Modelling Nature-based Solutions for Water Quality

7th May 2026

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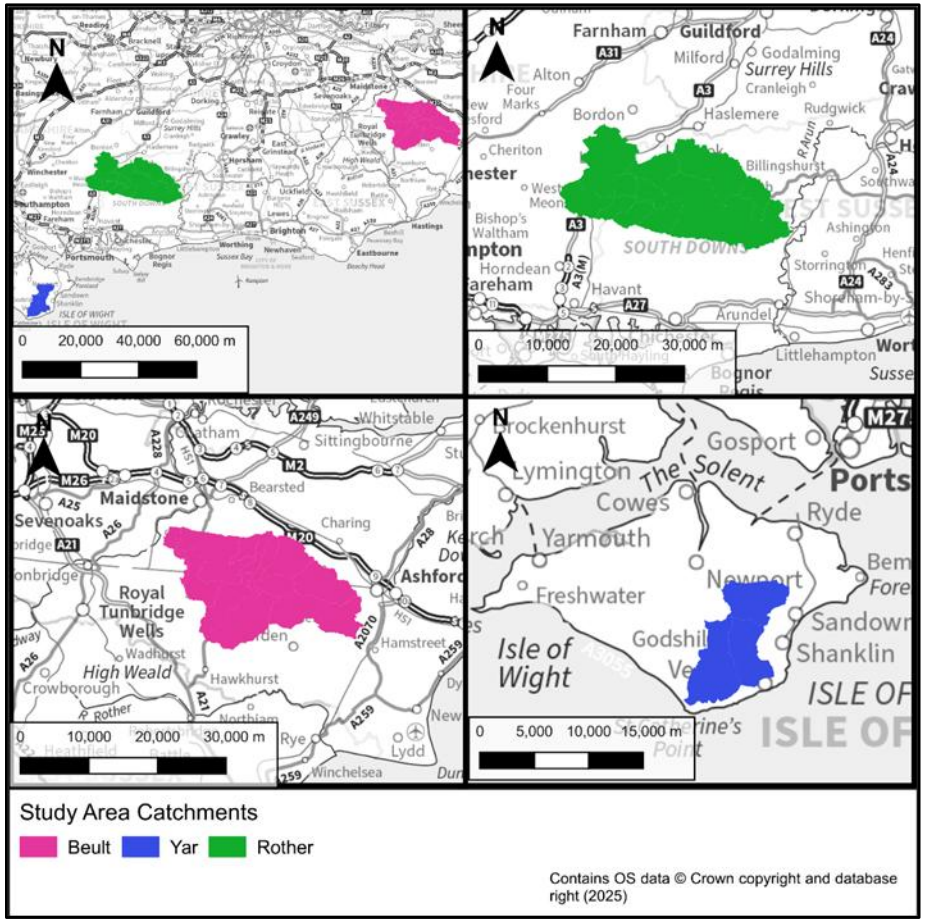
Project Aims

- Assess the potential water quality benefits that could be achieved with NbS
- Assess whether targeted NbS could lead to WFD class improvement.
- Develop prioritised NbS opportunity maps for water quality across the catchment
- Assess the wider benefits including water resources and natural capital.
- Provide a summary tool for engagement and summarizing the benefits.



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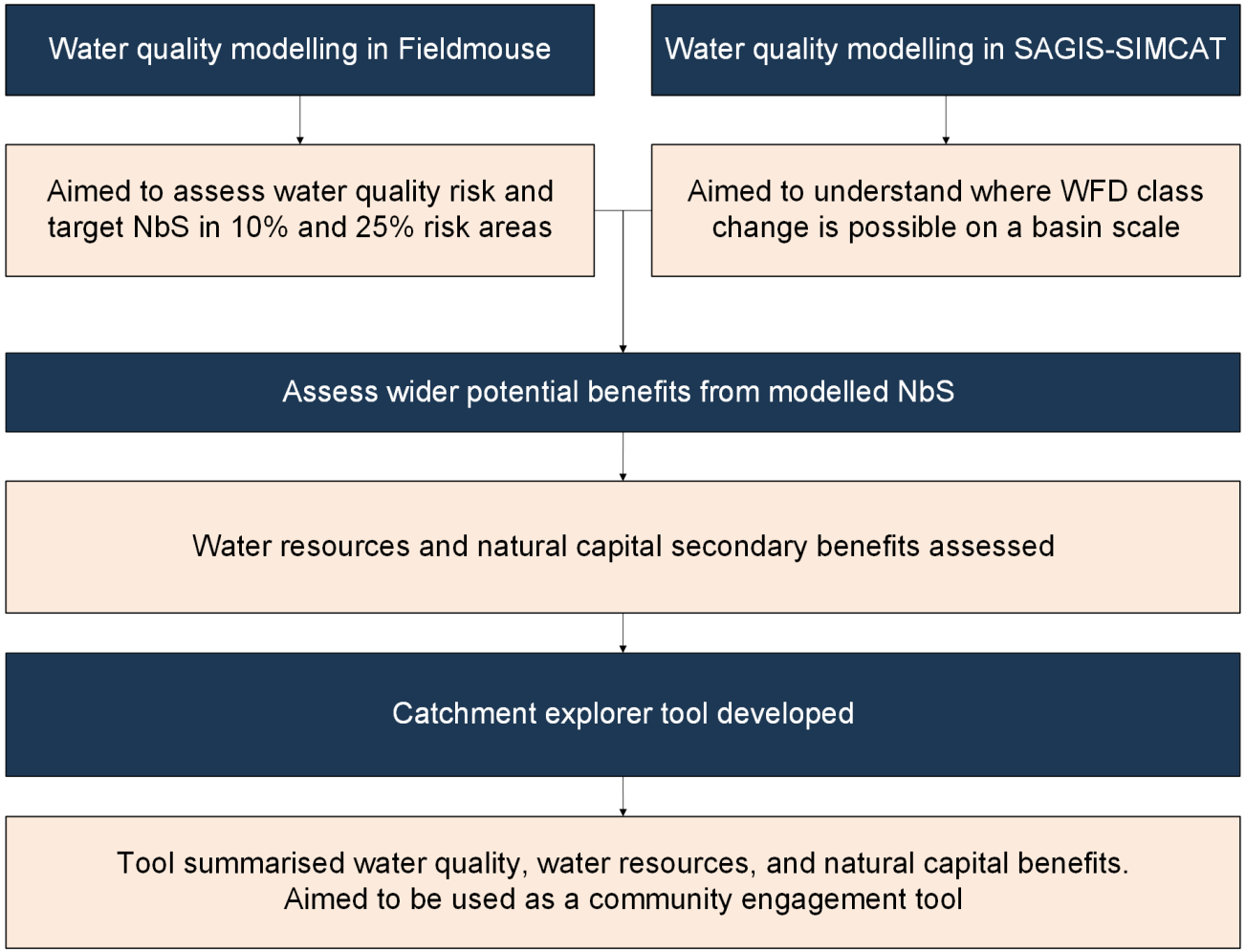
Method Overview



Water Quality, Water Resources and Natural Capital

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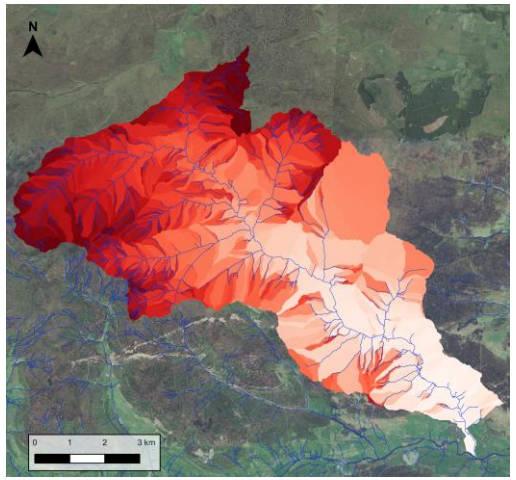
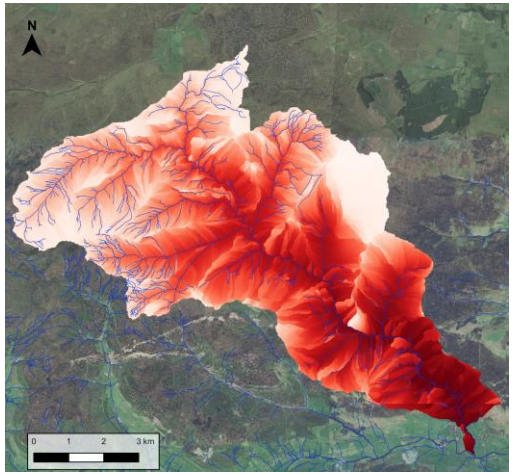
Fieldmouse

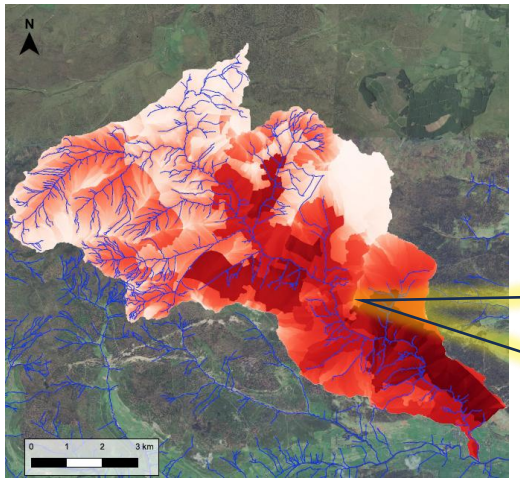


Travel Time Grid (days)

Time for pollutant to reach point of interest



Importance Rasters
(Unit Response Function)
Proportion of load that reaches the point of interest including nutrient decay (from 0-1)



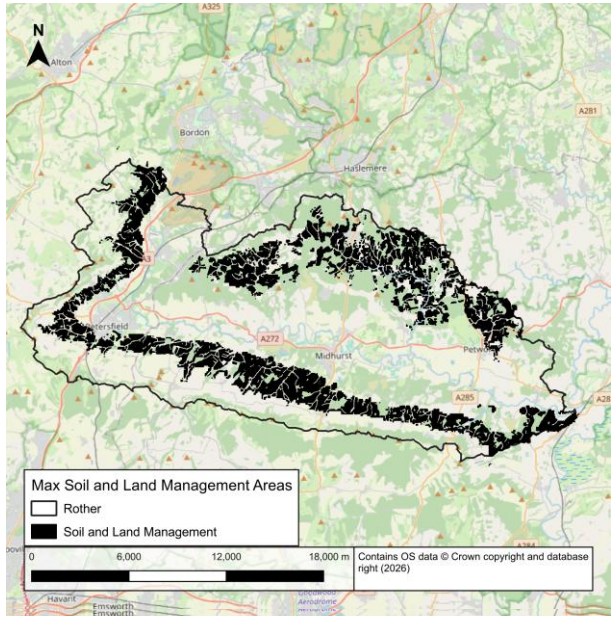
Risk Rasters
(source + pathway)
Multiplying the load and importance

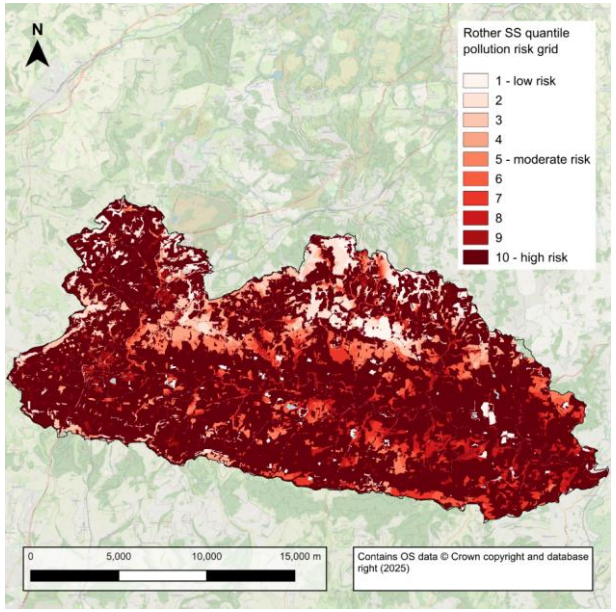
Use NbS to disrupt pathways in areas of greater risk

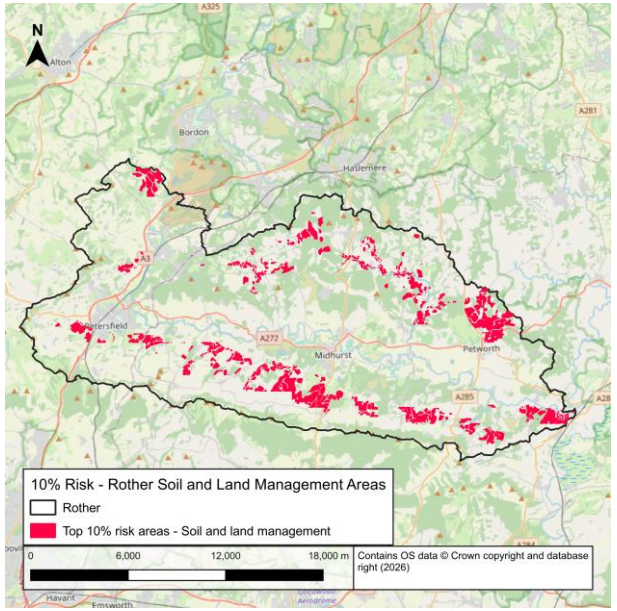
For further details on Fieldmouse - see Hankin, B., et al (2026). Multiscale Pollution Risk and Mitigation Modelling to Inform Efficacy of Nature-Based Solutions. *Water*, *18*(8), 906. https://doi.org/10.3390/w18080906

