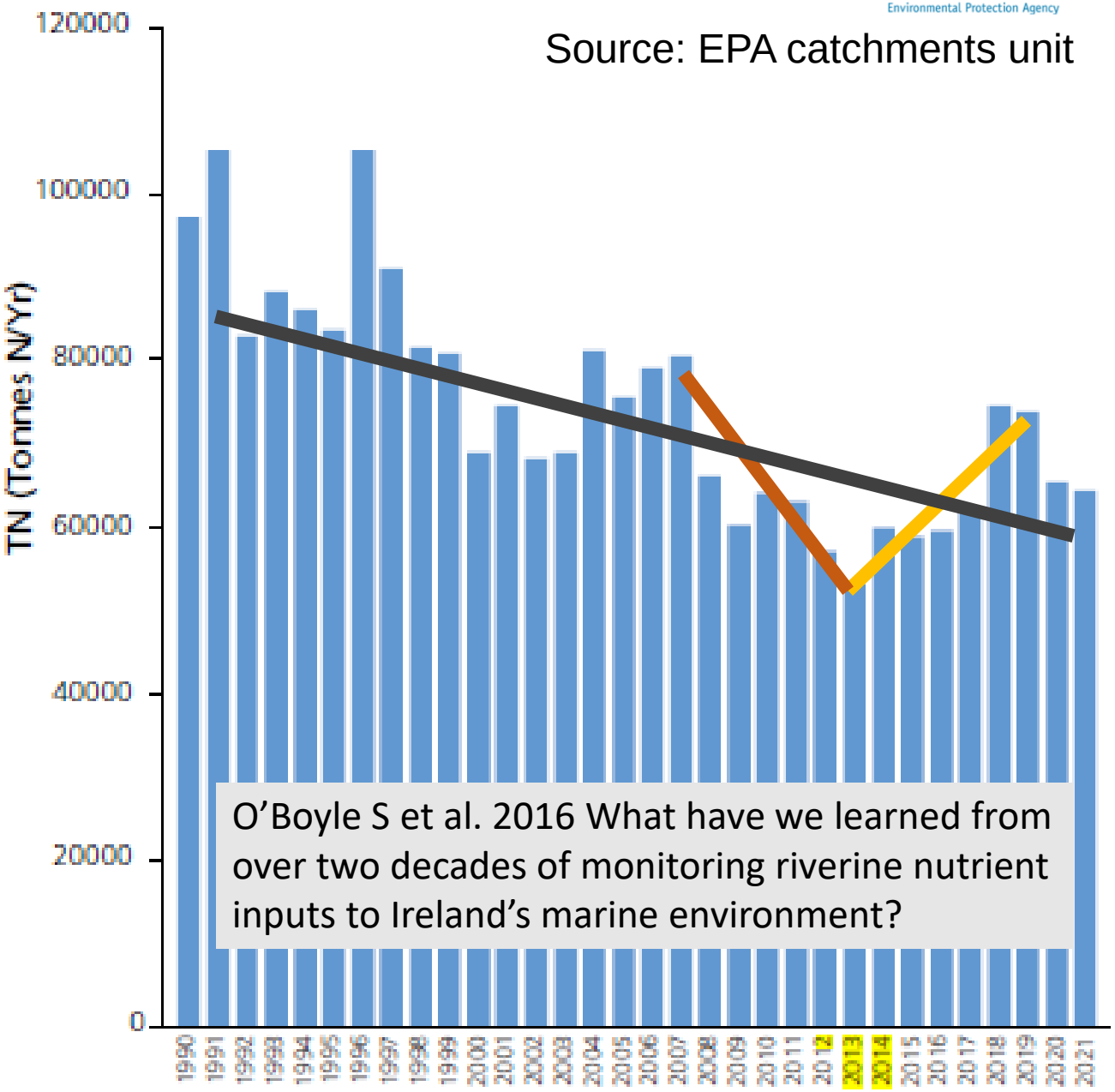
Nitrogen Reduction Assessment - 2021



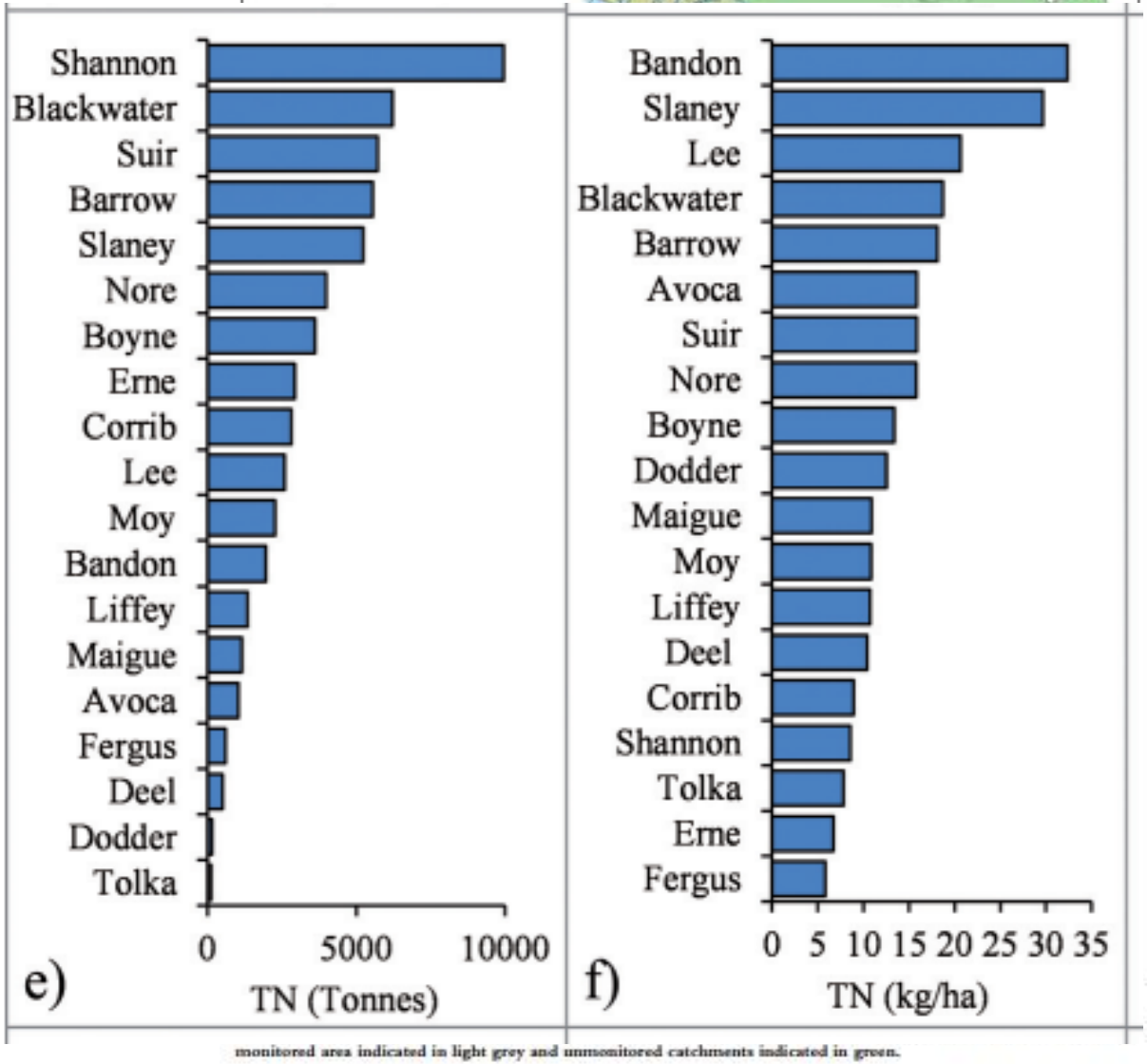
Source: EPA

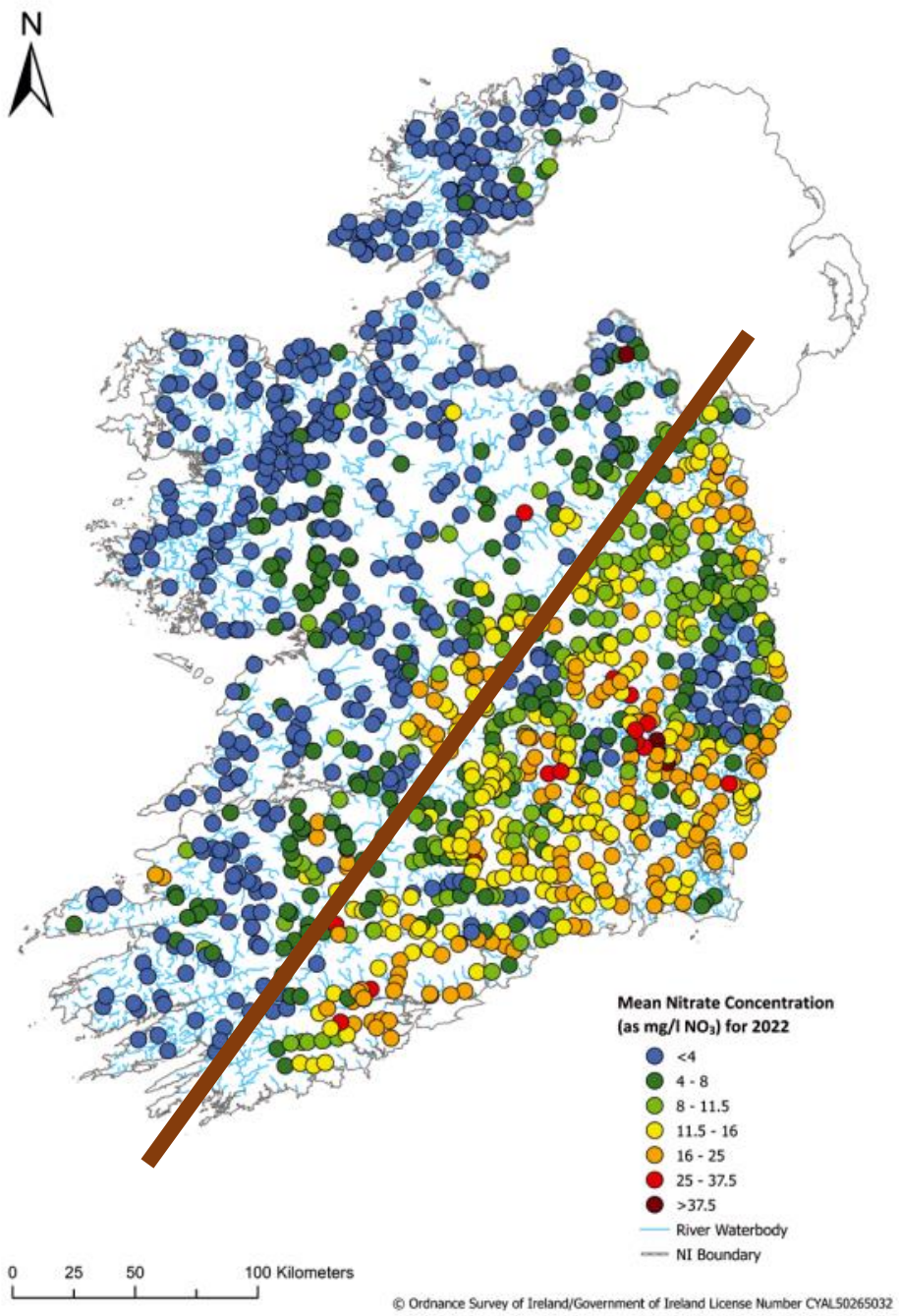
Total Nitrogen Loads

Source: EPA catchments unit

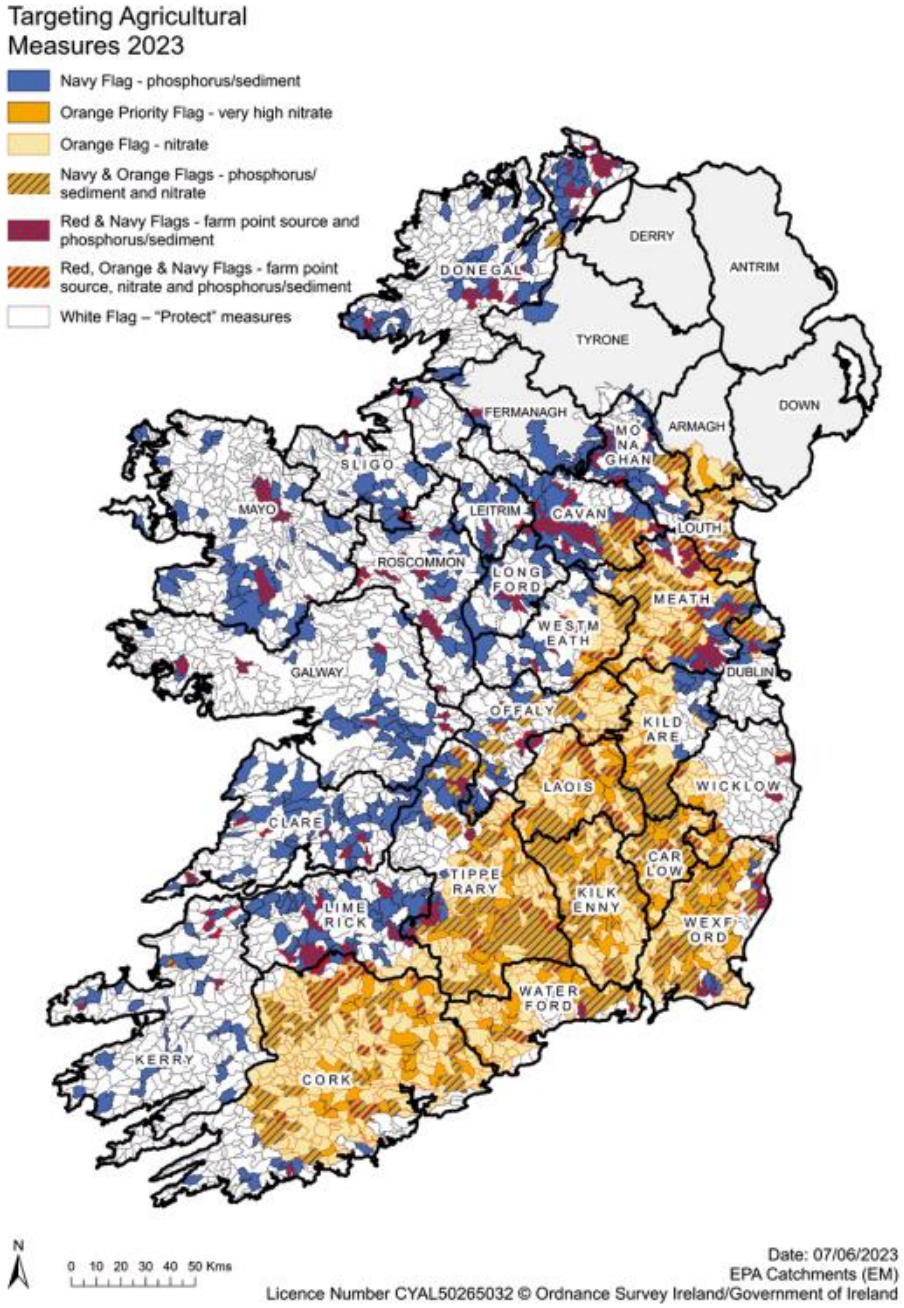


O'Boyle S et al. 2016 What have we learned from over two decades