A Chemical Monitoring Network to Evaluate Countryside Stewardship and Catchment Sensitive Farming

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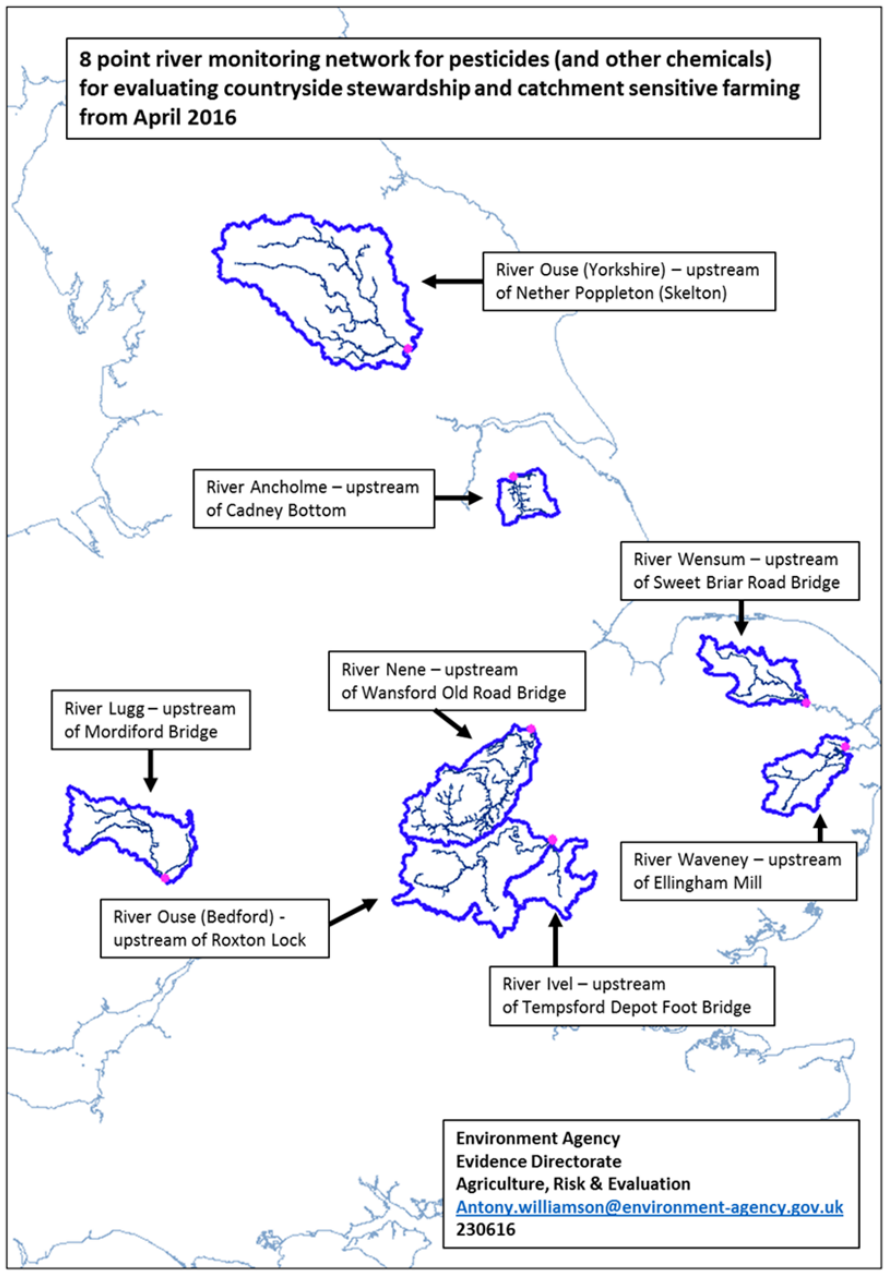


Voluntary Actions by farmers to reduce water pollution

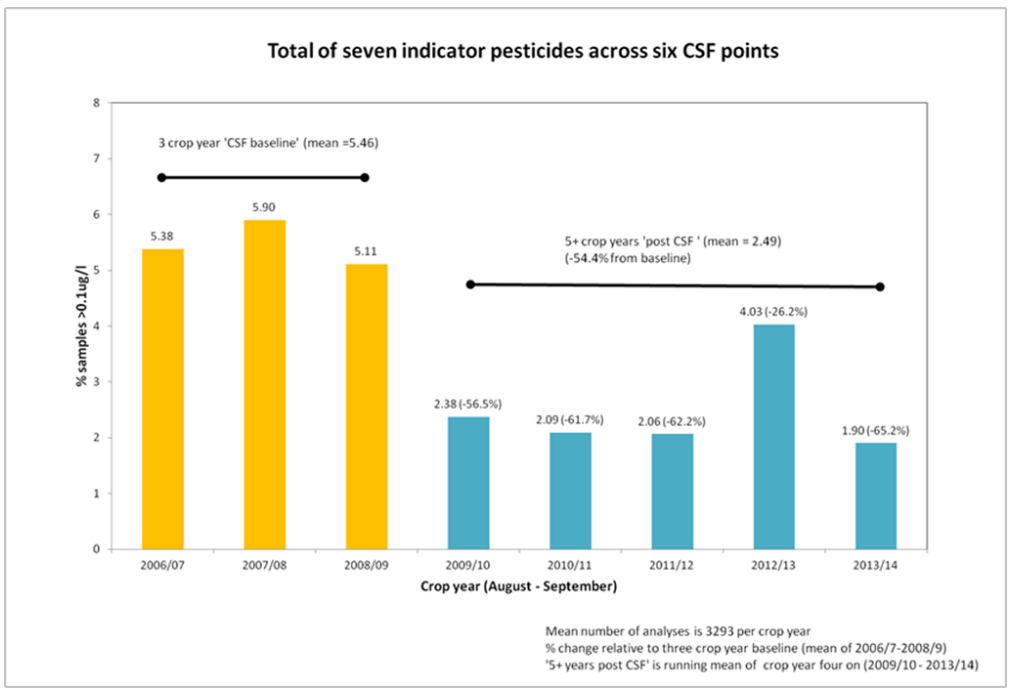
Countryside Stewardship and Catchment Sensitive Farming are both UK Government schemes to help farmers take voluntary actions to make environmental improvements in England. An important part of the work is aimed at implementing on-farm measures to reduce diffuse pollution of rivers by nutrients, sediment, pesticides and faecal indicator organisms. CSF has been running for 10 years and has delivered advice to 19,000 farmers covering 2.6 million hectares of land.