Fieldmouse Scenario Modelling Example

West Rother SLM Measures in the top 10% of risk areas







NbS areas identified for full catchment from EA's WwNP data

Fieldmouse risk grids used to identify top 10 and 25% risk areas

NbS clipped to high-risk areas for fieldmouse modelling

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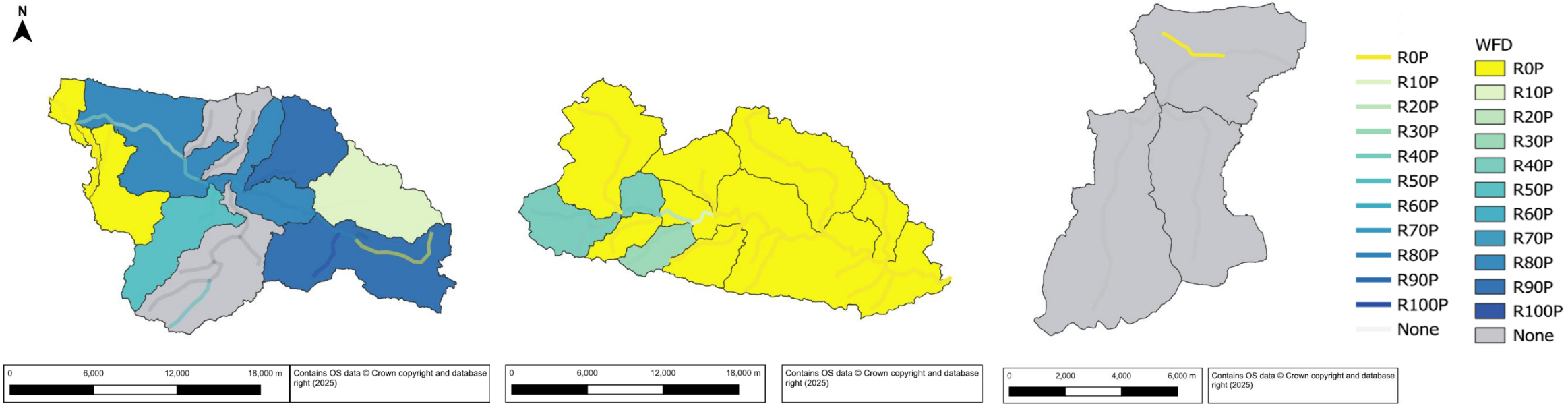
SAGIS-SIMCAT

Can we get a class change, or a change to good, with NbS?

Beult

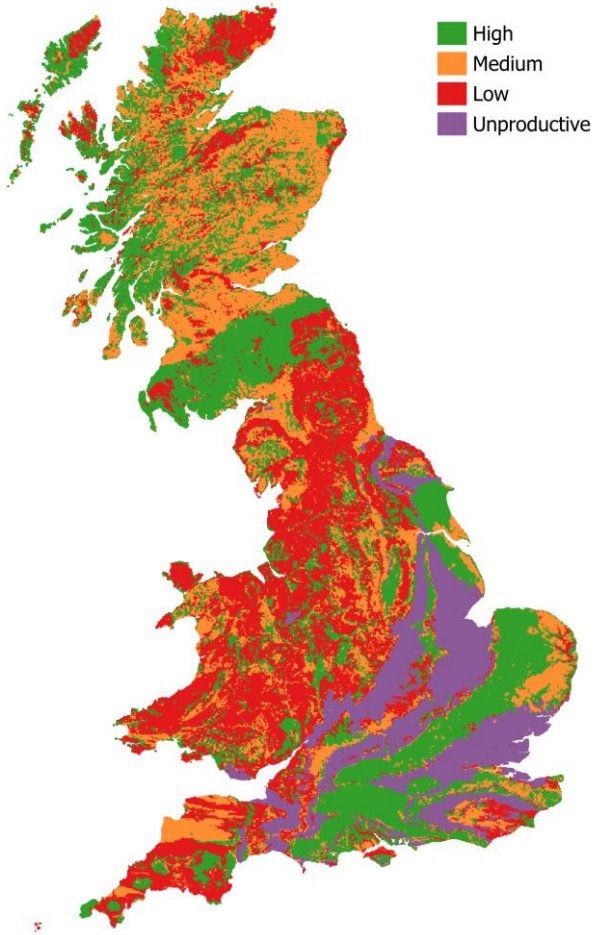
West Rother

Eastern Yar



Water resources

- JBA national recharge maps adapted for use with open data
- Estimate the efficacy to increase infiltration to groundwater
- Runoff features tagged with high, medium, low, and unproductive classes for recharge



Bedrock recharge potential map.

Natural capital

Economic valuation of the **uplift** in delivery of ecosystem services

Carbon	• **Wetlands** - highest sequestration rate & annual economic benefit
Air quality	• **Woodlands** – highest sequestration and economic value
Biodiversity	• **Woodlands** – highest economic value
Water quality	• Landowners willing to pay for measures to improve **WFD class**

→ combination of NbS is appropriate

Summarising multi benefits across catchment and basin scale

Catchment explorer tool

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Sub Catchment Explorer

1. Choose WFD Location	Rother	GB107041012830 - Lod

- Yar
- Rother
- Beult

Catchment Area (km²) (including all area upstream)	53.3	Catchment Area (km²) (only the water body)	53.3
Catchment Area (ha) (including all area upstream)	5329.0	Catchment Area (ha) (only the water body)	5329.0

Water Quality

NbS Areas

Scenario descriptions	Floodplain and Riparian Woodland area (Ha)	RAFs area (Ha)	Wetland area (Ha)	Floodplain Storage Enhancement area (Ha)	Soil and land management improvement area (Ha)
GB107041012830 - Lod - Top 10% region: Floodplain and Riparian Woodland	66.3				
GB107041012830 - Lod - Top 10% region: Floodplain Reconnection				1.80	
GB107041012830 - Lod - Top 10% region: Wetlands			85.17		
GB107041012830 - Lod - Top 10% region: RAFs		0.30			
GB107041012830 - Lod - Top 10% region: SLM NbS features					210.52
GB107041012830 - Lod - Top 10% region: Combined NbS Scenarios	66.2	0.15	52.77	0.82	175.35
GB107041012830 - Lod - Top 25% region: Floodplain and Riparian Woodland	144.6				
GB107041012830 - Lod - Top 25% region: Floodplain Reconnection				4.57	
GB107041012830 - Lod - Top 25% region: Wetlands			165.56		
GB107041012830 - Lod - Top 25% region: RAFs		1.43			
GB107041012830 - Lod - Top 25% region: SLM NbS features					423.39
GB107041012830 - Lod - Top 25% region: Combined NbS Scenarios	144.5	0.38	88.49	1.97	358.78

Water Quality Results - reach scale

NbS Scenario	SRP (%) reduction	SS (%) reduction	NO3 (%) reduction	SRP efficacy factor (change per / Ha NbS)	SS efficacy factor (change per / Ha NbS)	NO3 efficacy factor (change per / Ha NbS)
GB107041012830 - Lod - Top 10% region: Floodplain and Riparian Woodland	4.0	5.0	2.6	0.060	0.076	0.039
GB107041012830 - Lod - Top 10% region: Floodplain Reconnection	0.1	0.1	0.1	0.054	0.077	0.035
GB107041012830 - Lod - Top 10% region: Wetlands	5.3	6.8	3.4	0.062	0.080	0.040
GB107041012830 - Lod - Top 10% region: RAFs	0.0	0.0	0.0	0.071	0.121	0.038
GB107041012830 - Lod - Top 10% region: SLM NbS features	7.2	7.8	0.0	0.034	0.037	0.000
GB107041012830 - Lod - Top 10% region: Combined NbS Scenarios	13.4	14.7	4.8			
GB107041012830 - Lod - Top 25% region: Floodplain and Riparian Woodland	7.0	8.9	5.5	0.049	0.061	0.038
GB107041012830 - Lod - Top 25% region: Floodplain Reconnection	0.2	0.3	0.2	0.045	0.063	0.034
GB107041012830 - Lod - Top 25% region: Wetlands	8.4	10.6	6.3	0.051	0.064	0.038
GB107041012830 - Lod - Top 25% region: RAFs	0.1	0.1	0.1	0.047	0.065	0.040
GB107041012830 - Lod - Top 25% region: SLM NbS features	11.8	12.2	0.0	0.028	0.029	0.000
GB107041012830 - Lod - Top 25% region: Combined NbS Scenarios	22.2	23.9	9.5			

WFD analysis for SAGIS-

Baseline WFD class (phosphate)	Good
Maximum class change	no change
Reduction required to get to good	0

Water Resources

Water Resource Benefit

Scenario		Open WwNP Recharge Area Superficial	Open WwNP Recharge Area Bedrock
GB107041012830 - Lod - Top 10% region: RAFs	High		
	Medium		0.01
	Low		0.10
	Unproductive		0.19
	Not present	0.30	
GB107041012830 - Lod - Top 25% region: RAFs	High		0.30
	Medium		0.08
	Low		0.33
	Unproductive		0.77
	Not present	1.43	

Data has been derived from an open license recharge potential map developed by JBA. It comprises of JBA's open BFI index, BGS hydrogeology map, BGS Superficial deposits map, BGS superficial deposit thichness model, and BGS soil texture simple map.

Wider impact & opportunities

Modelling can enable data-driven decision-making in communities:

- Providing visual outputs to support community engagement
- Economic valuation of benefits
- Demonstrating potential for NbS
- Prioritising catchment management efforts
- Evidence-led justification for projects
- Enabling co-design with communities and stakeholders

Thank you!

For further details or information please contact –
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www.jbaconsulting.com

UK Water Vole Recovery

The data-driven eradication of invasive North American Mink

Darren Tansley

Chairman UK Water Vole Steering Group

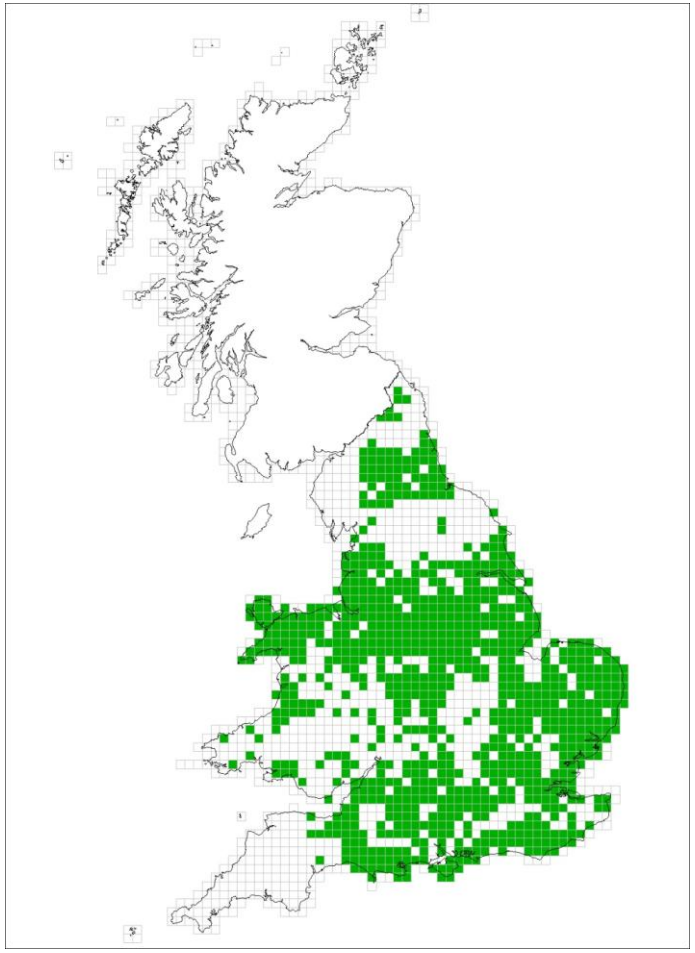
Wilder Rivers and Protected Species Manager – Essex Wildlife Trust