of monitoring riverine nutrient inputs to Ireland's marine environment?



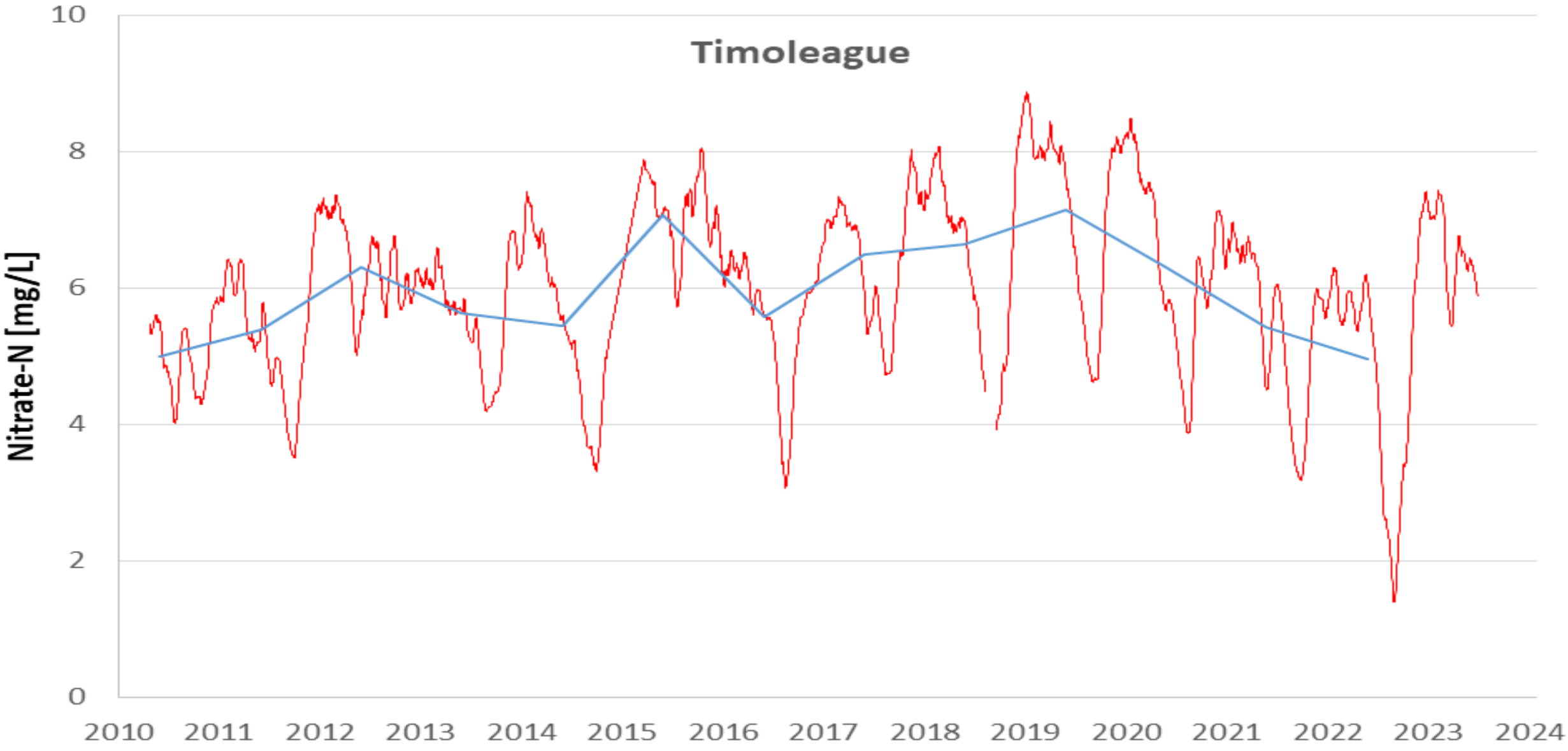


Map 4: Mean nitrate concentrations in rivers during 2022



Map 9: Targeting Agricultural Measures

Source: EPA



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Annual average NO3-N Concentration and Mass Load

