Leveraging UK Environmental Monitoring Data to Improve Regulatory Management of Environmental Chemical Pollutions

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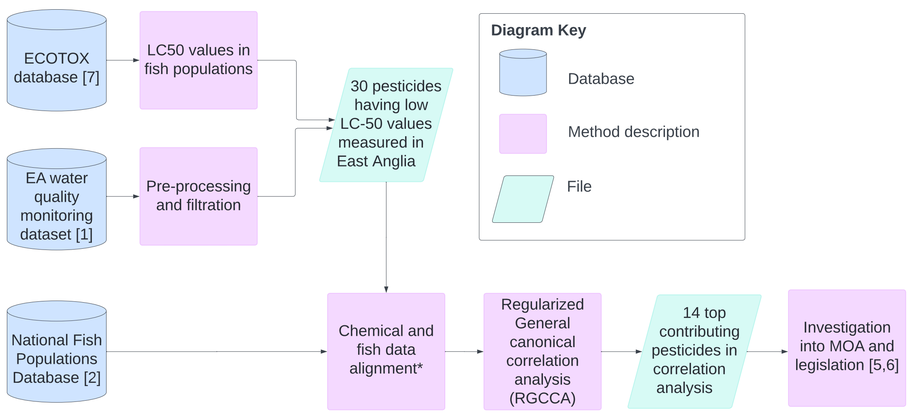
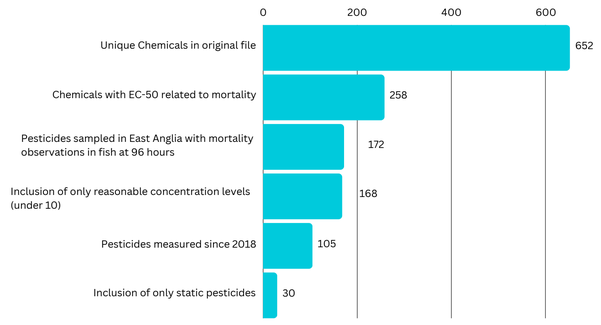
Abstract

- Despite advancements in monitoring, **comprehensive hazard information** is lacking for most substances, posing a challenge for regulatory authorities.
- Having discovered a negative correlation between mortality-causing chemical concentrations and fish populations, further analyses were carried out to shed light on key substances that may need revision in regulatory approval, with a focus on **pesticides** due to their prevalence and prominence in our analyses.
- Pesticides have long been used for pest and weed control for agricultural, domestic, and public health purposes. Their chemical modes of action on targeted species are well-defined. However, the hazards of such chemicals to **non-target organisms (aquatic organisms)** are largely unknown and must be considered for improving pesticide legislation [8].
- This study aims to identify pesticides in East Anglia rivers that may potentially impact fish population dynamics, which may require regular monitoring and regulation.

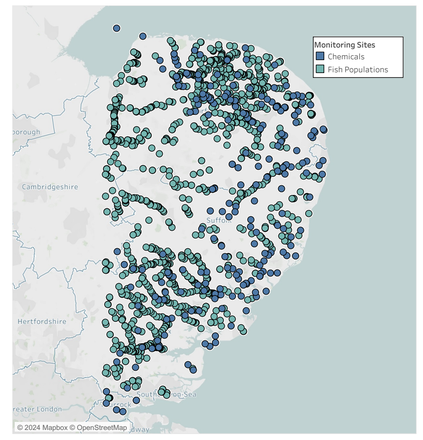
Methods



Flow chart depicting methods and datasets used in each step.
(*chemical and fish population data alignment based on time (6 months) and location (5km)).