Essex Wildlife Trust

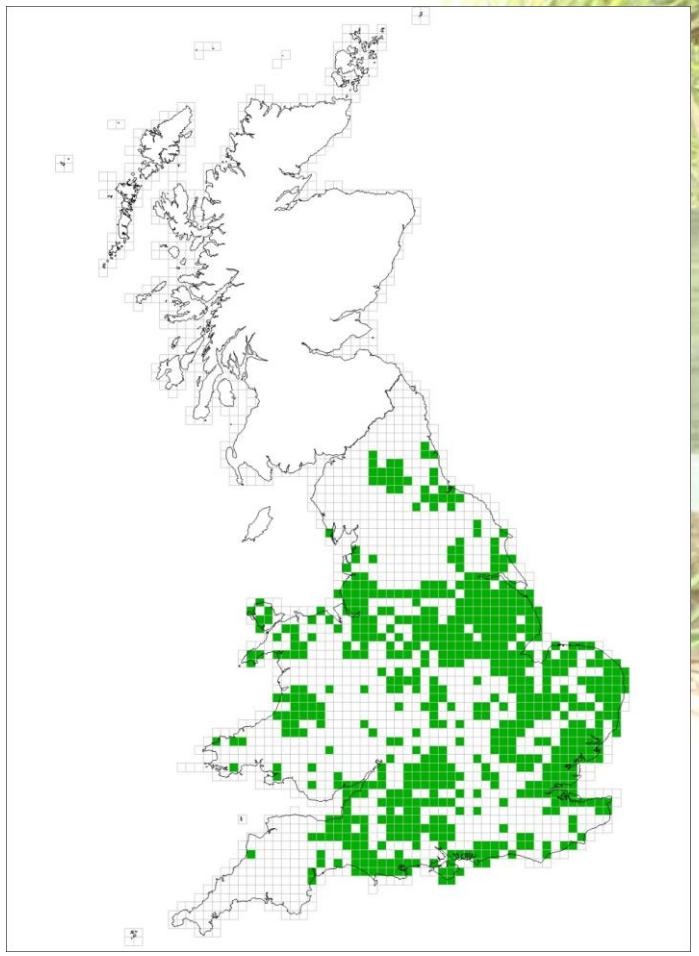
Water vole distribution England & Wales

Decrease of 30% in occupied tetrads in 10 years

2002-2006
913 occupied 10km grid squares



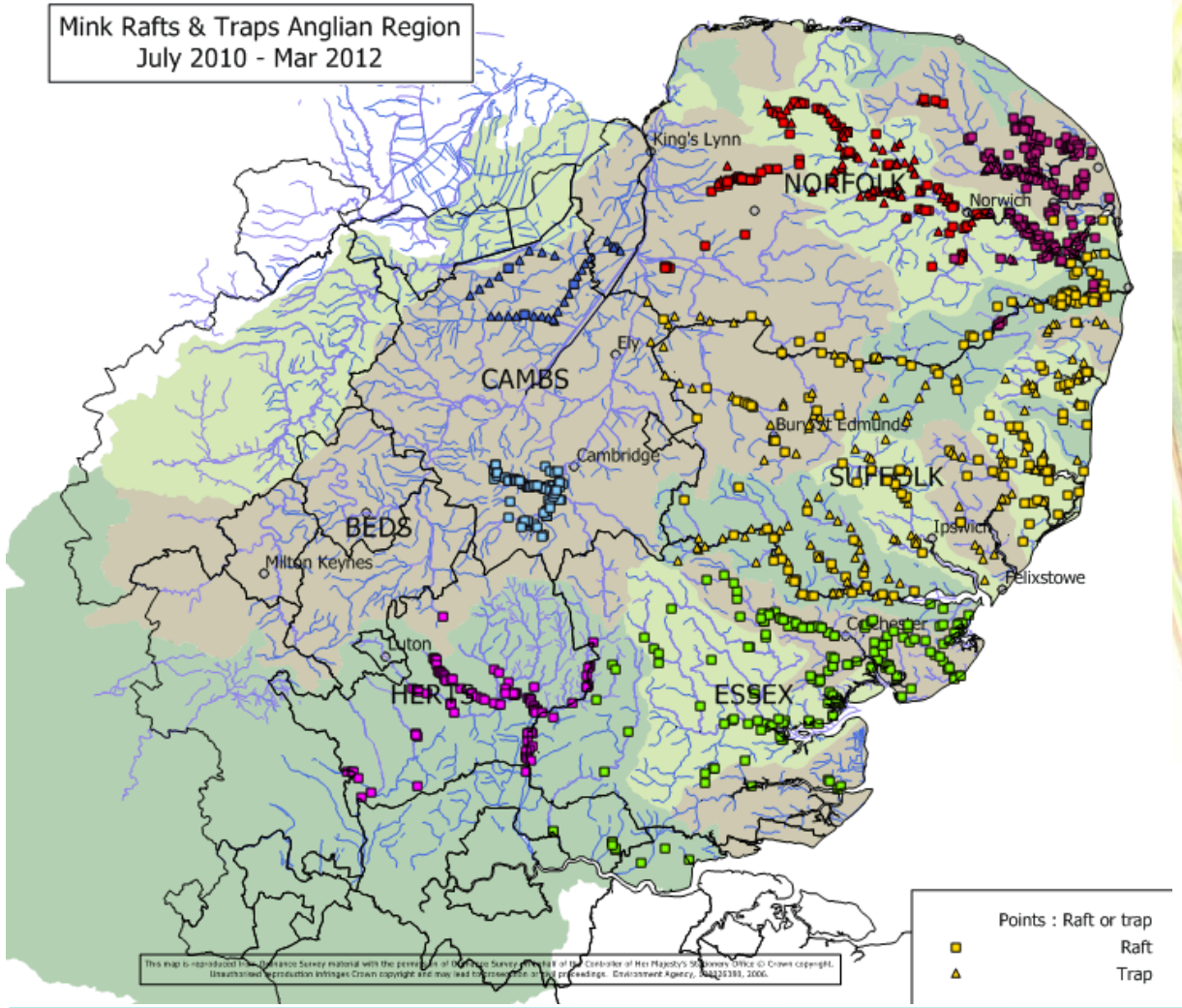
2011-2015
636 occupied 10km grid squares

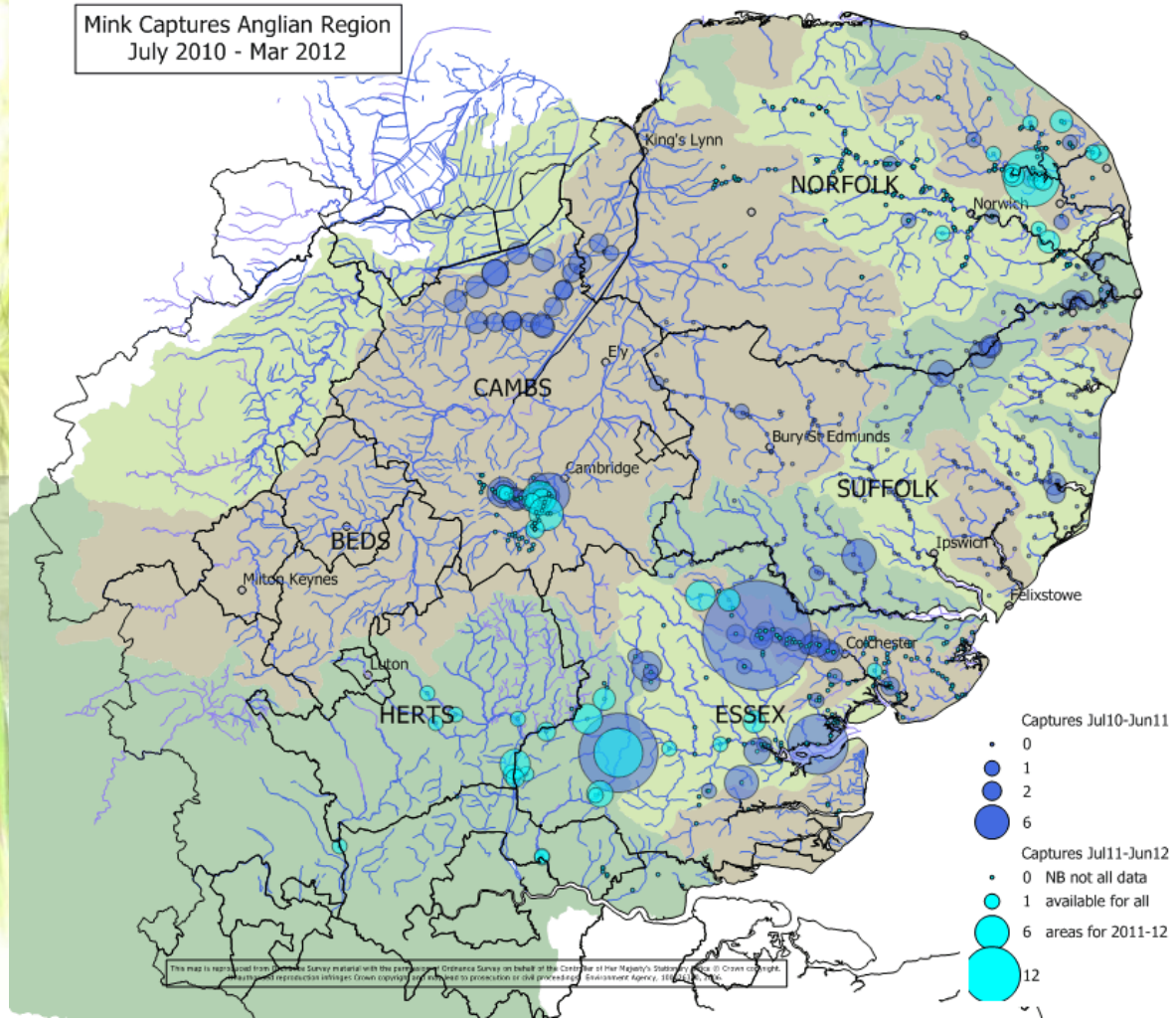


Maps: National Water Vole Database

2001-2019 Eastern Region Mink Control

Mapping mink rafts and captures across the Region
first on spreadsheets then county databases





Maps: Paul Gambling – Eastern Region Mink Control Group

Waterlife Recovery Trust set up

After 20 years of **mink control** in the Eastern Region we moved to a **mink eradication** pilot bringing together all the previous partners and some new ones under a dedicated coordinating charity

Why eradication?

- There is no exit strategy from mink control – high cost, never ending, trapping fatigue
- New technology and new techniques now available – Smart Traps, eDNA, direct DNA sampling, Scent Dogs, camera traps
- Welfare – intense trapping over a shorter timeframe reduces the huge numbers of trapped animals over decades

Waterlife Recovery Trust

The ‘Smart Raft’ trapping method

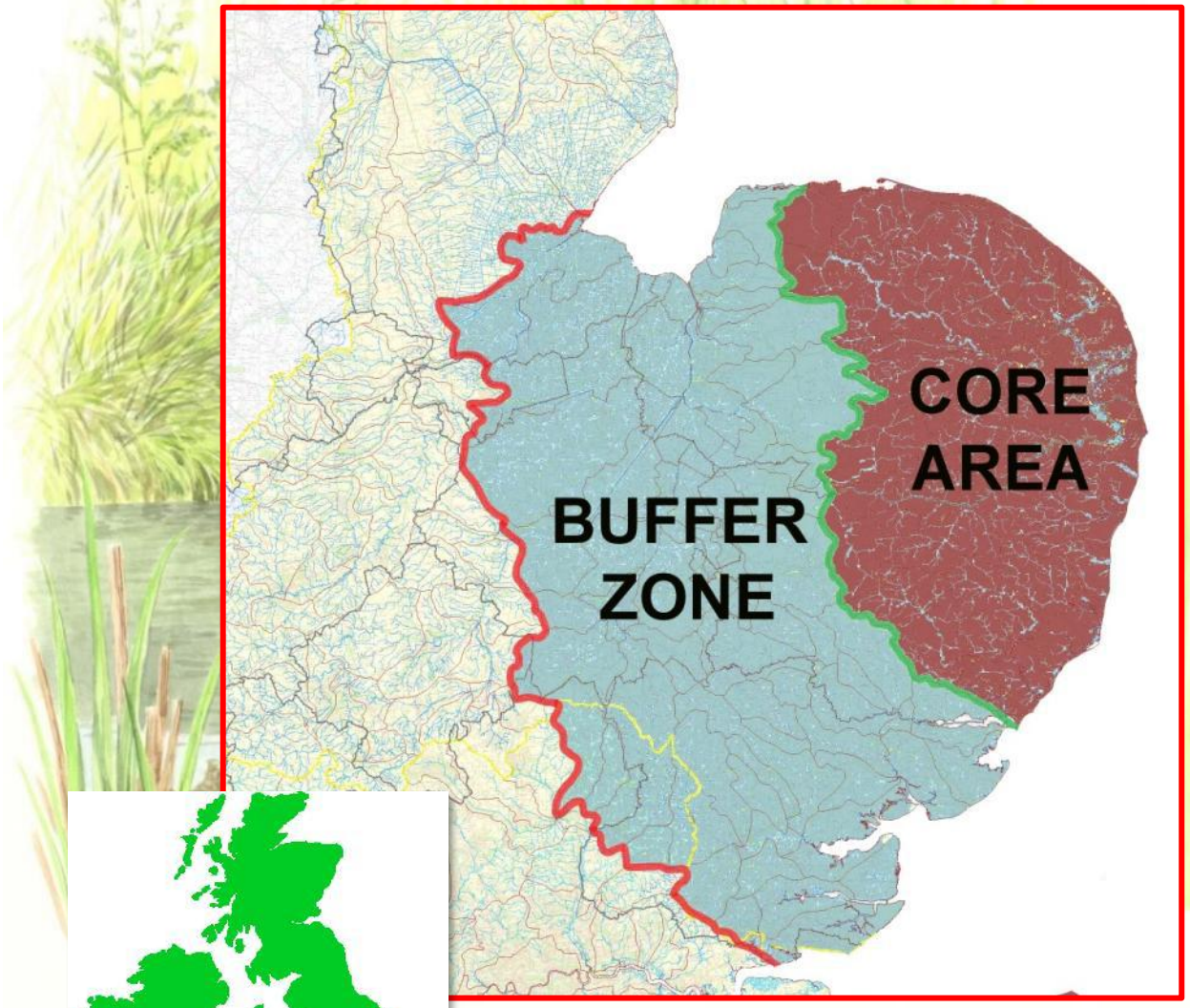
- A live capture cage trap is fitted with a Remoti sensor inside a floating raft
- No need to check for footprints on clay pads
- Bait is not used but most rafts have scent lures processed from previous mink captures
- Text and email alerts are sent as soon as a trap is triggered
- Non-target species such as water rail, polecat or water vole can be released unharmed
- More humane and less time-consuming than old style trapping