Year	NO3-N [mg/l]	NO3-N [kg/ha]
2010	5.00	
2011	5.39	23.2
2012	6.30	35.8
2013	5.64	25.9
2014	5.45	29.1
2015	7.07	48.2
2016	5.57	31.8
2017	6.49	34.3
2018	6.64	53.2
2019	7.15	40.0
2020	6.30	26.3
2021	5.43	34.9
2022	4.97	28.0

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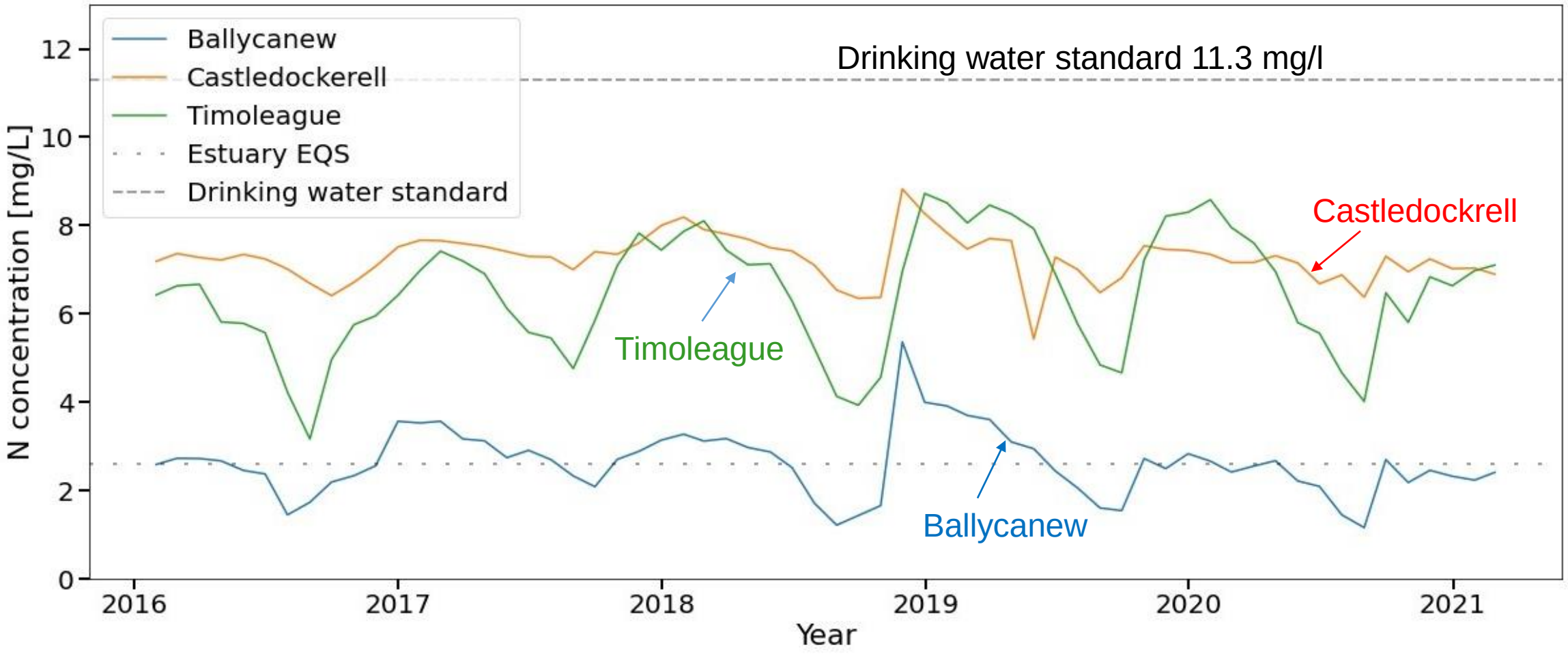
Monthly average N concentration



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Characteristics, rainfall, river flow & N

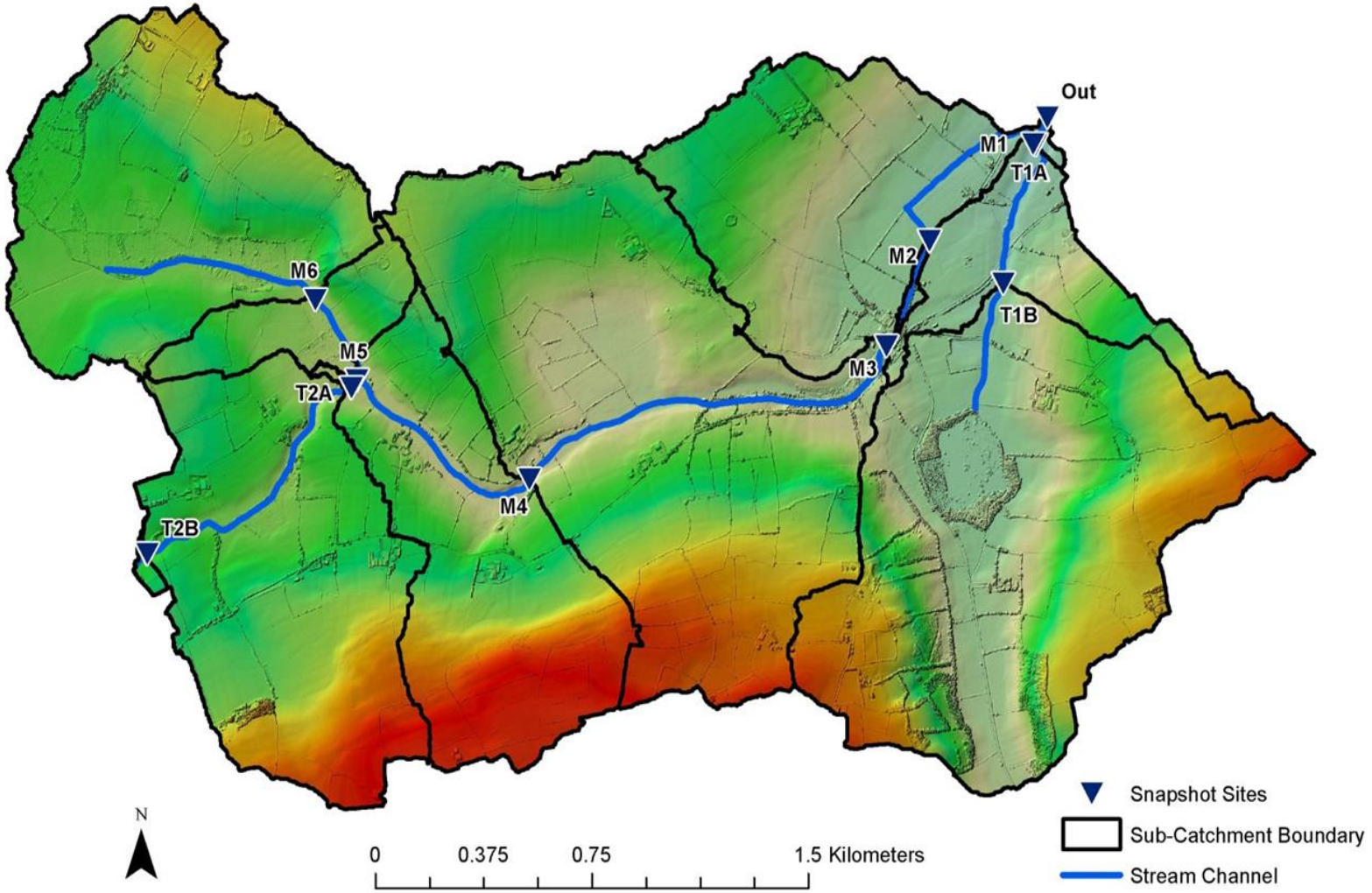
Catchment	Soil	Rainfall	River flow	Stocking rate	Concentration	Load
		mm	mm	kg N ha^{-1}	NO_3-N mg l^{-1}	kg ha^{-1}
Ballycanew	Clay	1044	512	101	2.59	13.4
Castledockrell	Loam	1009	528	41	7.05	37.3
Timoleague	Loam	1097	666	166	6.12	41.3

To achieve Good Ecological Status in marine water,

the target is 2.6 mg/l as N in waters that discharge from rivers into estuaries

(High Status EQS = 1 mg/l as N)

Catchment Snapshot Sites



- **10 minute monitoring at Outlet**
- **Monthly grab samples**
  - **8 Sub-catchments**
- **Stocking rate effect**
- **Comparison across similar soil & weather conditions**