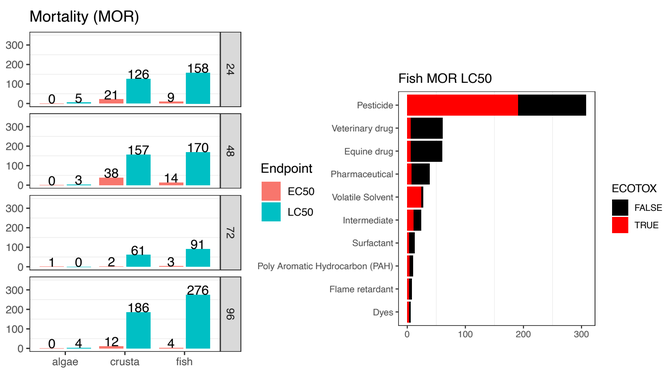
EA chemical monitoring dataset was filtered to include pesticides which have been consistently measured in East Anglia between 2018 and 2023.



This map of East Anglia shows monitoring sites for fish populations and pesticides.

Results

1. ECOTOX database (fish)



Summary of the number of chemicals with recorded EC50/LC50 values related to mortality for aquatic model organisms, including exposure time by hours.
Finding: 330/652 chemicals have ecotoxicity data that can be used for environmental risk assessment.

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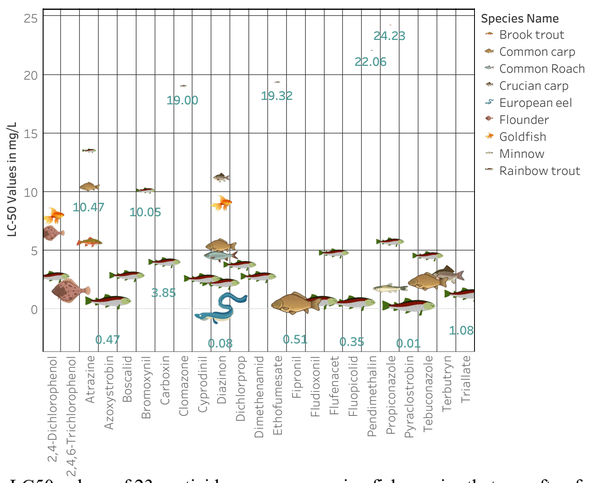
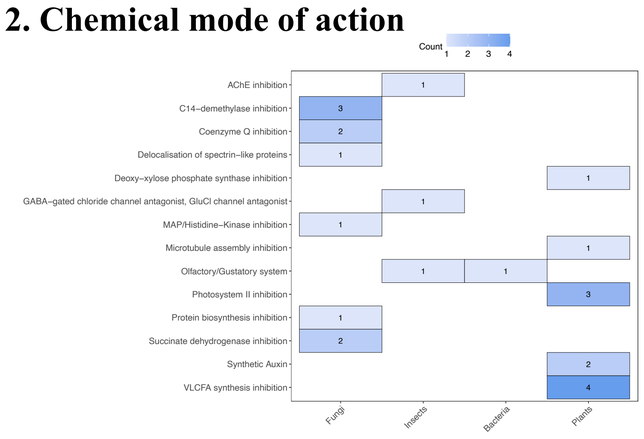


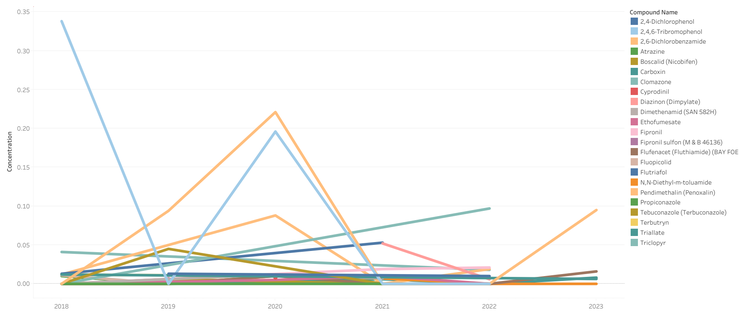
LC50 values of 23 pesticides vary across nine fish species that are often found in East Anglia.