The ‘Mink Free East Anglia pilot

Eradication cannot happen everywhere at once so a core area was essential at the start

The strategy

- Use of volunteers with paid staff as Coordinators
- Intensive network of hundreds of ‘smart traps’ across a core area – 5800km2 Norfolk and Suffolk
- Traps run all year and all details of captures entered into a single live mapping database
- Every mink collected for processing including taking DNA samples

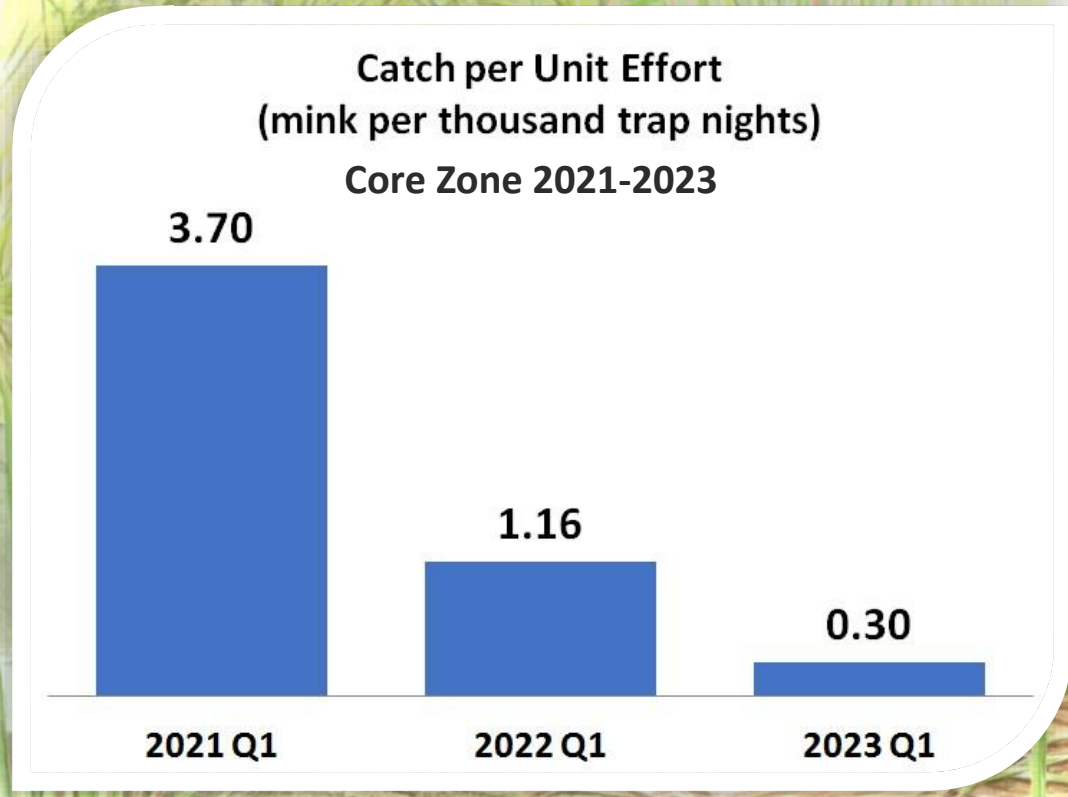


The power of the mink database

We used to record number of mink caught but this provides no figure for the overall population or the effort taken to catch them

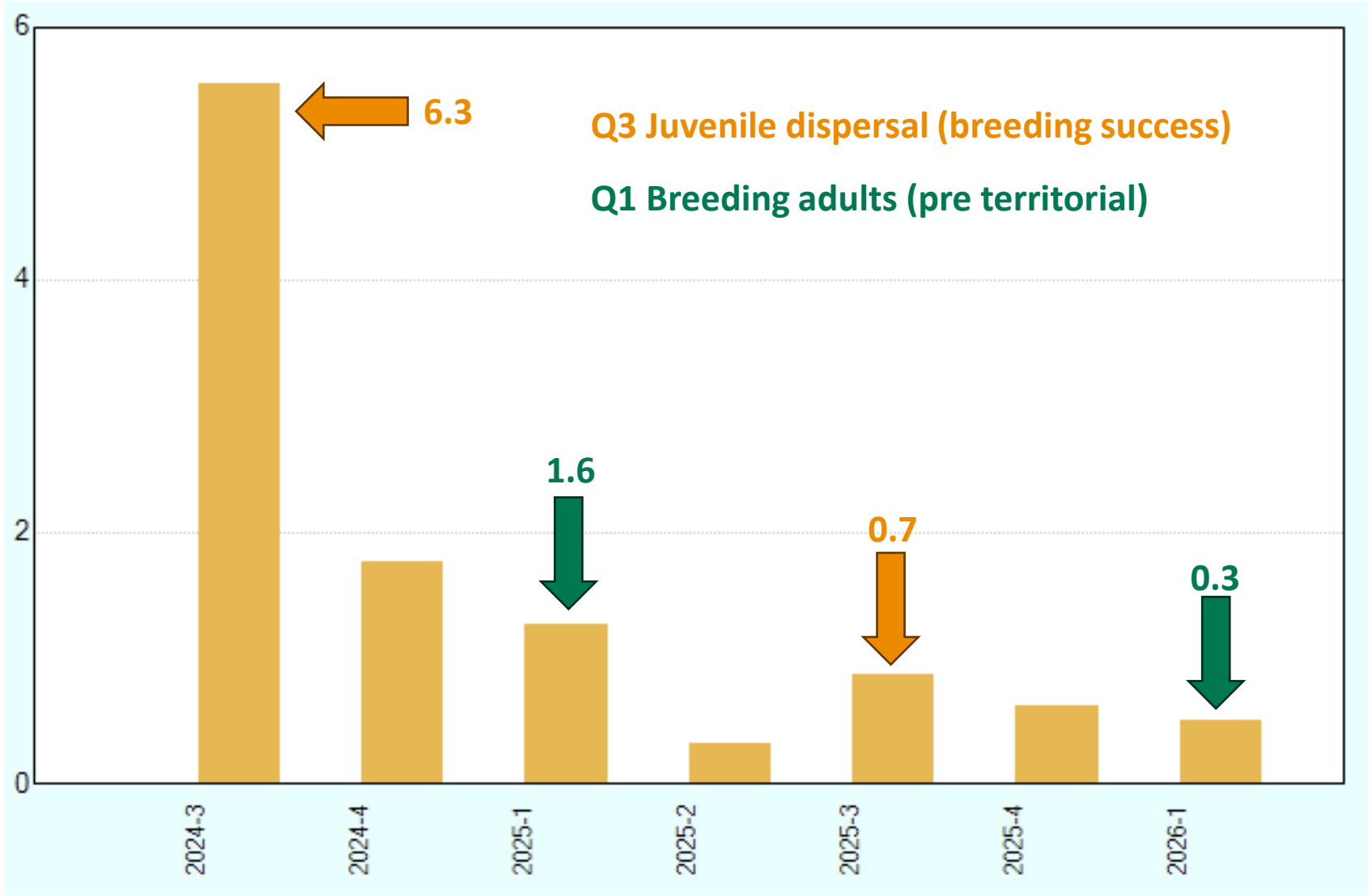
Catch per unit effort (CPUE)

- Database records allow us to calculate CPUE, the number of mink caught per 1000 trap nights
- Modelling using CPUE now demonstrates that mink numbers are **reduced by 67-70% per year** within a fully functioning eradication zone
- Mink captures are therefore are likely to represent **two thirds** of the number alive at the beginning of the trapping year.
  Population estimates now possible



Catch per Unit Effort in Essex

A real world example of the decline in mink captures for every 1000 trap nights

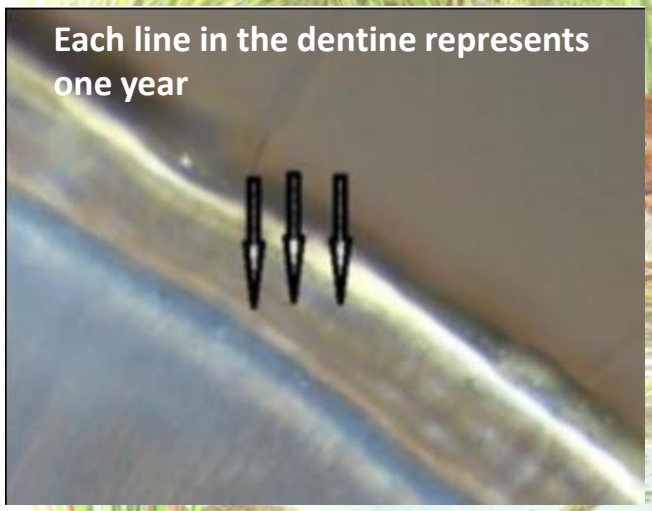


Research and data

How old are mink?

Prof Tony Martin (Chair of WRT) initiated a project using canines from mink carcasses to assess age

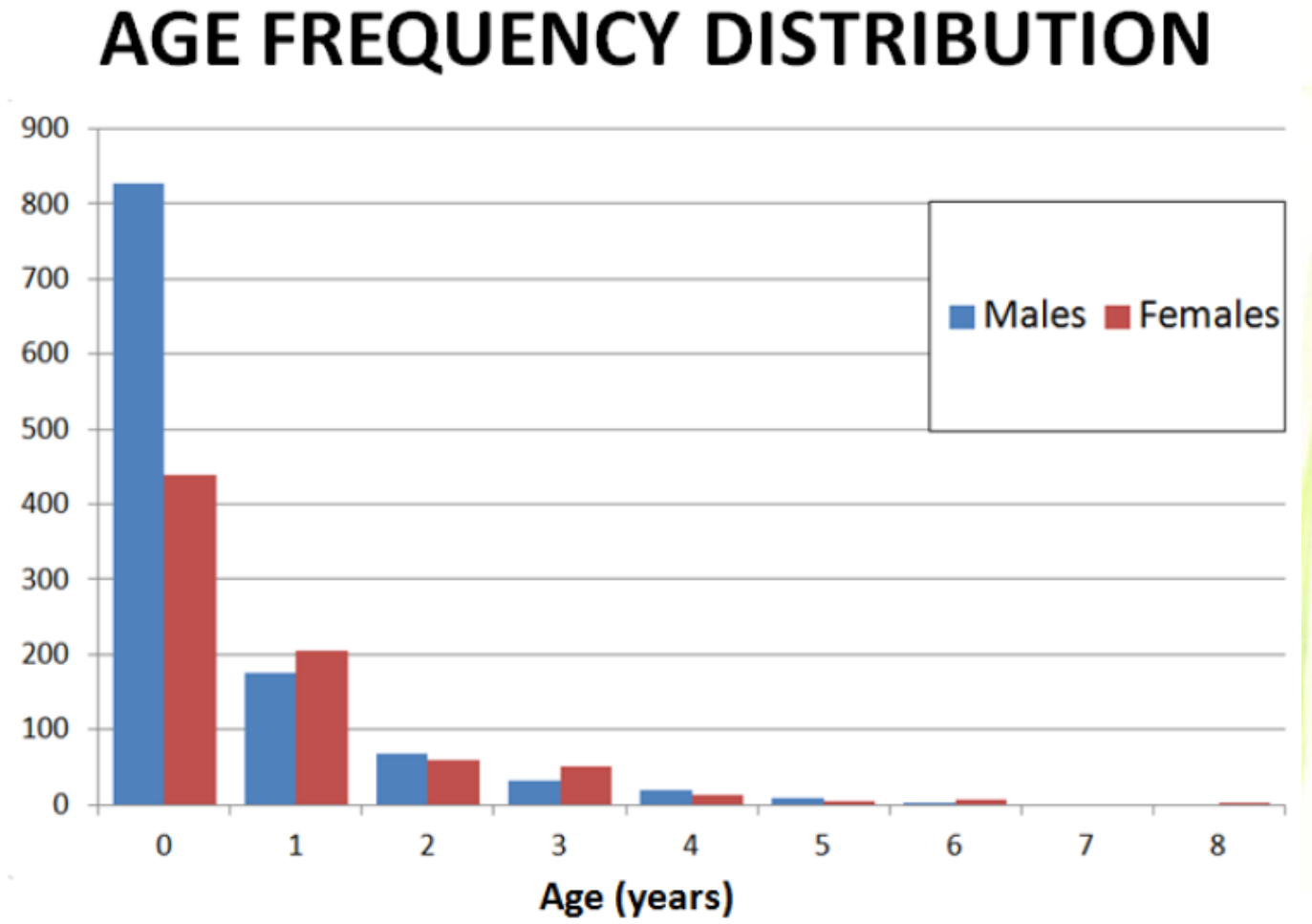
- Mink teeth are x-rayed to identify juveniles from the thin tooth enamel
- Adult teeth can be aged from growth rings in the dentine – process undertaken at the Matson lab in Montana