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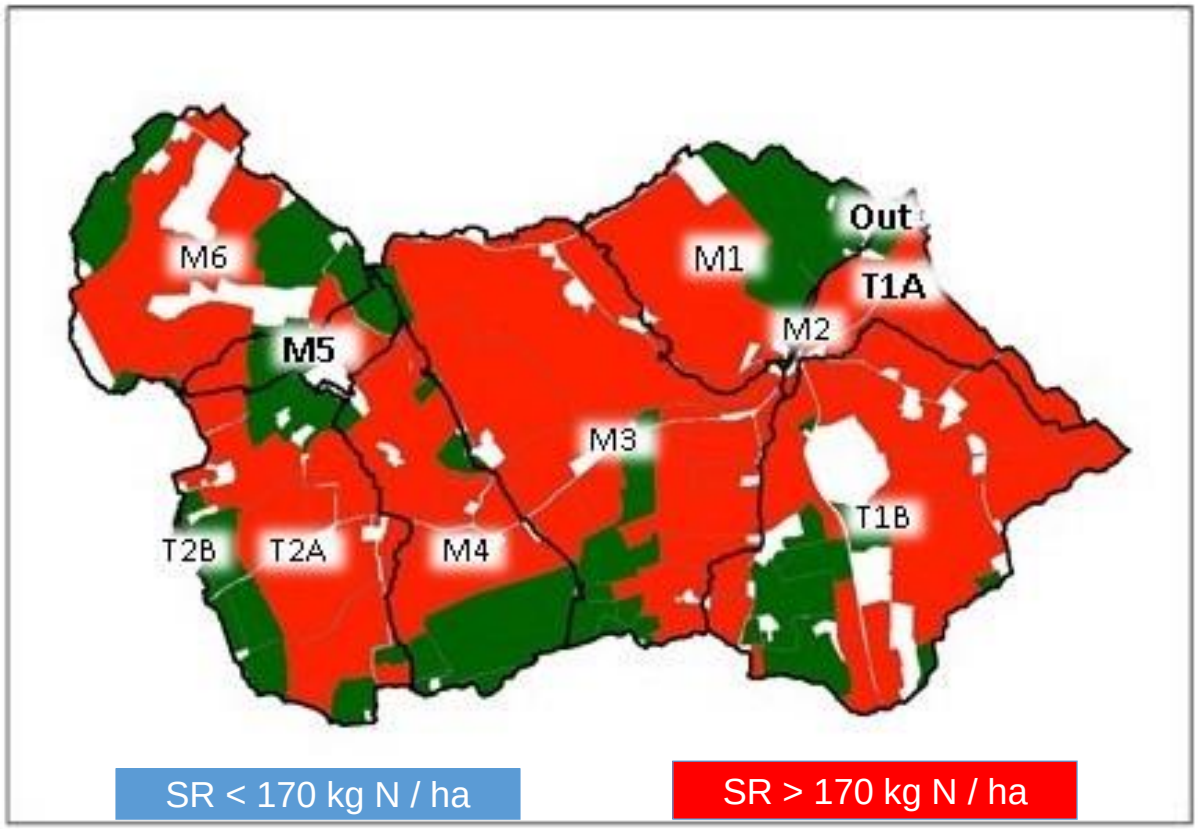
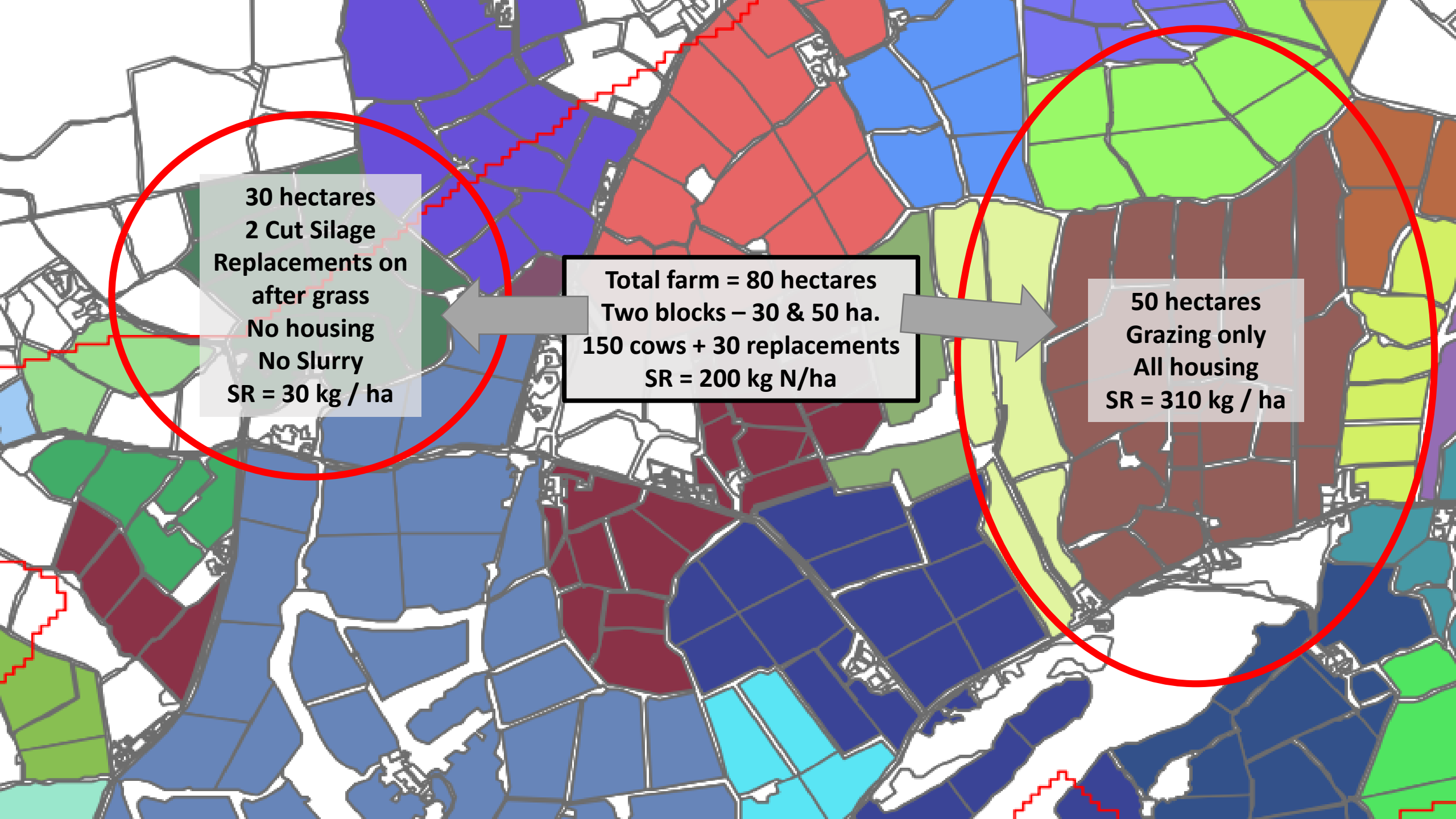
Timoleague Sub-catchment SR & NO_3-N mg l^{-1}

	Total	M5	T1A
%>170	80	12	80
N mg l^{-1}	5.97	4.24	5.73

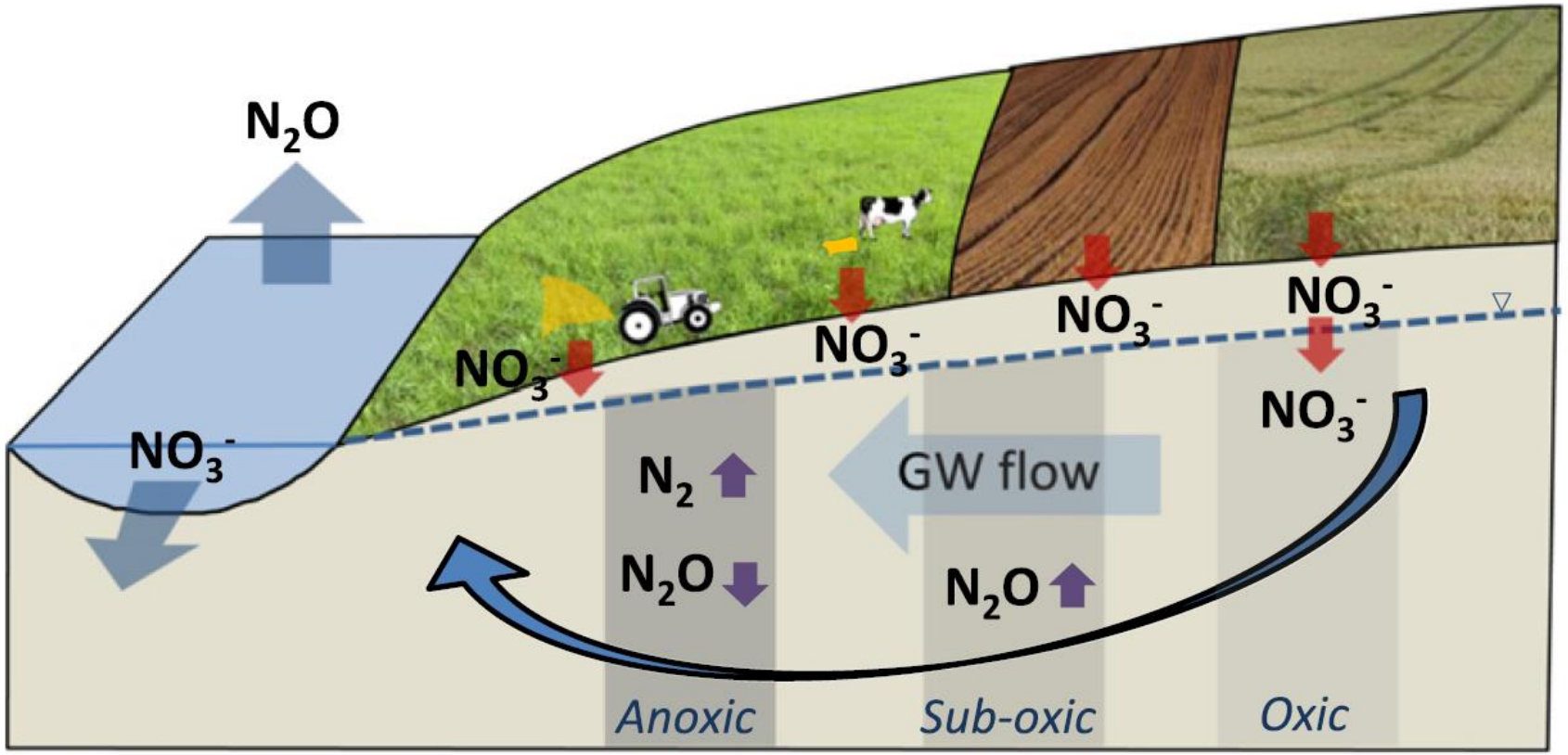
In Timoleague, higher SR was reflected in the NO_3-N concentrations monitored in sub-catchment stream water




30 hectares
2 Cut Silage
Replacements on after grass
No housing
No Slurry
SR = 30 kg / ha
Total farm = 80 hectares
Two blocks – 30 & 50 ha.
150 cows + 30 replacements
SR = 200 kg N/ha
50 hectares
Grazing only
All housing
SR = 310 kg / ha