2. Chemical mode of action

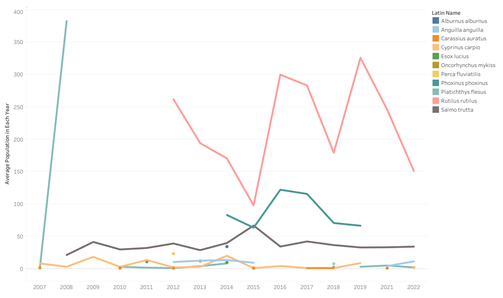


Heatmap summary of chemical MOA for 30 pesticides commonly detected in East Anglia. Showing the number of pesticides associated with each specific MOA.
Finding: All detected pesticides have known MOA for their target pests, though potential impact on non-targeted animals (here, fish), are largely unknown and further investigations regarding their aquatic organism toxicity are required.

3. Monitoring data



Concentrations of static chemicals in East Anglia from 2018-2023.
(concentrations with values below 0.005 have been removed)

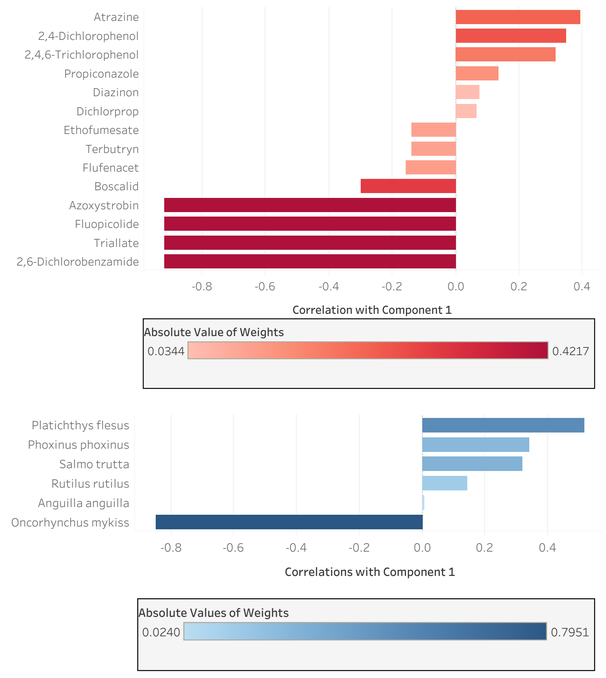


Average fish population dynamics each year, data from EA freshwater fish surveys[2].

Discover more!

Scan this QR code to explore our interactive map and uncover additional insights.

4. Correlation analysis



RGCCA established a linear correlation between 14 pesticides and 6 fish populations, suggesting potential impact from pesticide mixtures.

6. Current regulation

Chemical Name	Mode of Action	Approved in the EU	Approved in the UK	Pesticide type
Diazinon	cholinesterase /acetylcholinesterase (AChE) inhibitor	✗	✗	Insectacide
Dichlorprop	Aryl Hydrocarbon receptor binding	✗	✗	Herbicide
Ethofumesate	Inhibition of lipid synthesis.	✓	✓	Herbicide
Terbutryn	Inhibition of photosynthesis	✗	✗	Herbicide
Flufenacet	Inhibition of VLCFA which inhibits cell division	✓	✓	Herbicide
Boscalid	Succinate DeHydrogenase inhibitor	✓	✓	Fungicide
Azoxystrobin	Respiration inhibitor (QoL fungicide)	✓	✓	Fungicide
Fluopicolide	This delocalises spectrin-like proteins	✓	✓	Fungicide
Triallate	Lipid Synthesis inhibitor	✓	✓	Herbicide
2,6-Dichlorobenzamide	N/A	✓	N/A	Metabolite

Content table of the top resultant chemicals from the RGCCA, including MOA, UK [5] and EU [6] legal approval and pesticide types.

Conclusions

- Pesticides (Azoxystrobin, Diazinon, Fipronil, Fludioxonil, Flupicolid and Pyraclostrobin) have been consistently detected close to their LC50 values for fish in East Anglia waterways in the last five years.
- Correlation analysis reveals linear relationships between 14 of 30 consistently detected pesticides and 6 fish populations.
- All five pesticides contributing to the correlation model are currently approved for use in UK.

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