Evaluating environmental improvements

Key to both schemes is the ability to track environmental improvements brought about by the changes that farmers have made in their river catchments. The Environment Agency has a network of 117 CS/CSF river monitoring sites designed to track river quality parameters. A subset of 8 of these sites is used to track organic chemicals (mainly pesticides) and that network is discussed here. Using a single downstream monitoring point and frequent regular monitoring has proved successful in tracking improvements at a broad catchment scale.

Monitoring

We have been monitoring a range of pesticides at 6 sites continuously since 2006 showing a general reduction of around 50% in overall pesticide levels in the test areas. More recently (from April 2016) we have established the 8 point network shown here. Grab samples of river water are taken twice per week (about 100 per year) and analysed using a scanning LC-MS technique. The method gives results for some 335 pesticides and 179 other organics (mainly pharmaceuticals).



Sample point ref.	Site name	NGR	Purpose
50050	R. Lugg at Mordiford Bridge	SO5700037460	CSF (2006-2016) CSF+CS (2016-)
49100488	R. Ouse at Nether Poppleton (Skelton)	SE5684055364	CSF (2006-2016) CSF+CS (2016-)
WAV120	R. Waveney at Ellingham Mill	TM3640091600	CSF (2006-2016) CSF+CS (2016-)
WEN250	R. Wensum at Sweet Briar Road Bridge	TG2060009500	CSF (2006-2016) CSF+CS (2016-)
ANCN5	R. Ancholme at Cadney Bottom	TA0009802866	CSF+CS (2016-)
19M07	R. Ivel at Tempsford Depot Foot Bridge	TL1610053300	CSF+CS (2016-)
NENE550W	R. Nene at Wansford old Road Bridge	TL0750099100	CSF+CS (2016-)
12M08	R. Ouse at Roxton Lock	TL1593553417	CSF+CS (2016-)

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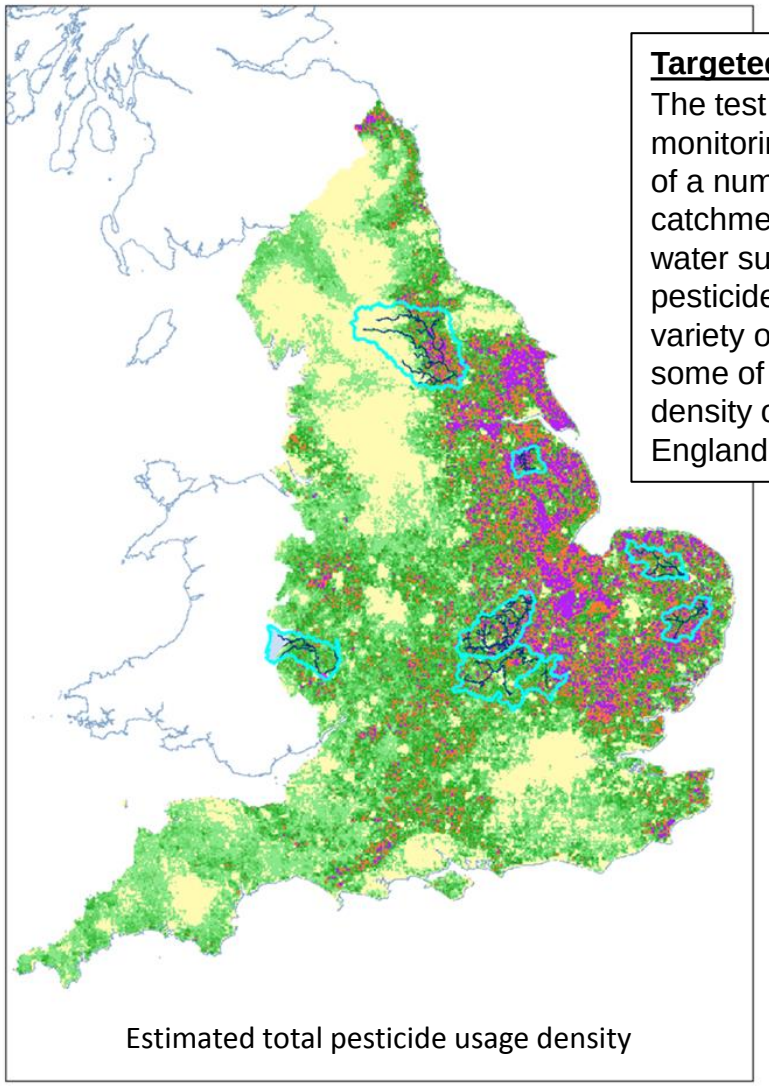
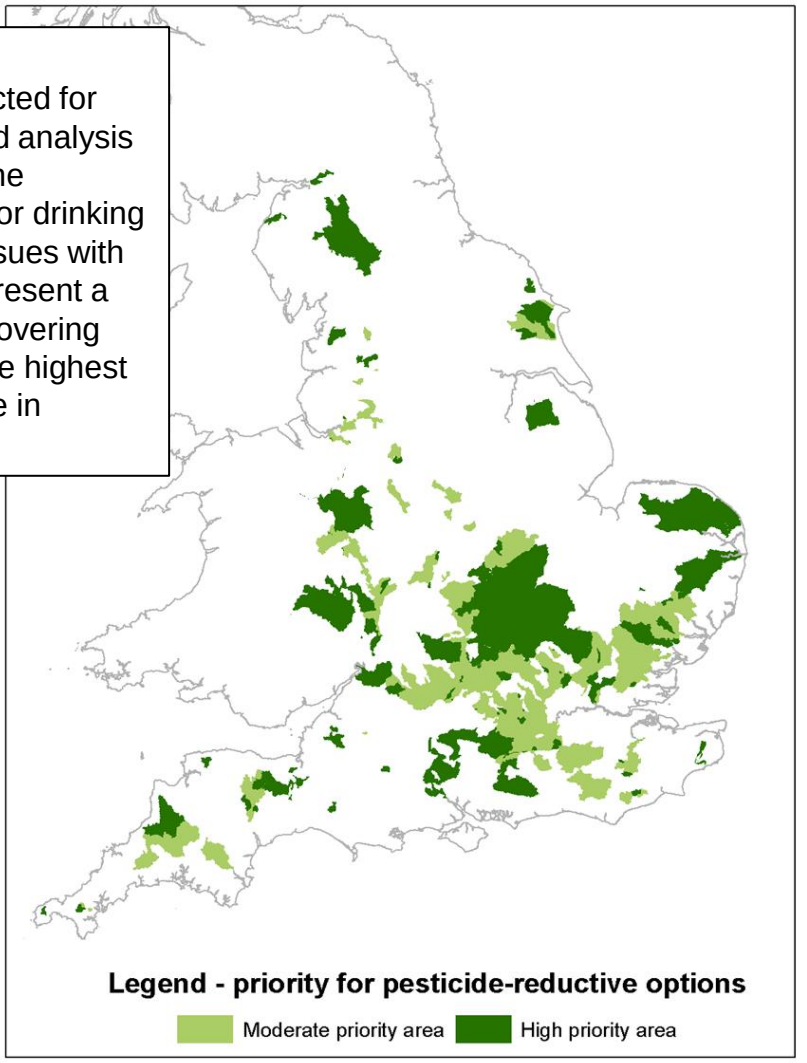
Targeted Monitoring