Research and data

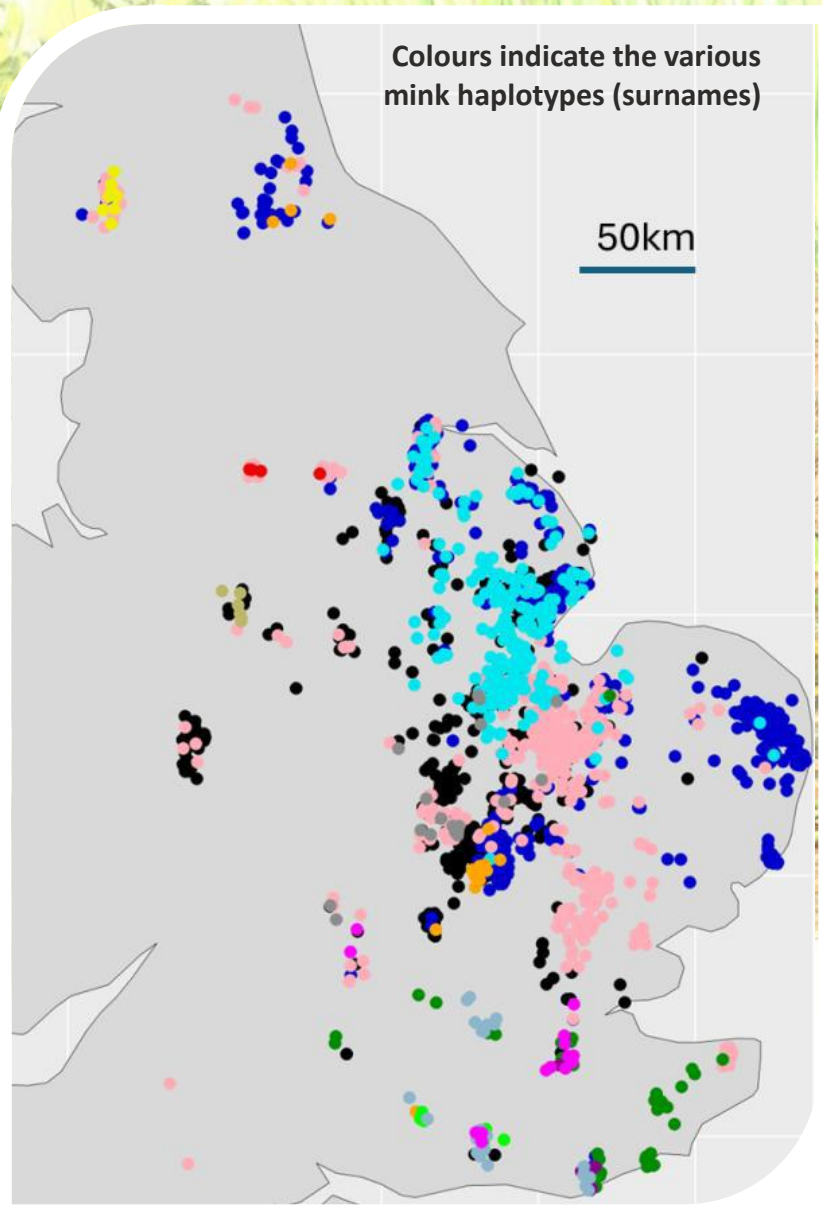
How old are mink?

- 1911 mink have been analysed so far
- The oldest mink was 8, but that female was exceptional
- Only 10% of females and 5% of males reach their third birthday
- Only 27% of males and 44% of females reach reproductive age (1 year old)
- Mink are therefore vulnerable to population collapse with the coordinated removal of breeding adults



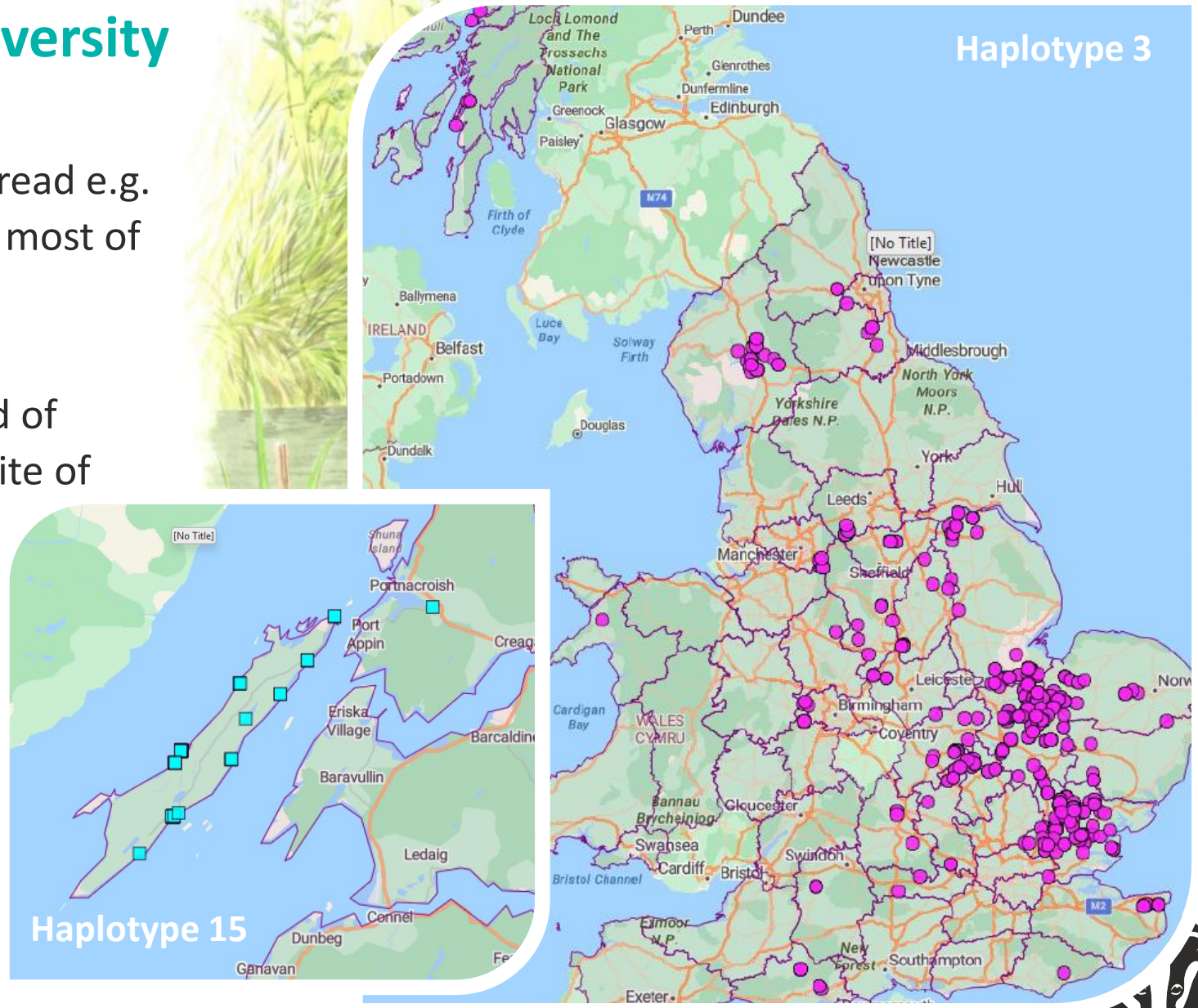
DNA Research Cambridge University

- Since 2020 DNA samples have been systematically collected from invasive American mink in the Eastern Region
- Cambridge University and the Waterlife Recovery Project Partnership now have a growing database of 2600+ mink DNA samples
- Mitochondrial DNA extracted from captured mink tracks the female breeding bloodline – the haplotype (think surname in a human context)



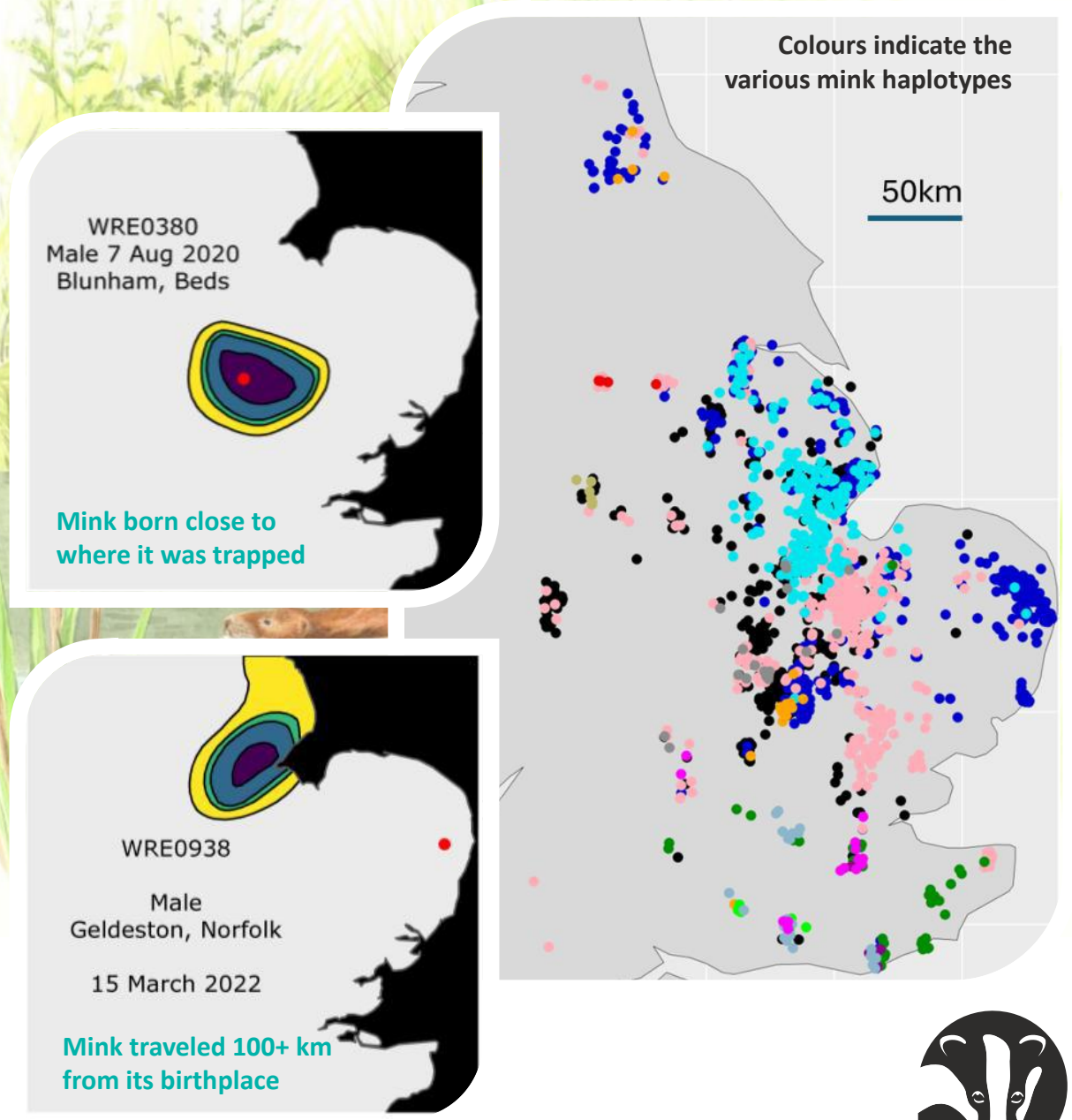
DNA Research Cambridge University

- Some haplotypes are incredibly widespread e.g. Haplotype 3 which can be found across most of the UK
- Some are restricted to small areas e.g. haplotype 15 is only found on the island of Lismore off the Scottish coast and the site of the original fur farm on the mainland