- Drinking water standard and health
- 11.3 mg/l limit
- Nitrates Directive
- Standard in Ireland is good
- Ground Water 98% below drinking water limit

Multi-Level Monitoring Wells & Stream Samples

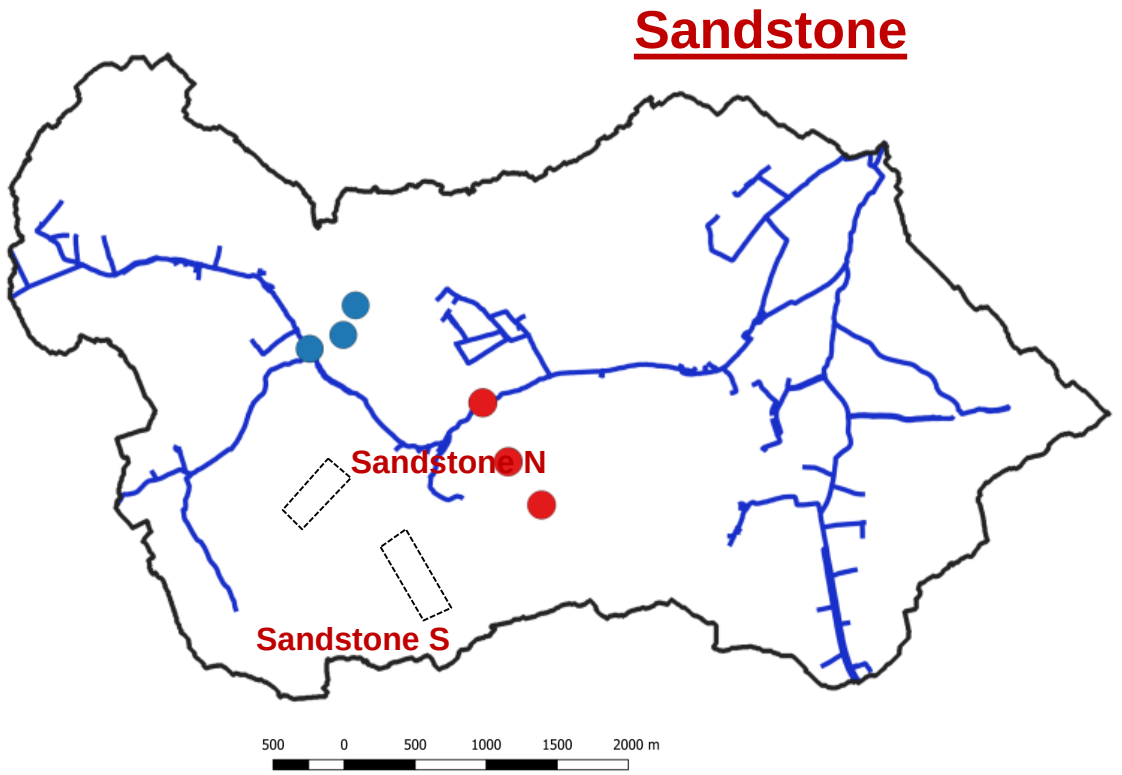


[McAleer et al., STOTEN 2017]

- **A variety of soil types**
- **N removal capacity varies highly between and within catchments**
- **Transformation processes occur along the pathway from the rooting zone to surface water**
- **Poor link between N leaving the root zone and N in the stream**

Landscape impact on Nitrate-N in water

- **Three** Bore holes per hill slope

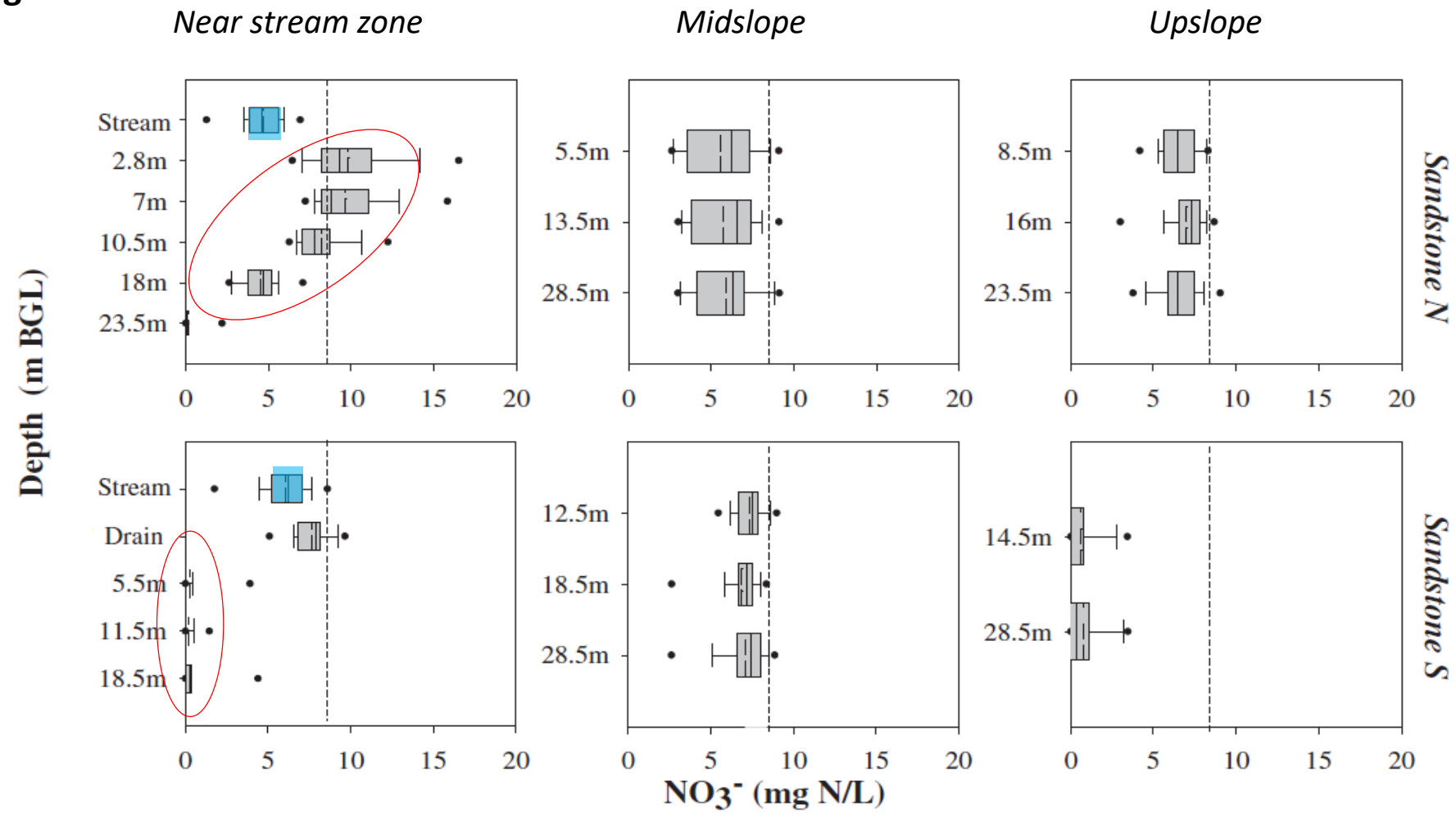


N in groundwater

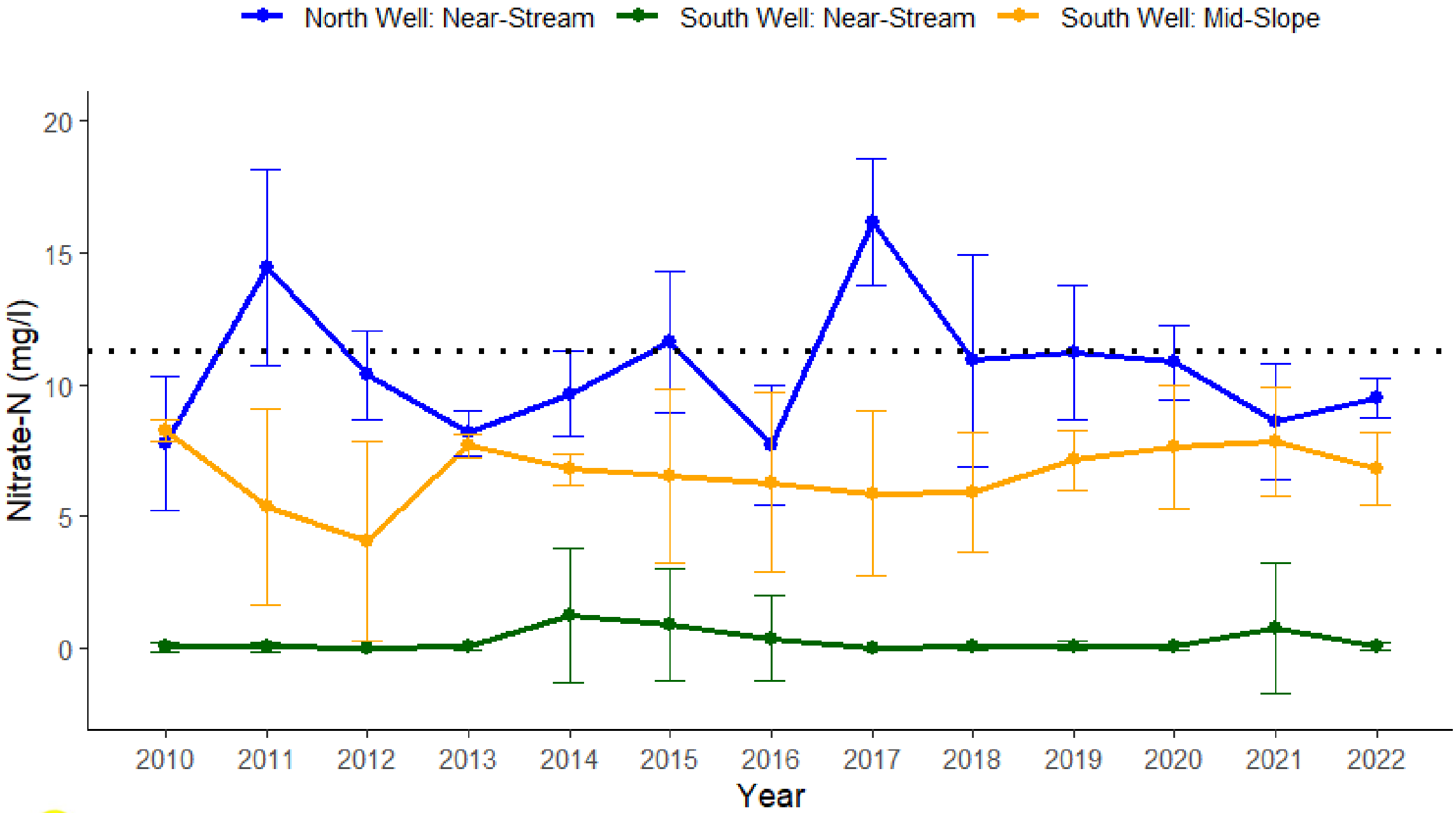
[McAleer et al., STOTEN 2017]