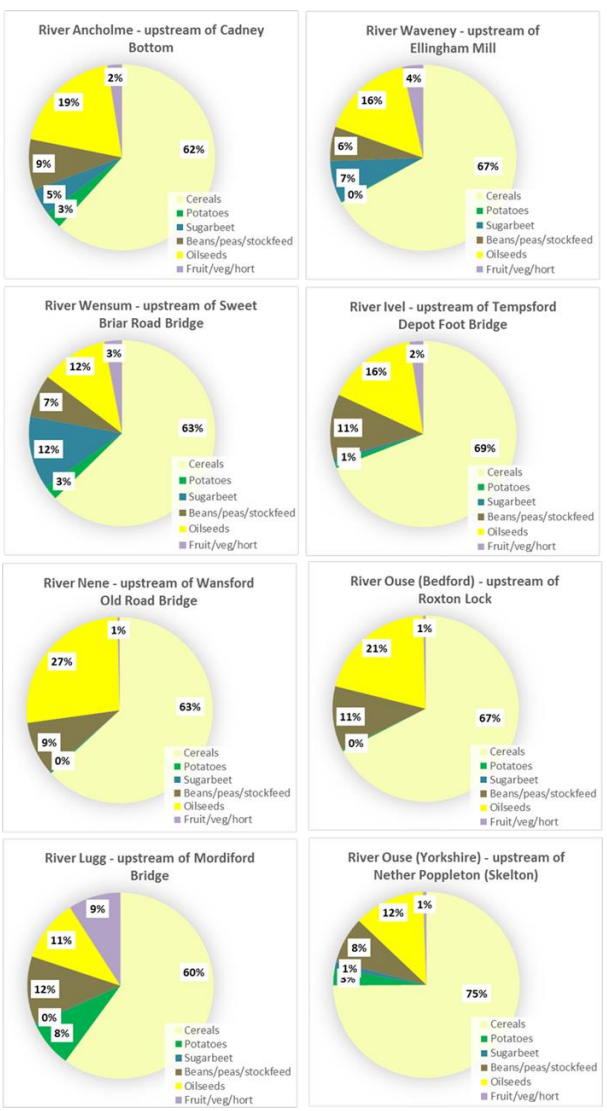


Estimated total pesticide usage density

Targeted monitoring

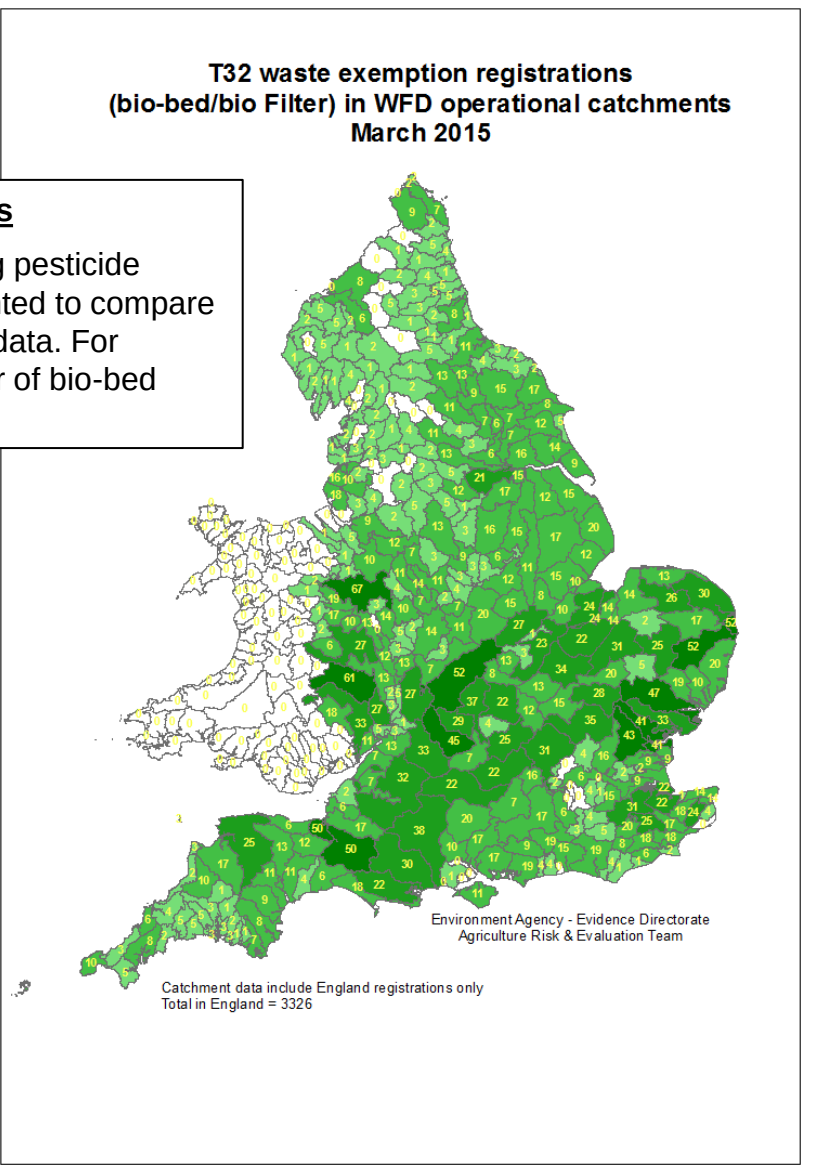
The test areas were selected for monitoring after a detailed analysis of a number of factors. The catchments are all used for drinking water supply and have issues with pesticides. They also represent a variety of farming types covering some of the areas with the highest density of pesticide usage in England.