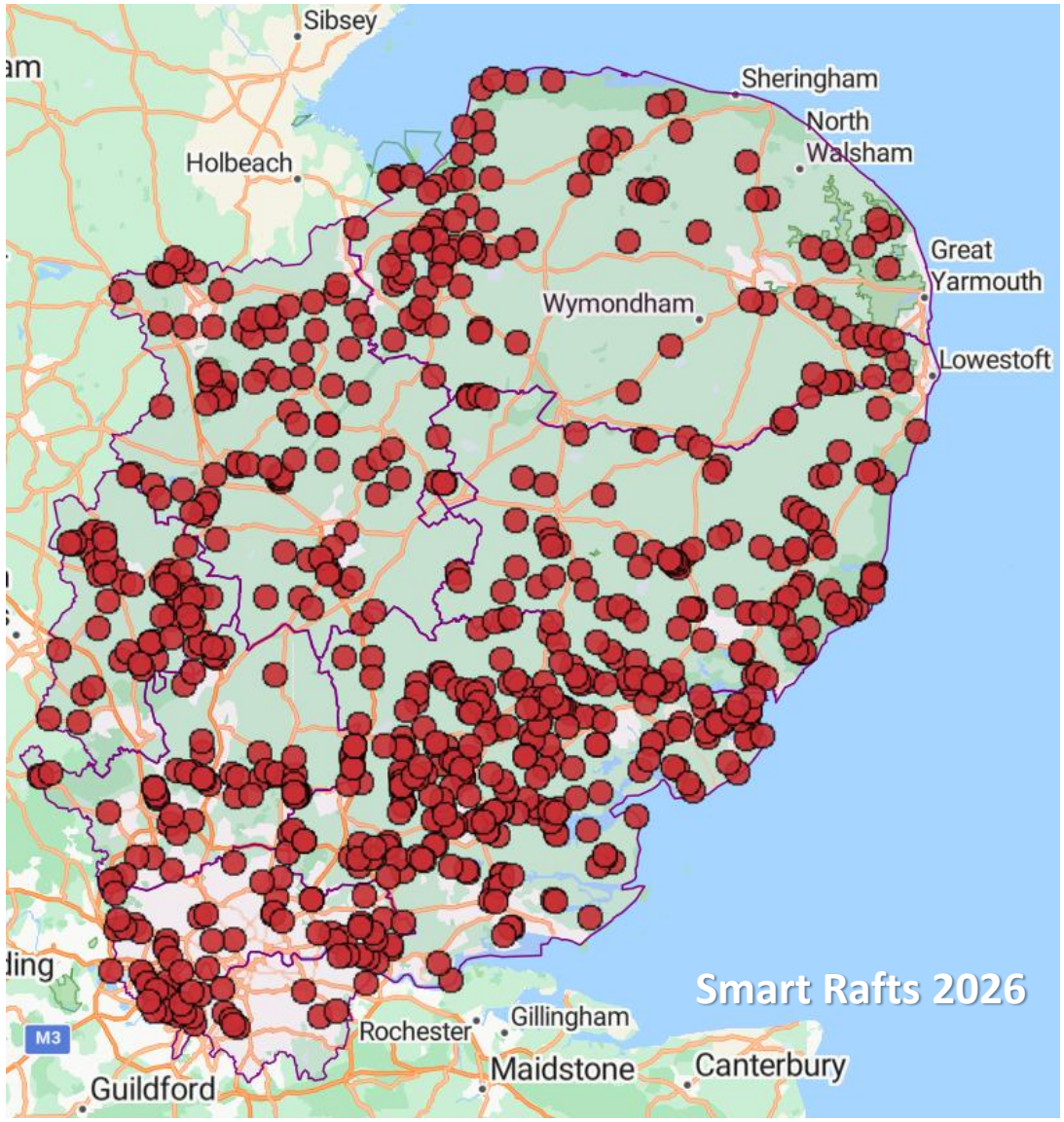


DNA Research Cambridge University

- From the inter-relatedness of mink and identification of haplotypes we can now estimate how far mink disperse from their birthplace
- Most animals have a haplotype origin close to where they were caught, generating a bulls-eye pattern centred on the location where they were trapped (red dot)
- Occasionally, the trap location (red dot) lies some distance from where the DNA haplotype exists, indicating that the animal has travelled away from where it was born



Since 2021 mink captures have ceased across >12000km2



Future of the mink free core

Water vole response

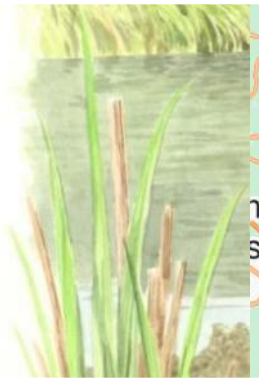
Now mink are absent the main trap captures in core area are water vole

Water vole excluders required

Redundant rafts

The density of rafts in counties now no longer catching mink is being reduced. Considerations are to:

- Retain a viable monitoring network
- Target redeployment of equipment in or beyond the current buffer zone
- Ensure biosecurity of rafts moved between areas by heat sterilisation



A hopeful future for water voles?

- Eradication of mink allows full connectivity of suitable water vole habitat across a landscape
- Water voles respond rapidly to safe areas and will naturally re-colonise
- Where water voles have become functionally extinct across a landscape, well co-ordinated water vole translocations/reintroductions are more likely to succeed in a mink free landscape
- Habitat restoration and creation projects can now assist with the goal of water voles reaching Favourable Conservation Status by 2030

This project demonstrates how a data-driven and conservation evidence led project can result in a paradigm shift in attempts to remove this invasive species

Steering Group Member of

Waterlife Recovery Trust

Essex Wildlife Trust

Darren Tansley – darrent@essexwt.org.uk
Chairman of the UK Water Vole Steering Group

Mud Spotter

A Citizen Science Sediment Inflow Survey

Dr Jo Wright

Cartogapher

What is Mud Spotter?

- Standard method for data collection and monitoring fine sediment inputs to rivers & streams
- App based
- Rural and urban
- During or just after rainfall events
- All data accessible on a nationwide map
- Also useful in conjunction with other data/surveys such as water quality testing, and outfall safaris

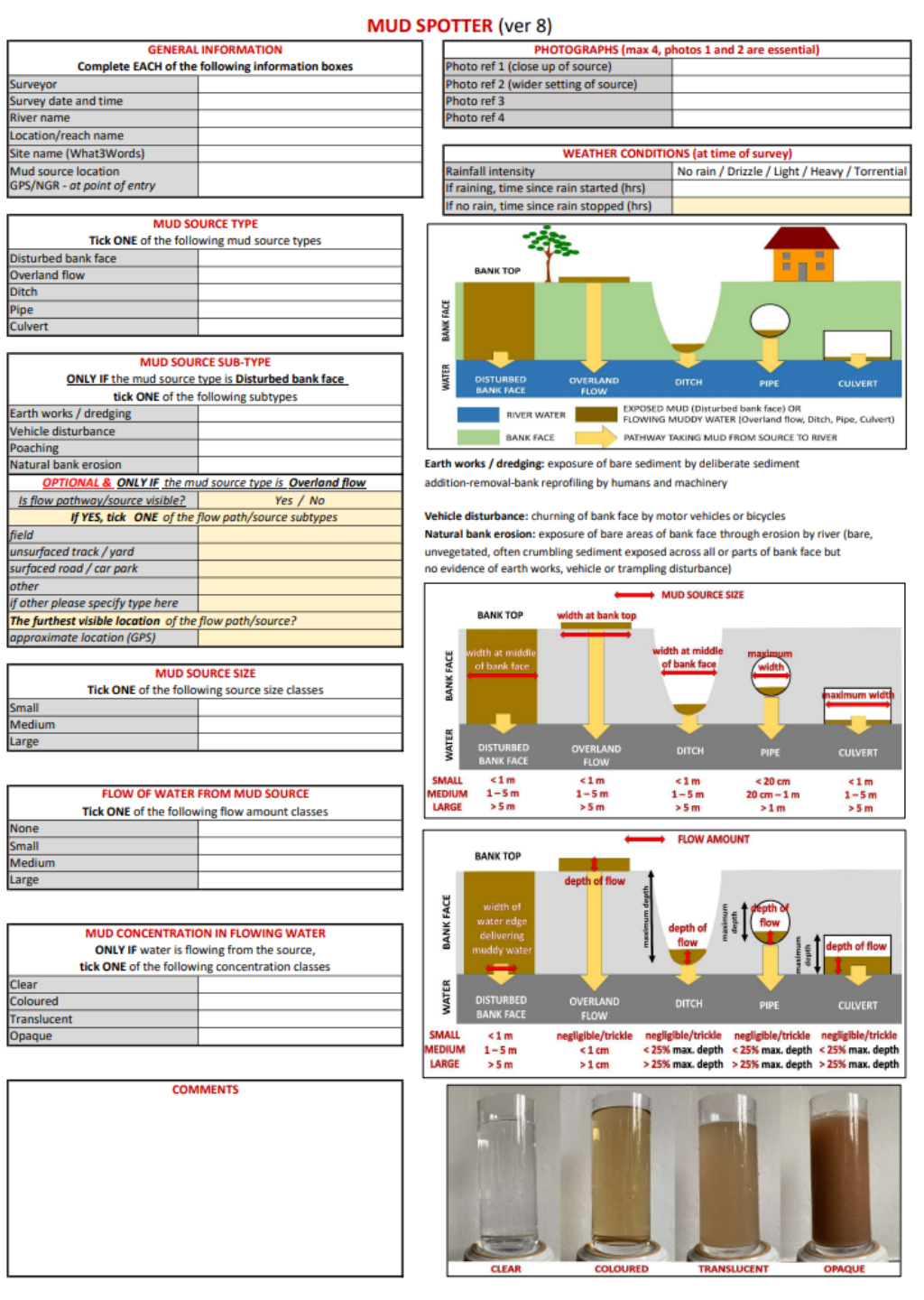
https://modularriversurvey.org/mud-spotter/

Why bother spotting mud?

- Fine sediments are a natural part of river systems
- But they can cause problems if they:
  - exceed the natural balance for the system
  - increase suspended loads
  - clog gravels on river beds
  - bind with polluting substances and nutrients

Mud Spotter

- Survey form
- Phone app
- Easy to use
  - Tick boxes/drop down menus



MUD SPOTTER (ver 8)

GENERAL INFORMATION Complete EACH of the following information boxes	
Surveyor	
Survey date and time	
River name	
Location/reach name	
Site name (What3Words)	
Mud source location GPS/NGR - *at point of entry*	

PHOTOGRAPHS (max 4, photos 1 and 2 are essential)	
Photo ref 1 (close up of source)	
Photo ref 2 (wider setting of source)	
Photo ref 3	
Photo ref 4	

WEATHER CONDITIONS (at time of survey)	
Rainfall intensity	No rain / Drizzle / Light / Heavy / Torrential
If raining, time since rain started (hrs)	
If no rain, time since rain stopped (hrs)	

MUD SOURCE TYPE **Tick ONE** of the following mud source types	
Disturbed bank face	
Overland flow	
Ditch	
Pipe	
Culvert	

MUD SOURCE SUB-TYPE **ONLY IF** the mud source type is **Disturbed bank face** **tick ONE** of the following subtypes	
Earth works / dredging	
Vehicle disturbance	
Poaching	
Natural bank erosion	
*OPTIONAL & **ONLY IF** the mud source type is **Overland flow***	
Is flow pathway/source visible?	*Yes / No*
***If YES, tick ONE** of the flow path/source subtypes*	
field	
unsurfaced track / yard	
surfaced road / car park	
other	
if other please specify type here	
***The furthest visible location** of the flow path/source?*	
approximate location (GPS)	

MUD SOURCE SIZE **Tick ONE** of the following source size classes	
Small	
Medium	
Large	

FLOW OF WATER FROM MUD SOURCE **Tick ONE** of the following flow amount classes	
None	
Small	
Medium	
Large	

MUD CONCENTRATION IN FLOWING WATER **ONLY IF** water is flowing from the source, **tick ONE** of the following concentration classes	
Clear	
Coloured	
Translucent	
Opaque	

COMMENTS

Earth works / dredging: exposure of bare sediment by deliberate sediment addition-removal-bank reprofiling by humans and machinery