[Mellander et al., JAS 2014]

Timoleague



- **N concentrations varies largely between location and with depth**
- **Poor link between N in groundwater and in the stream**



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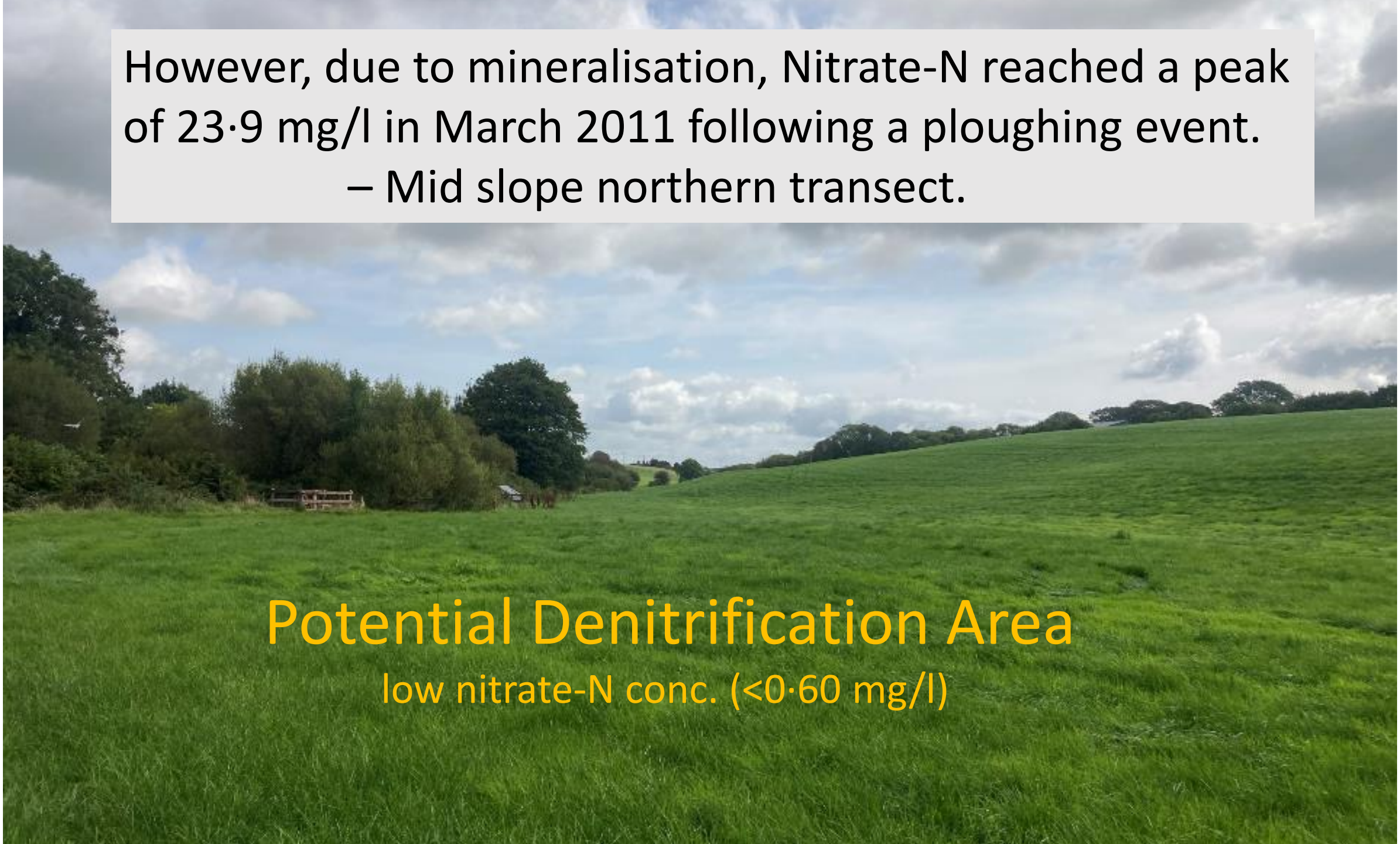
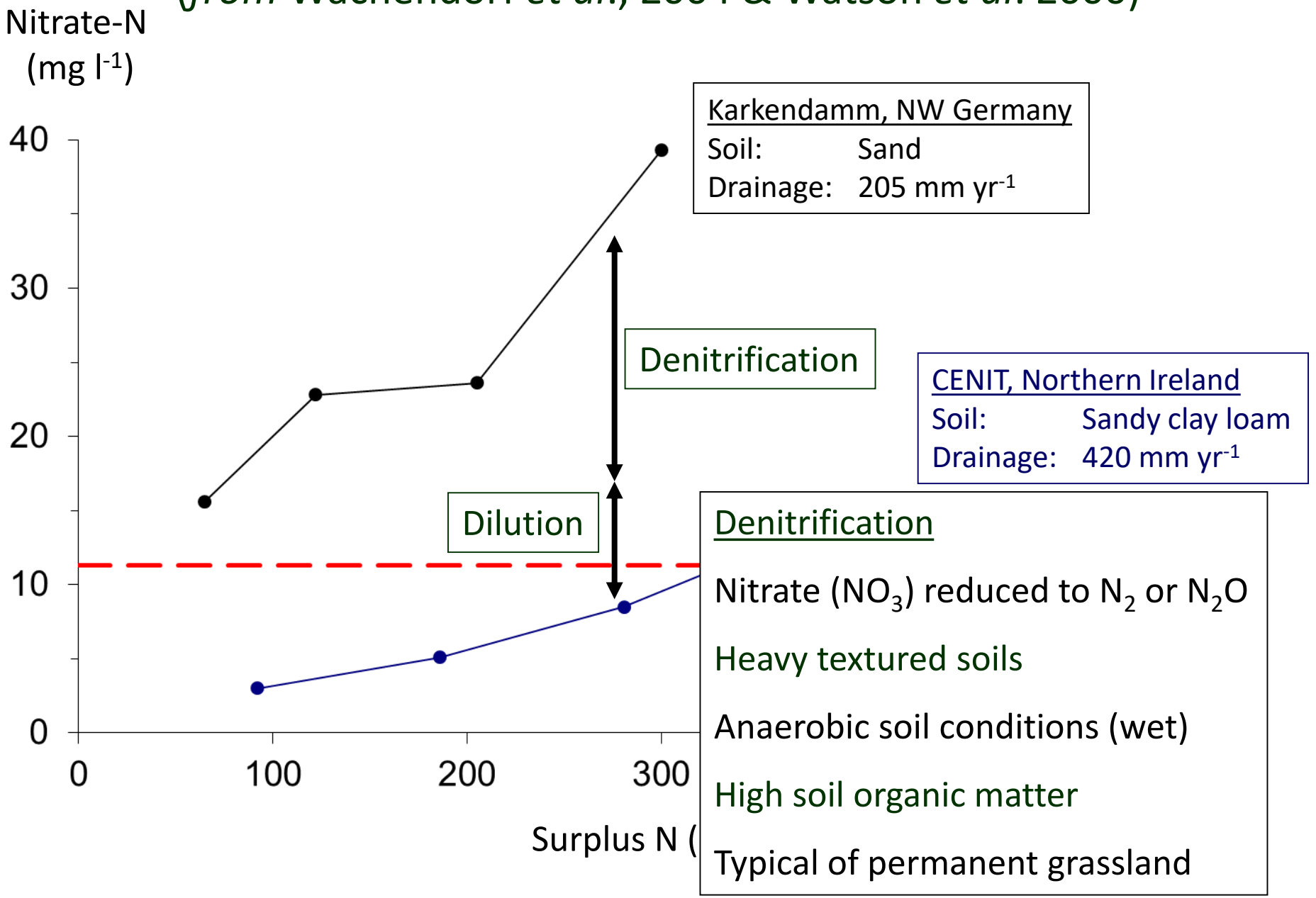
Average Annual Nitrate-N Concentration in Shallow Groundwater in Timoleague

However, due to mineralisation, Nitrate-N reached a peak of 23·9 mg/l in March 2011 following a ploughing event.
– Mid slope northern transect.