Pesticide measures

We are also tracking pesticide measures implemented to compare with the monitoring data. For example the number of bio-bed treatment facilities.



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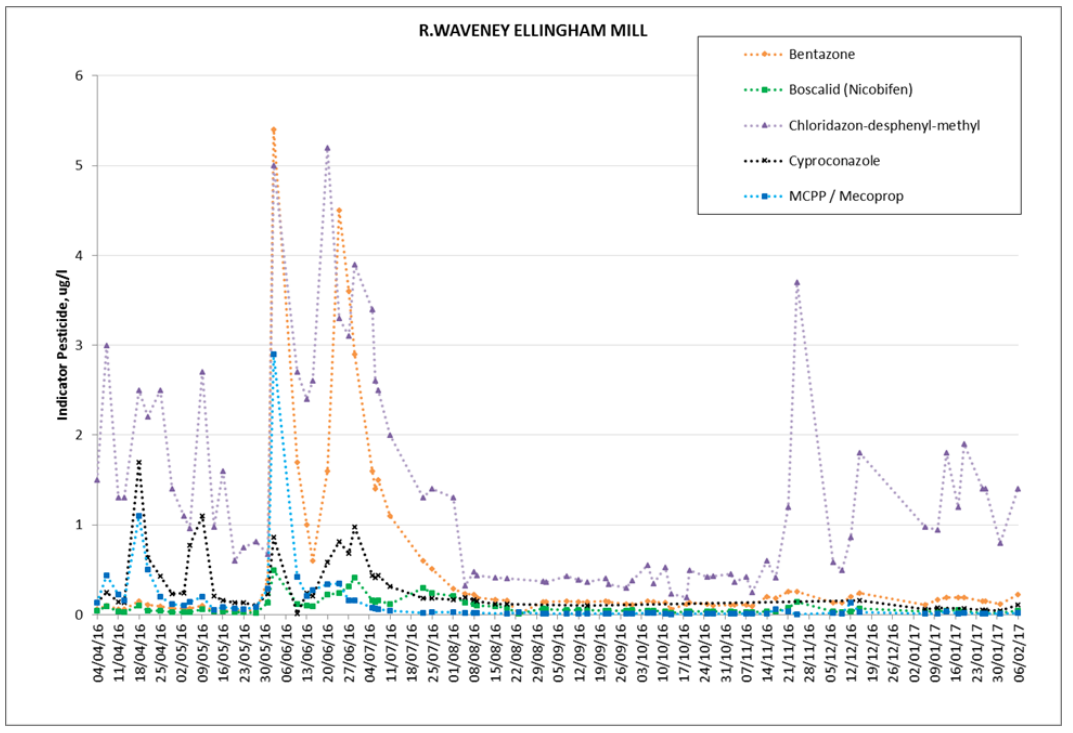
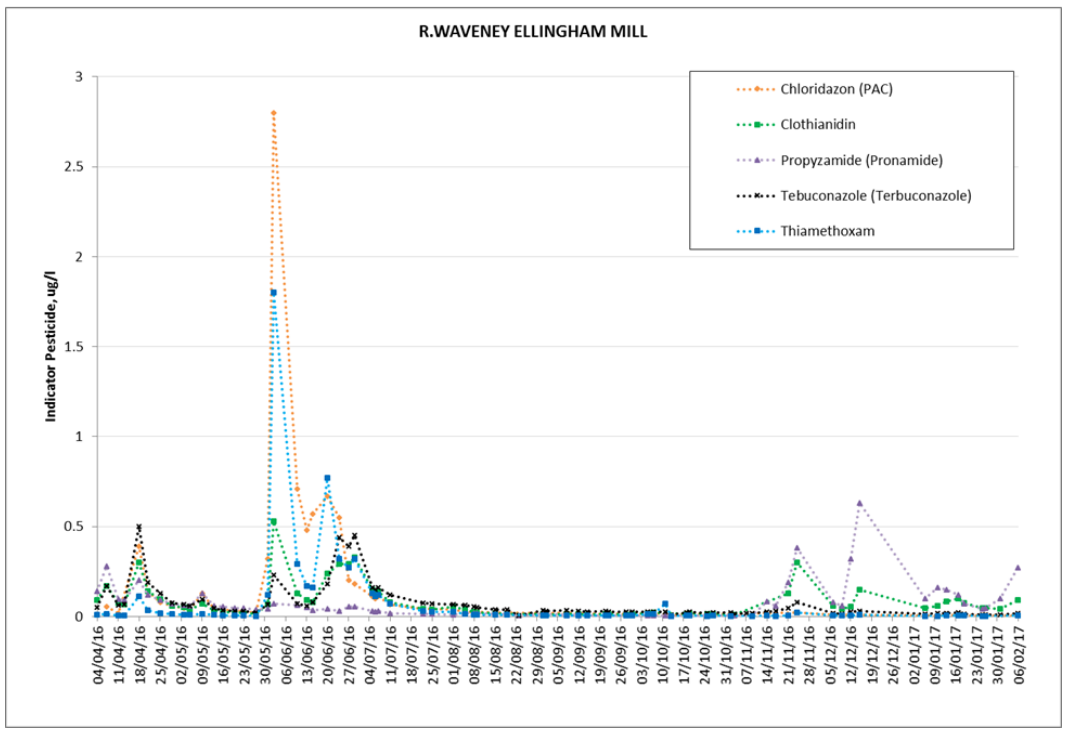
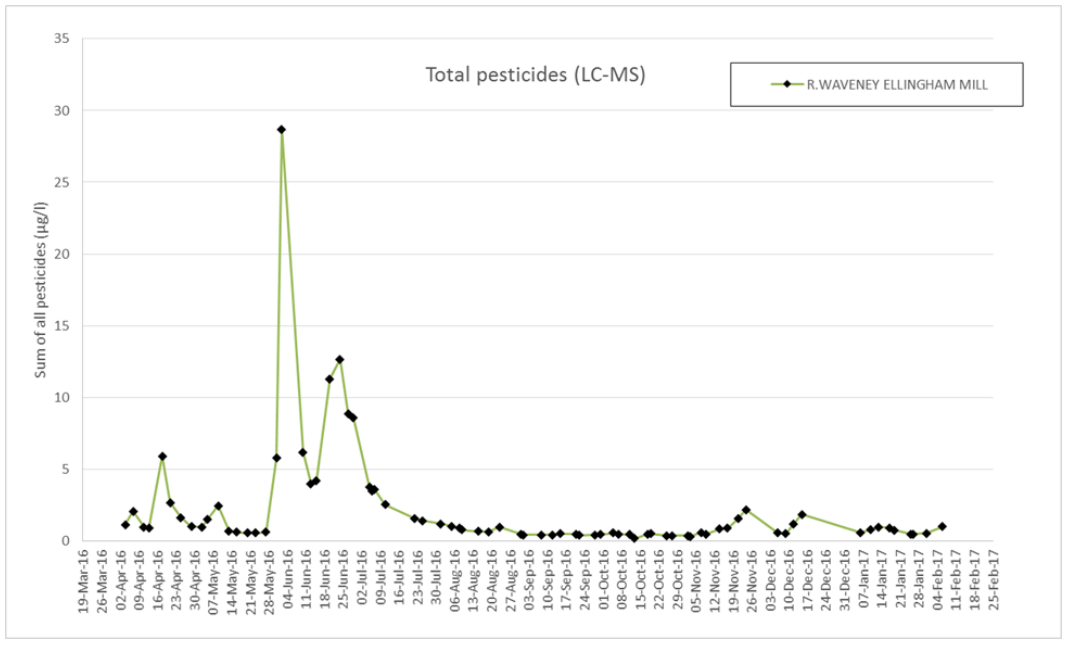
Pesticide monitoring – some example time-series results