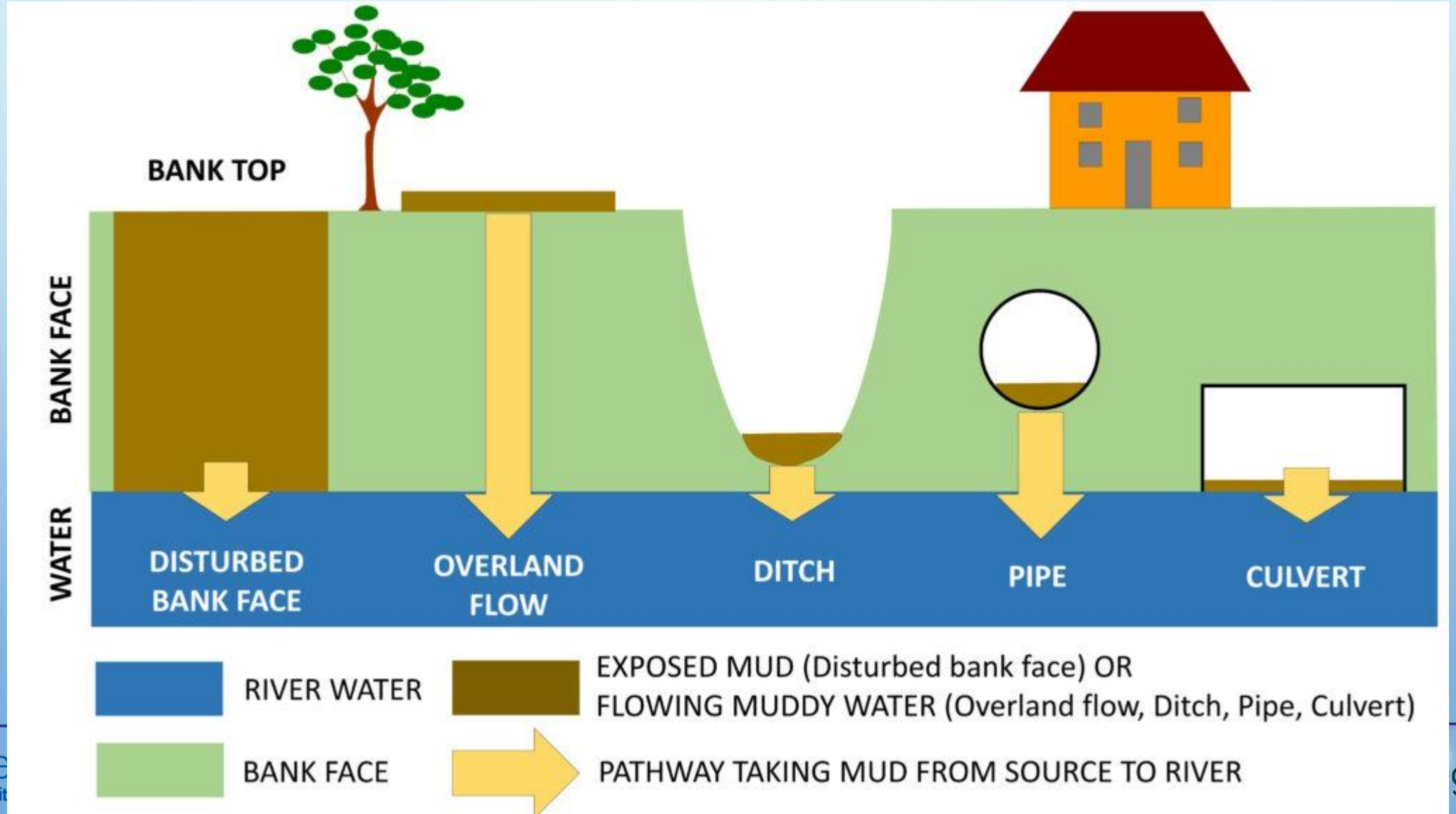
Vehicle disturbance: churning of bank face by motor vehicles or bicycles

Natural bank erosion: exposure of bare areas of bank face through erosion by river (bare, unvegetated, often crumbling sediment exposed across all or parts of bank face but no evidence of earth works, vehicle or trampling disturbance)

Queen Mary University of London

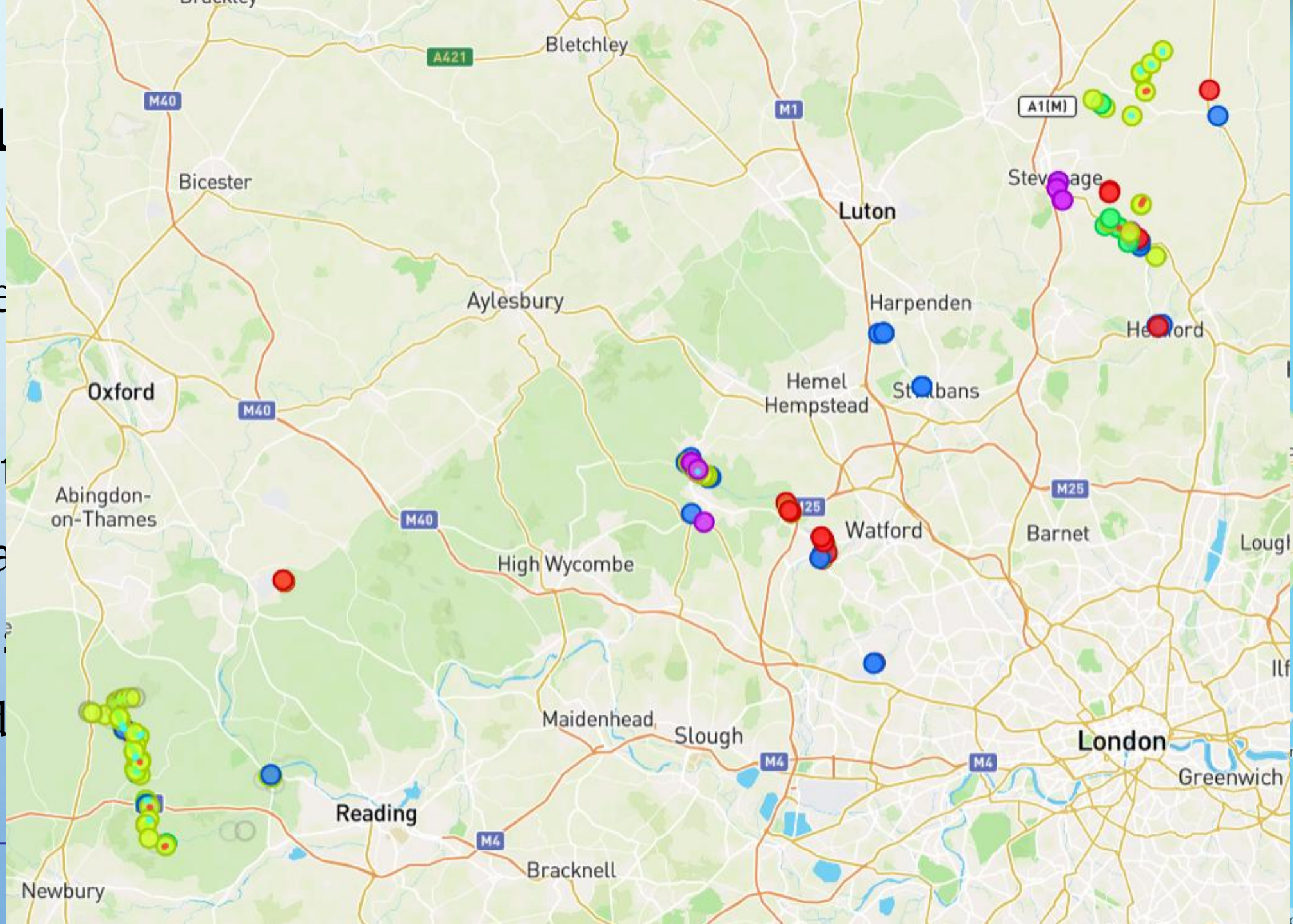
Modular River Sur

Mud Spotter


BANK TOP
BANK FACE
WATER
DISTURBED BANK FACE
OVERLAND FLOW
DITCH
PIPE
CULVERT
RIVER WATER
EXPOSED MUD (Disturbed bank face) OR
FLOWING MUDDY WATER (Overland flow, Ditch, Pipe, Culvert)
BANK FACE
PATHWAY TAKING MUD FROM SOURCE TO RIVER

Mu

- Mudspotte
  date
- Some clus
  - Kennet a
  - Chiltern
  - Lea Mud



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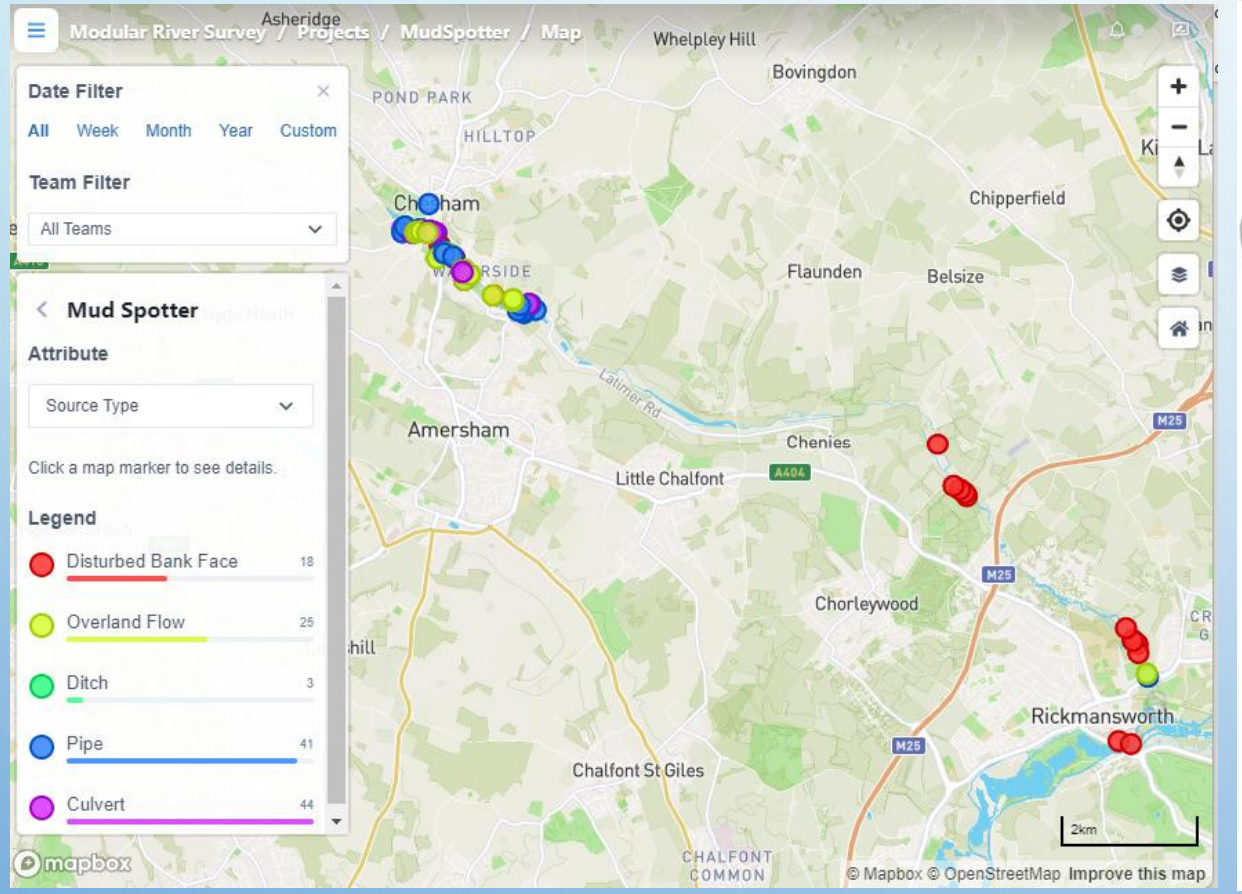
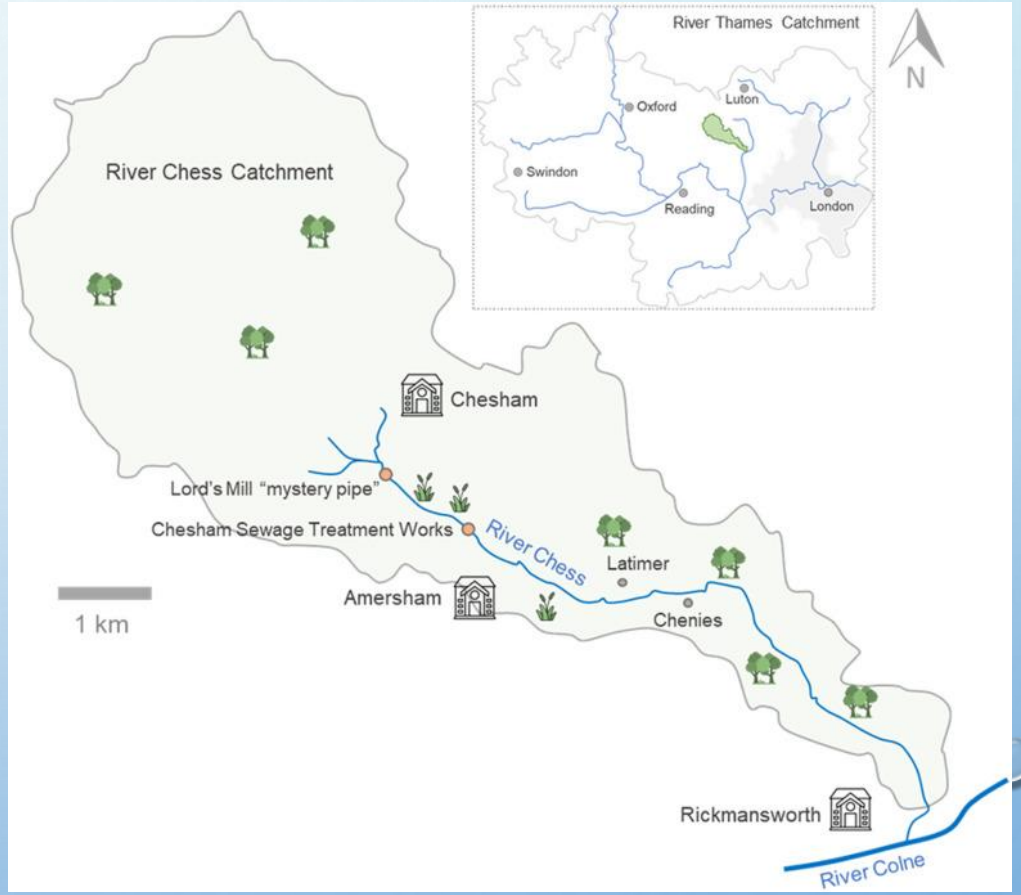
Chilterns Chalk Streams Project