Surplus N and nitrate-N conc. in grassland (grazing-only) (*from* Wachendorf *et al*., 2004 & Watson *et al*. 2000)



Groundwater vs. Rivers

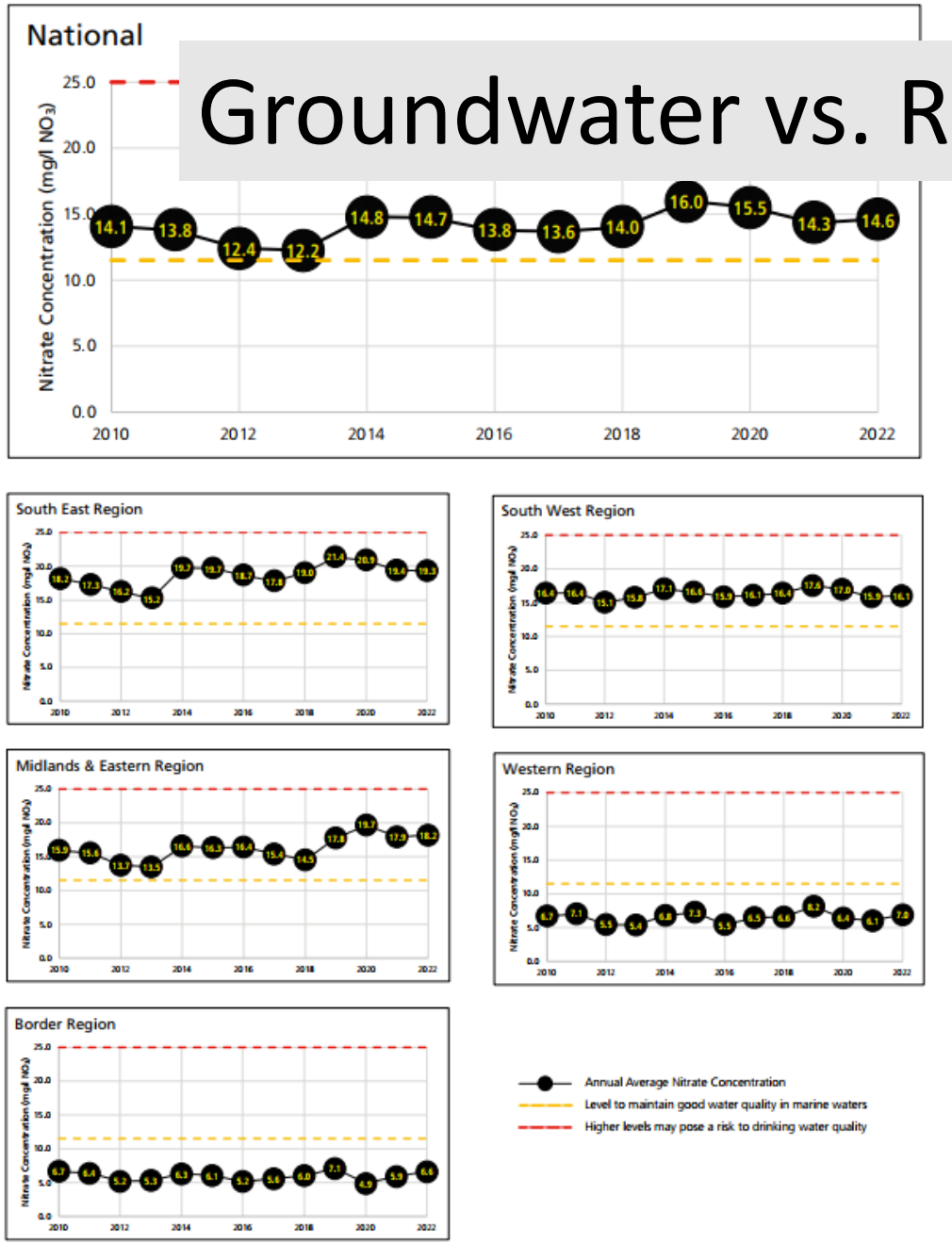


Figure 2: Mean groundwater nitrate concentrations since 2010

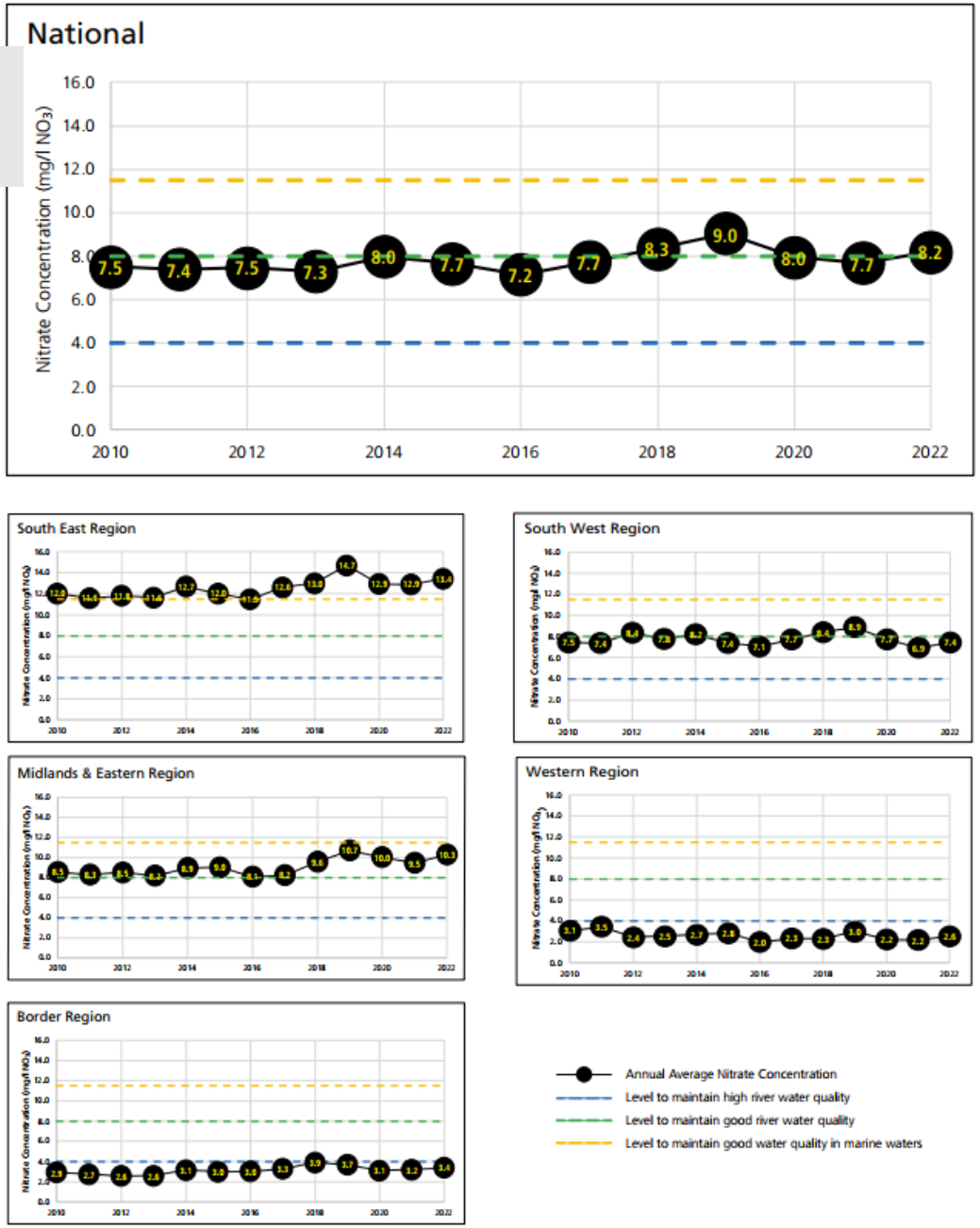
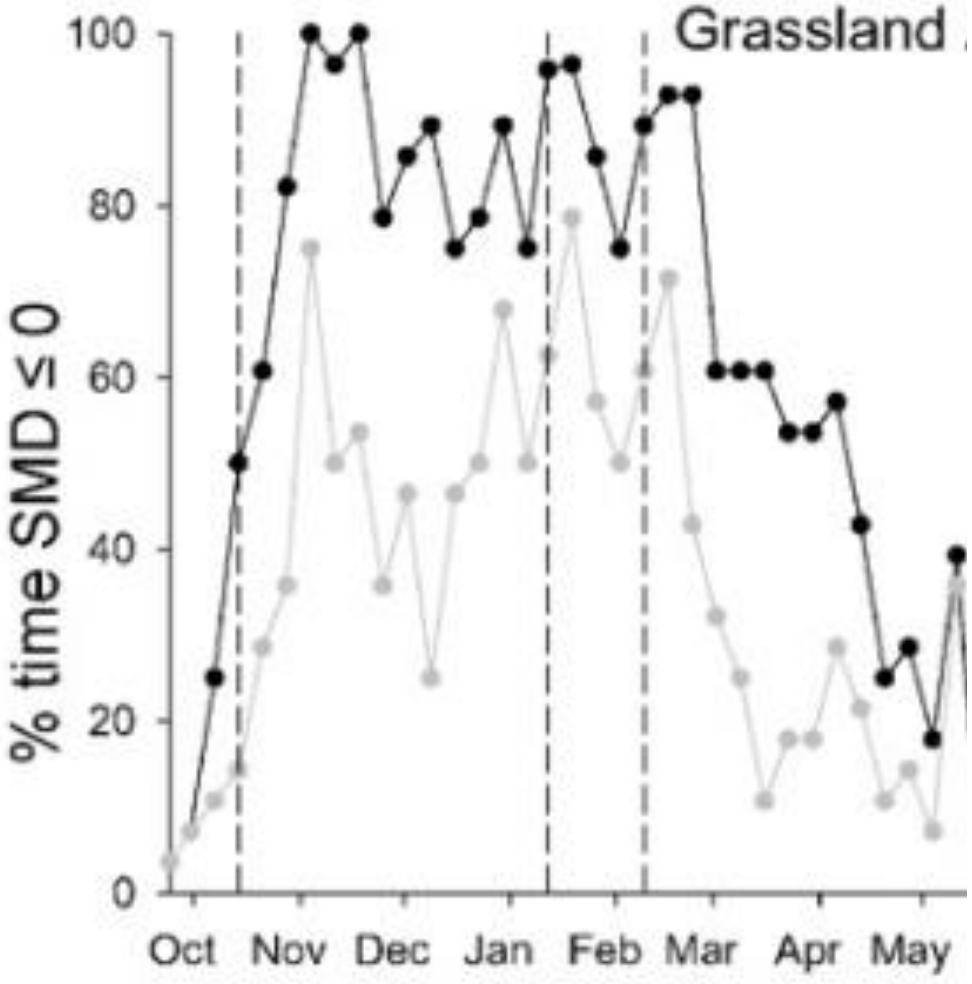
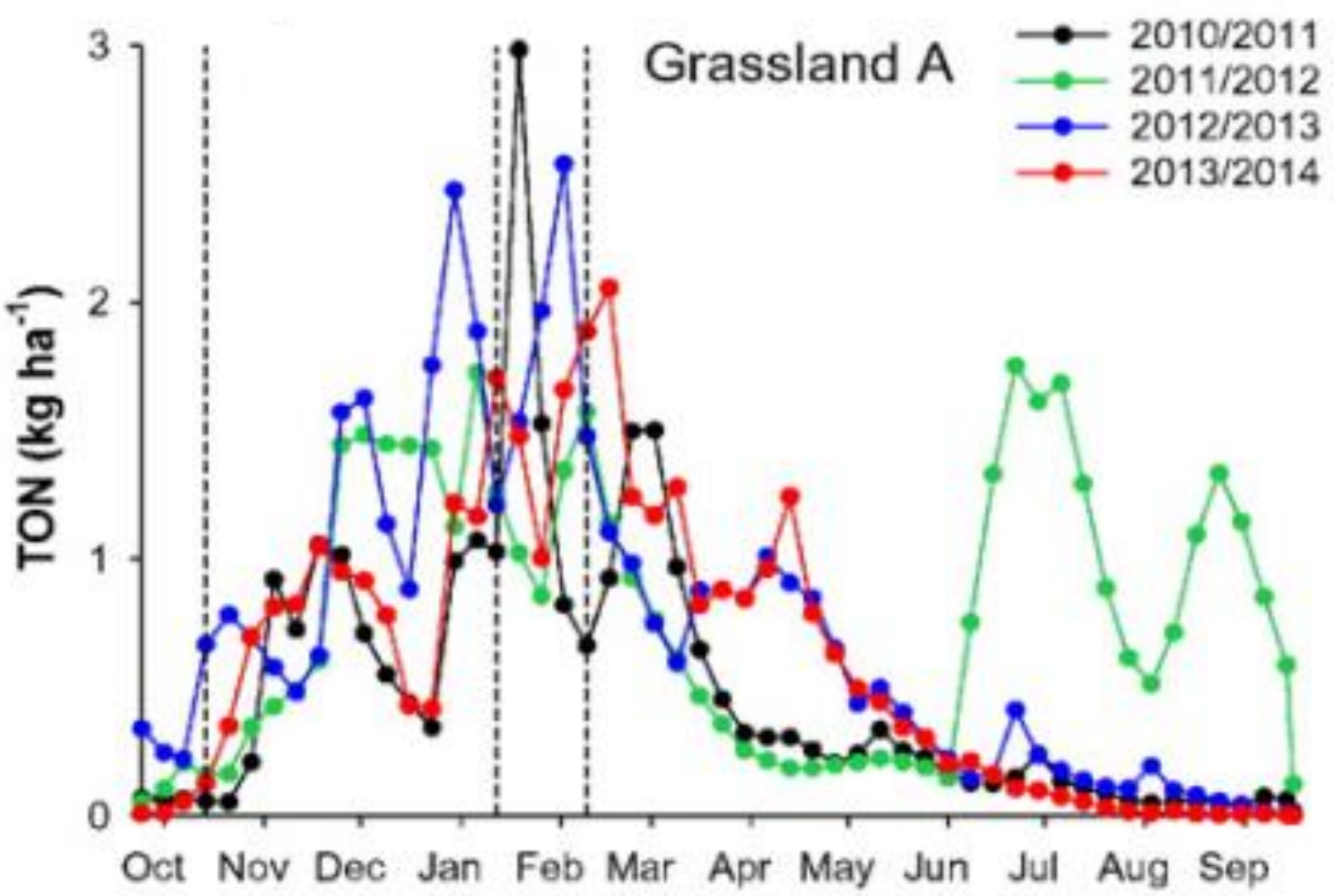