Using time series data

We supply time series data on pesticide concentrations to our catchment officers on a regular basis. These data provide information to them for use in their work with farmers. We can relate pesticide occurrences to contemporary cropping and management practices. The overall aim is to influence farmers and to demonstrate that their actions can produce positive benefits, both in terms of reducing pollution levels, and threats to drinking water sources.

Which pesticides are detected? Of the 335 pesticides (and related chemicals) included in the monitoring suite, around 130 were detected at least once in this initial monitoring period. Most of these however were at extremely low levels. We detected 51 pesticide chemicals >0.1µg/l across the eight sites.

Pesticides and related chemicals can sometimes be used in a range of sectors including (but not just) agriculture. Our monitoring will contain a composite of these sources. The monitoring will also pick up some 'break-down products' and a few chemicals that are not approved for use. **Almost all the pesticide chemicals found >0.1µg/l are current Plant Protection Products used in agriculture**.

'Total pesticides'

For the first time using this method we can estimate the concentration of 'total pesticides' in a sample rather than looking at a limited range of individuals. Tracking this will allow us to assess overall catchment improvements.

Pesticide detection frequency – early results across 8 river catchments

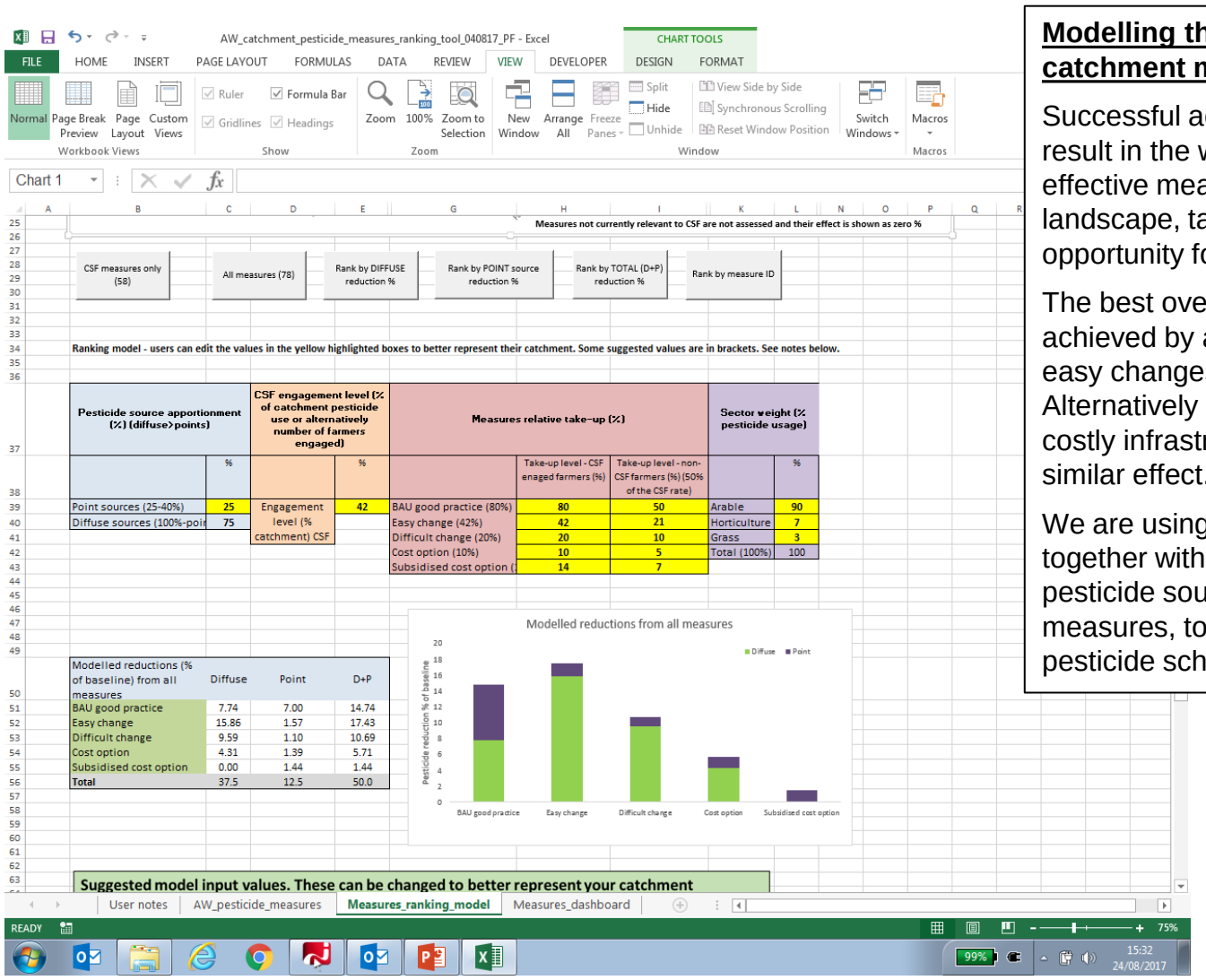
Detections from 01 Apr 2016 to 16 Feb 2017
Pesticide detections at 8 site composite