Mud Spotter on the River Chess





https://chesssmarterwatercatchment.org/citizen-science/water-quality-surveys/mudspotter/

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Modular River Survey

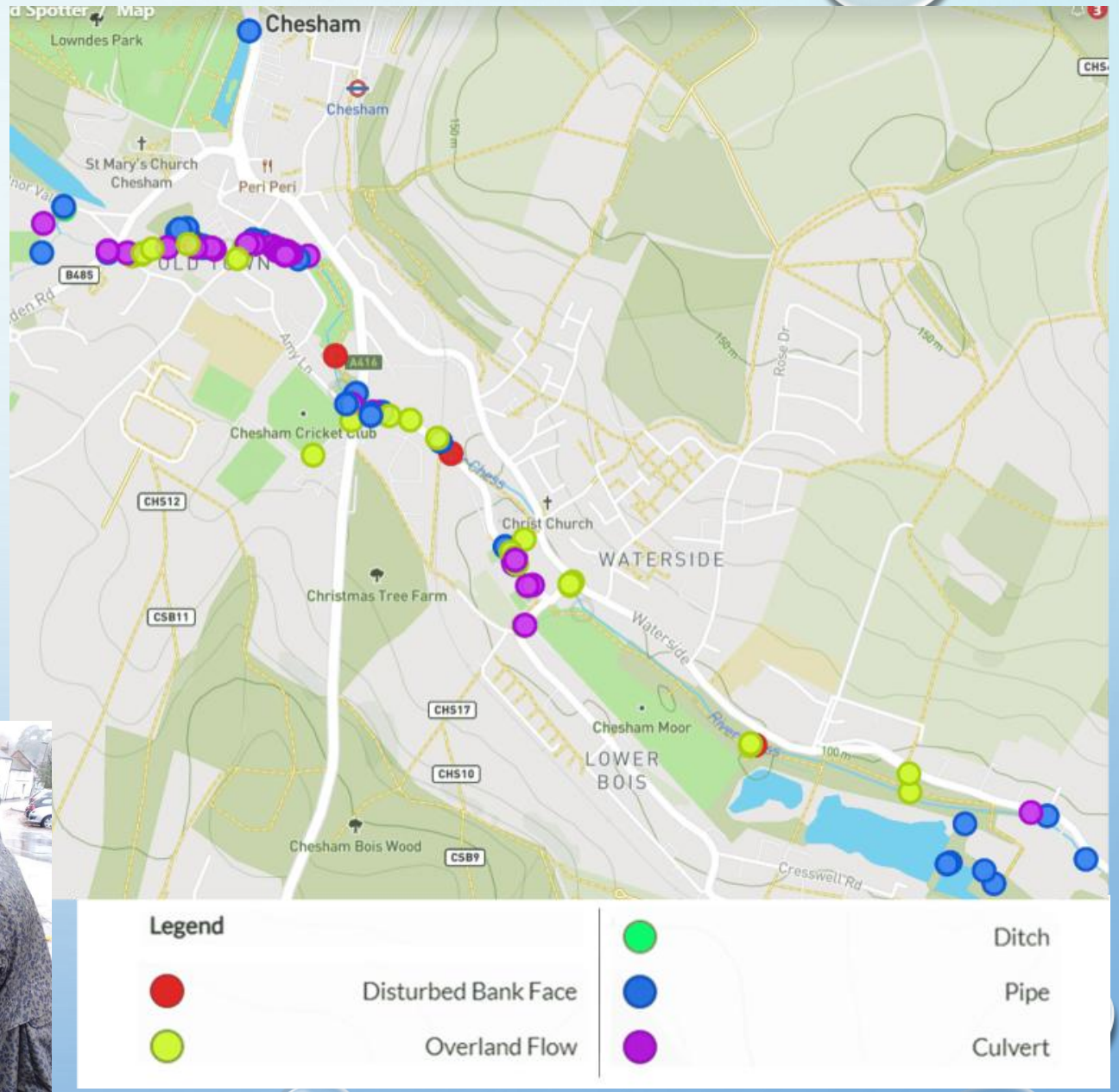
cartographer

MudSpotter & Sediment Studies

We have trialled a pilot citizen science method to identify sediment entry points to the river in Chesham, carried out sediment source apportionment and more.

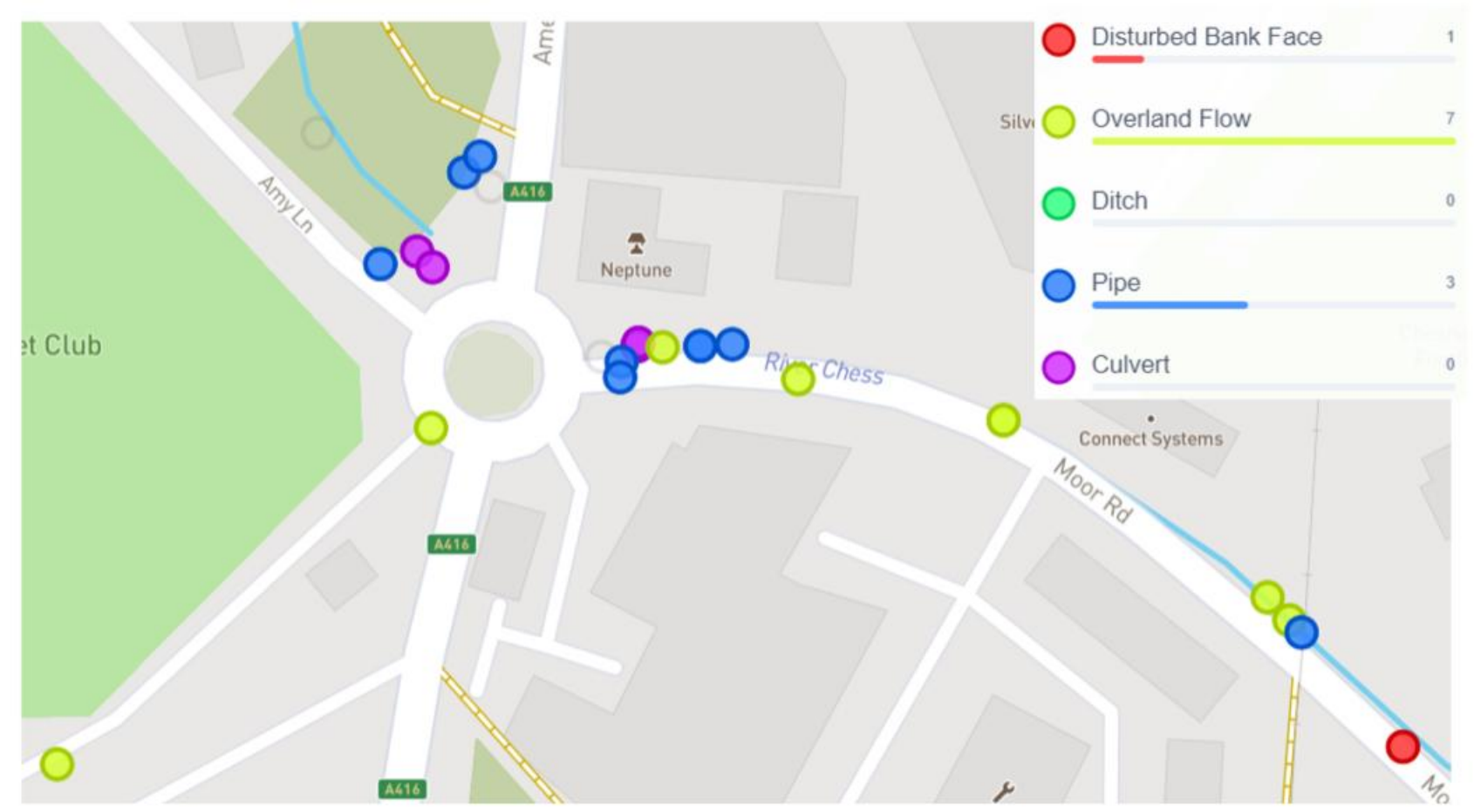
River Chess

- Identified a number of problem areas in Chesham during wet weather MudSpotter surveys



Mud Spotter River Chess sediment sources

- Agricultural runoff via steep valley sides,
- Urban runoff from unmetalled parking areas and road verges.



Mud Spotter part of a larger sediment study on the River Chess

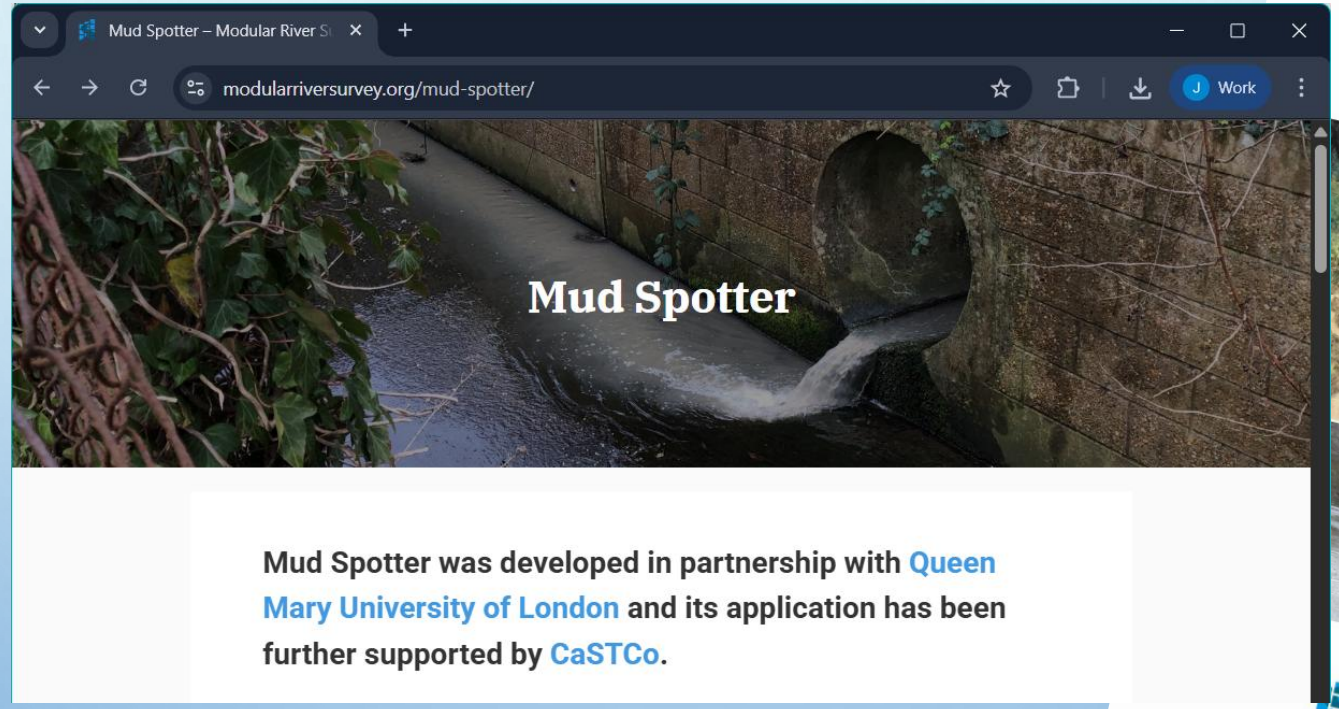
- **Sediment source apportionment** study with Rothamsted Research
- **Ecological impacts of sediment** in the River Chess:
  - through a consultancy study with APEM
  - using the SmartRivers citizen science method with Wildfish
- **Key locations for sediment issues** in the River Chess including:
  - suspended sediment collection with QMUL
  - piloting the Mud Spotter citizen science method to determine sediment entry points to the river.

Mud Spotter Training

- Recently trained a group in Dorset – Wessex Water and volunteers
- Plans to train Mud Spotters in Nidderdale, North Yorkshire, for the Nidd Action Group

Mud Spotter Resources

- Manual
- Website



https://modularriversurvey.org/mud-spotter/

Mud Spotter

- For more information on Mud Spotter or to get training please email: **training@cartographer.io**
- Training can be in person or online