Figure 5: Mean riverine nitrate concentrations since 2010

Source: EPA

Seasonality of Soil Moisture & Nutrient Loss





Mairead Shore, 2016

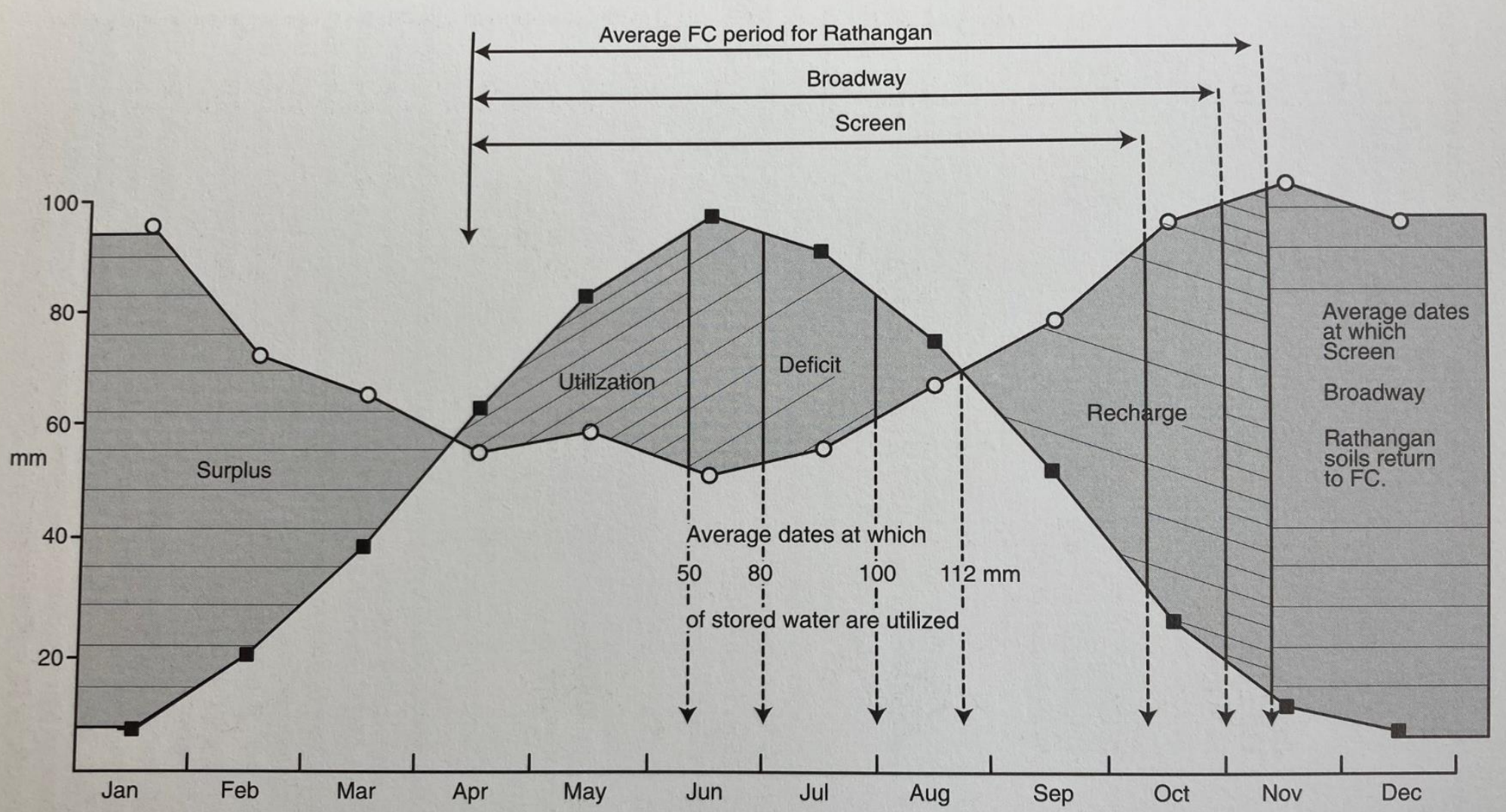


Fig 6.4 Average annual soil-water relations in three South Co. Wexford soils based on precipitation (O-O) and evapotranspiration (■-■) data for Rosslare (1958-82) and on the following calculated values for AWC: Broadway 90 mm, Rathangan 115 mm and Screen 45 mm.

Keane & Collins, 2004, Climate, Weather and Irish Agriculture

2 factors influence the amount of N leached

1. Amount of water passing through the soil profile
   - excess of rainfall over evapotranspiration
2. Concentration of nitrate in soil at the onset of leaching

10 cm of rainfall will displace a much greater depth of soil moisture in a sandy soil compared to a clay soil.

Soil Texture	Mean Displacement (cm)
Sandy	45
Medium	30
Clay	20

Burns, 1979

Factors that influence N soil content

- Nutrient Management
- Urine Patches
- Mineralisation
- Legumes
- Crop uptake / growing season
- Weather
- ????




What do we need to do to minimise N loss ?

- There is no “silver bullet”
- A good understanding of the Nitrogen Cycle
- Do not ignore the influence of the landscape - hydromorphology
- Timing of actions are critical
- Target “hot spots” – scale of mitigation action implementation

Regulation alone can not achieve this!