Pesticide	Use notes	Count > 0	Count > 0.1µg/l
Chloridazon-desphenyl-methyl	Break-down product of chloridazon	486	230
Bentazone	Current herbicide - peas/beans	550	212
Triallate	Current herbicide - cereals	383	93
MCPP / Mecoprop	Current herbicide - grass/cereals/home and garden	534	86
Propyzamide (Pronamide)	Current herbicide - OSR/ range of arable crops	540	63
MCPA (MCP)	Current herbicide - grass/cereals/home and garden	153	62
Fludioxonil	Current fungicide/seed treatment - range of arable crops and grass	77	58
Cyproconazole	Current fungicide - range of arable crops	100	57
2,4-D / 2,4-Dichlorophenoxyacetic acid	Current herbicide - grass/cereals/home and garden	291	55
Flufenacet (Fluthiamide) (BAY FOE 5043)	Current herbicide - range of arable crops	468	35
Tebuconazole (Terbuconazole)	Current fungicide - range of arable crops and grass	539	32
Boscalid (Nicobifen)	Current fungicide - range of arable crops and fruit	569	26
Clothianidin	Current insecticide - seed treatment/ range of arable crops	410	22
Phenoxyacetic acid	Probably not pesticide related	31	22
Fluroxypyr	Current herbicide - range of arable crops and grass	30	22
Carbetamide	Current herbicide - OSR/beans	164	18
Chloridazon (PAC)	Current herbicide - sugar beet/ fodder beet	104	16
Azoxystrobin	Current fungicide - range of arable crops and grass	561	15
Thiamethoxam	Current insecticide - seed treatment/ range of crops	223	15
Ethofumesate	Current herbicide - beet crops	115	15
Metazachlor	Current herbicide - OSR/ others	380	11
Dimethomorph	Current fungicide - potato/ others	105	10
Triclopyr	Current herbicide - grassland/ amenity	119	8
Dimethenamid (SAN 582H)	Current herbicide - OSR/maize	397	7
Famoxadone	Current fungicide - potato	10	7
Imidacloprid	Current insecticide - hops/ ornamental	429	6
Propamocarb	Current fungicide - potato/vegetables	48	6
Epoxiconazole (BAS 480F)	Current fungicide - cereals	577	5
Pencycuron (Monceren)	Current fungicide - potato	79	5
Desthio-Prothioconazole	Break-down product of Prothioconazole (current fungicide)	512	4
Linuron	Current herbicide - range of mainly horticultural crops	394	4
Imazamox	Current herbicide - OSR/peans/beans	45	4
Thifensulfuron-methyl	Current herbicide - range of arable crops	40	4
Pendimethalin (Penoxalin)	Current herbicide - range of arable and hoticultural crops	151	3
Clethodim	Current herbicide - OSR/Sugar beet	42	3
Clopyralid	Current herbicide - range of arable crops/grass/amenity	3	3
Fluoxastrobin	Current fungicide - cereals/other crops	429	2
Nicosulfuron	Current herbicide - maize	85	2
Fenamidone	Current fungicide - potato/ornamental	10	2
Mesotrione	Current herbicide - maize	5	2
Fluopicolid	Current fungicide - potato	438	1
Penthiopyrad	Current fungicide - cereals/OSR	305	1
Isoproturon	Current herbicide - cereals/ wider historic use on cereals	170	1
Metobromuron	Current herbicide - potato	70	1
Metribuzin	Current herbicide - potato	65	1
Metolachlor	Not approved - herbicide	55	1
4-CPA / 4-Chlorophenoxyacetic acid	Not approved - plant growth regulator	30	1
Dichlorprop	Current herbicide - cereals/amenity/home and garden	29	1
Carbendazim (Azole)	Current fungicide - turf	10	1
Propazine	Not approved - herbicide	4	1
Isopyrazam	Current fungicide - cereals/other crops	3	1

Herbicide
Fungicide
Insecticide
Breakdown product/not approved

Note: metaldehyde and glyphosate are not detected using this method.
Clopyralid has an elevated detection limit so might be under-reported.

Use of pesticide monitoring data – measures selection and catchment strategies

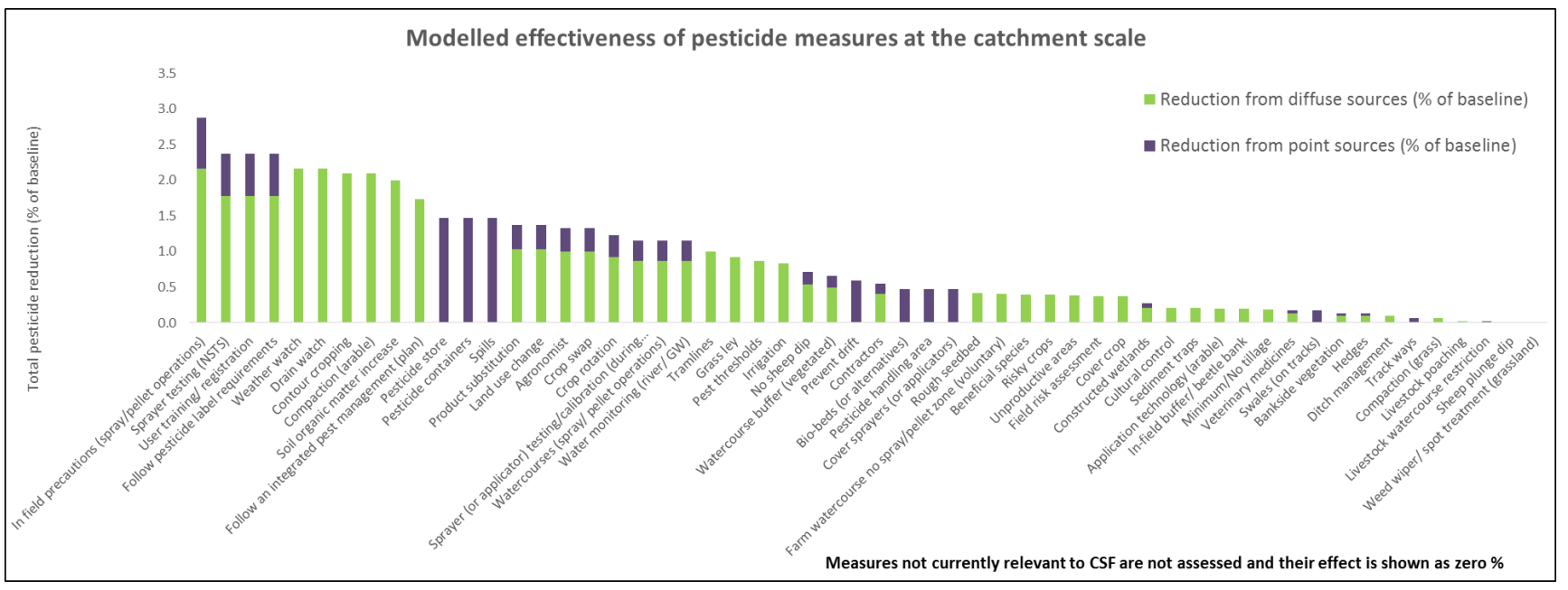


Modelling the effectiveness of catchment measures

Successful action to reduce pesticides will result in the wide implementation of effective measures across the farming landscape, targeted where there is greatest opportunity for reductions.

The best overall catchment affect might be achieved by a large number of small and easy changes across many farms. Alternatively a smaller number of more costly infrastructure changes may have a similar effect.

We are using the CS/CSF monitoring data together with knowledge of the catchment pesticide sources and implemented measures, to help guide future strategies for pesticide schemes and policy.



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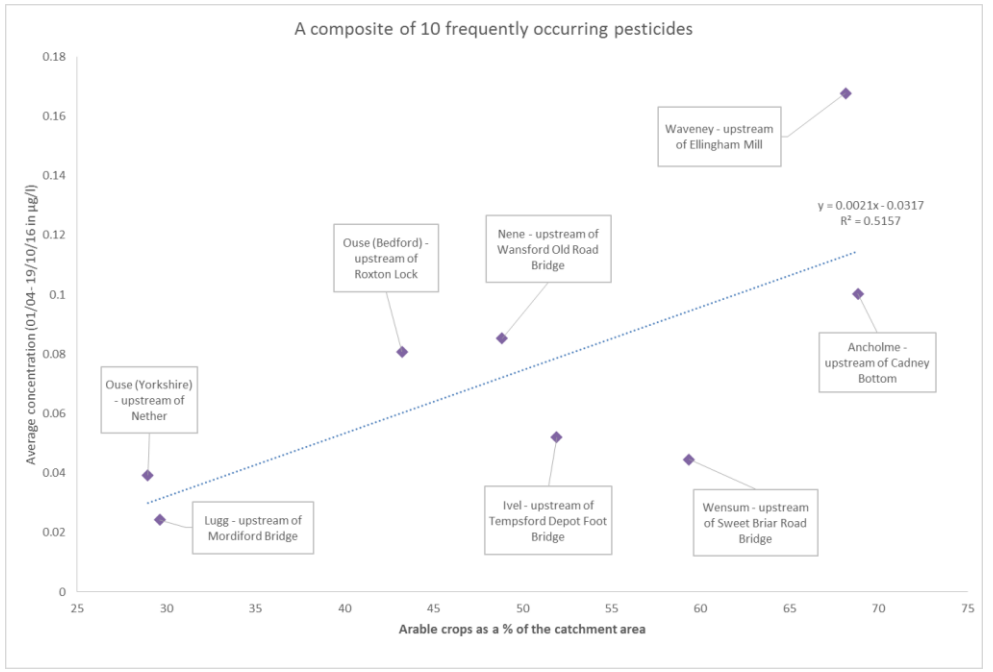
Use of pesticide monitoring data – modelling



Predictive modelling

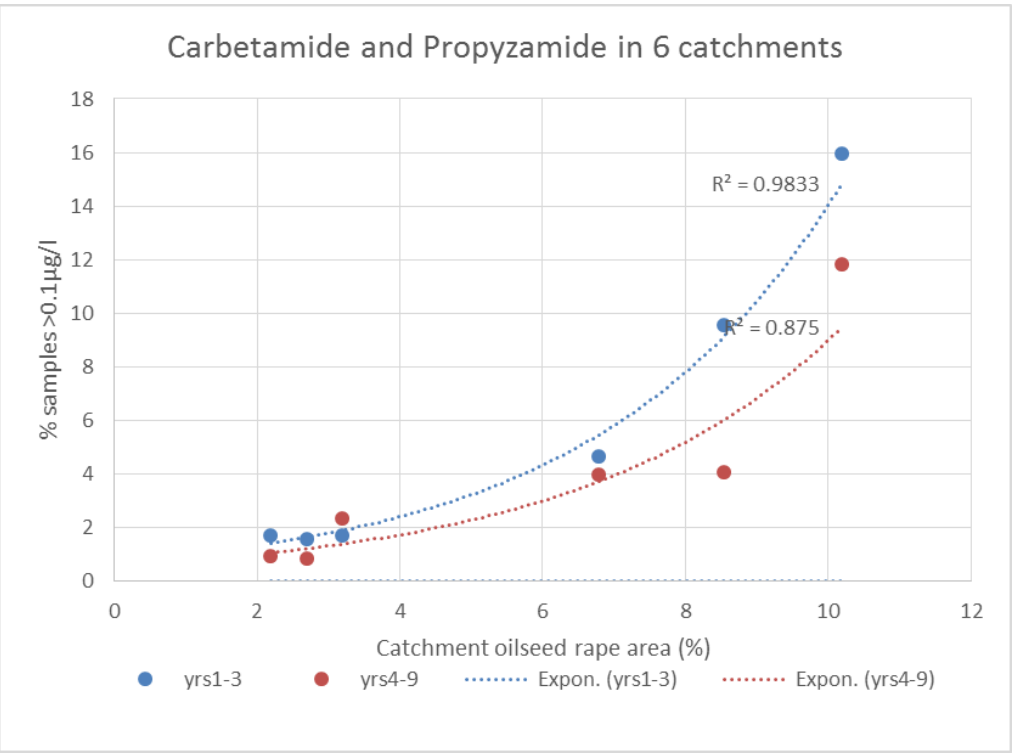
The CS/CSF monitoring data provide a good opportunity for catchment scale modelling and this is a developing area for us. River flow data are also recorded at the monitoring sites, enabling us to calculate pesticide loads and estimate proportions of the applied pesticides lost in the river.

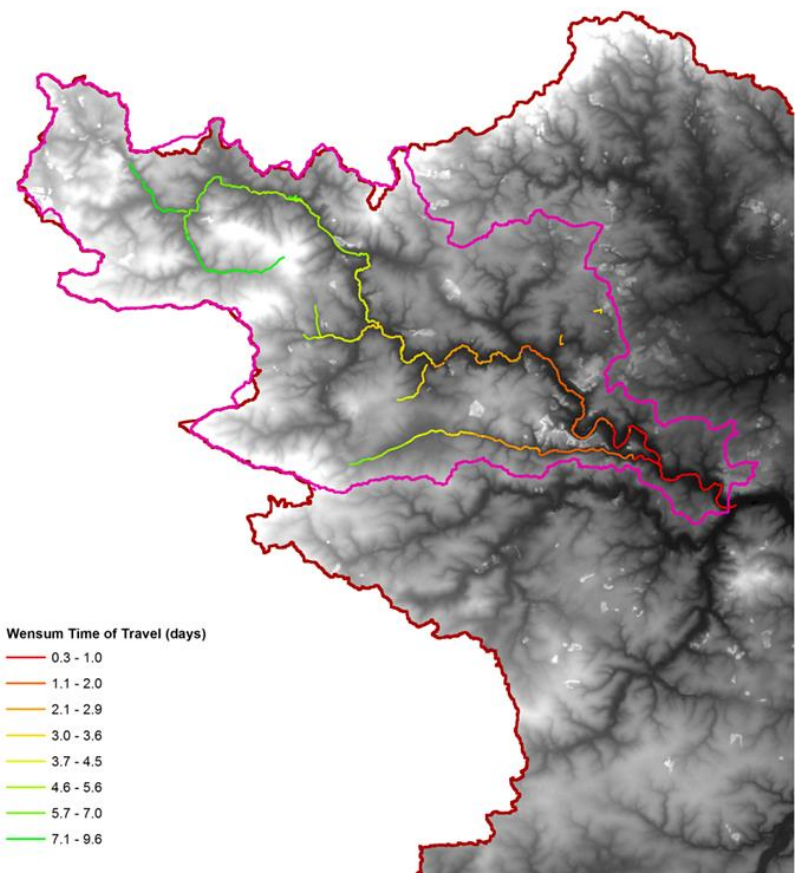
The occurrences of pesticides is broadly predictable simply by considering basic factors like crop type density as a proxy for usage. Other factors such as weather will have more subtle influences at this scale.

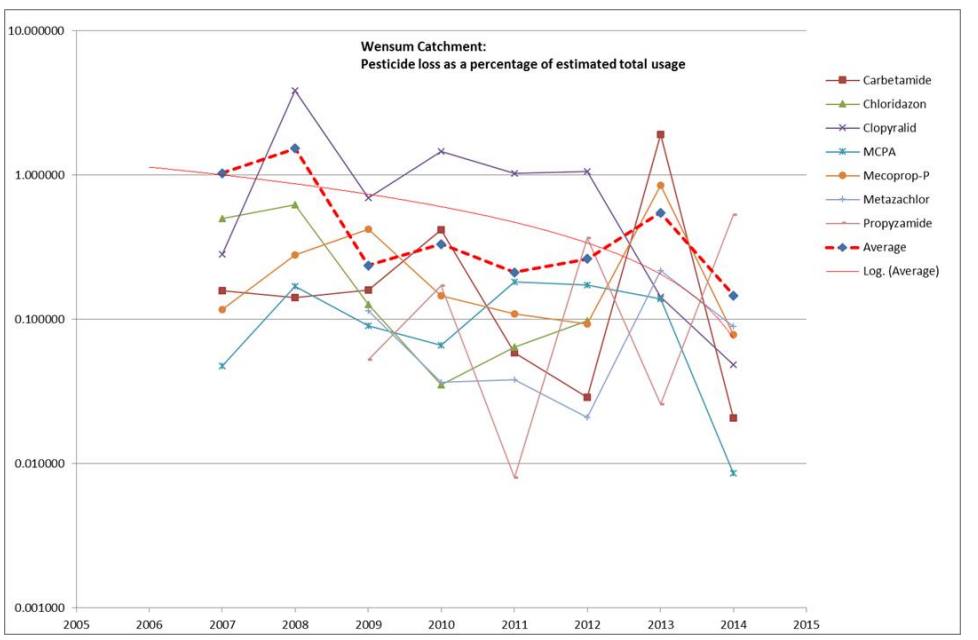
Predictive modelling

We are developing a modelling capability to extrapolate some of these findings to other catchments. Being able to estimate pesticide levels using scenario testing of land use for example, and other factors, is key to investigating future policy options.

We can also use this modelling work to improve general environmental monitoring to develop 'sentinel networks' that will give a good surveillance capability for pesticides in rivers, whilst being affordable to maintain on a long term basis.







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