Pesticide Watch 2023: Summary report

Community Science Project

PESTICIDE WATCH

Pesticide Watch is an innovative citizen science program that is working with communities to learn how pesticide residues are impacting our waterway ecosystems.

Understanding the Impact of Pesticides on Freshwater Ecosystems

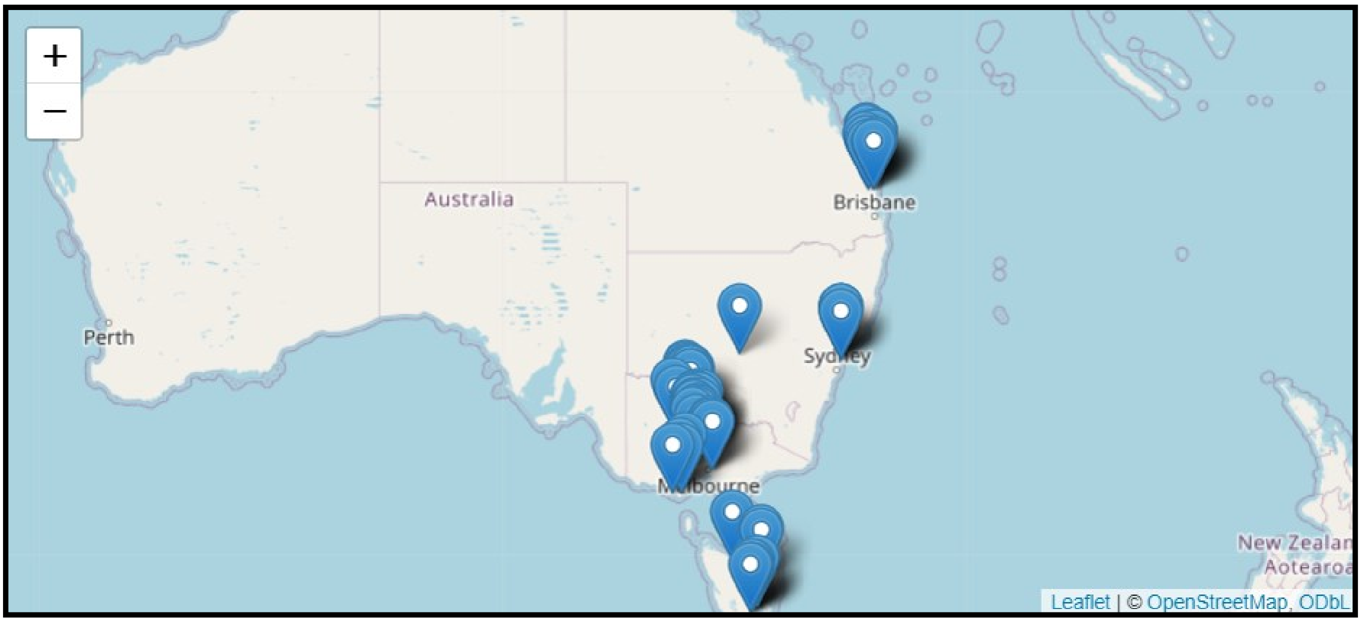
The potential contamination of the natural environment by pesticides is an issue of growing significance globally. Pesticides can be toxic, bioaccumulative, and persistent to varying degrees depending on the chemical properties of each pesticide.

Rivers and streams are crucial components of our environment, acting as pathways that can carry various substances across landscapes. Among these substances, pesticides stand out due to their potential harm to biodiversity and human health. Pesticides are chemicals designed to eliminate pests but can inadvertently affect other species. Globally, millions of tonnes of pesticides are used in agriculture each year, with their movement and impact on ecosystems still not fully understood.

In Australia, there are over 11,000 registered pesticide products. Surprisingly, some of these are banned in other parts of the world due to health risks. What's more concerning is that some banned pesticides, known as legacy pesticides, continue to linger in the environment, adding to the overall toxicity to non-target species. This ongoing environmental exposure highlights the need for widespread monitoring of pesticide residues to understand how these chemicals move through ecosystems and affect both ecosystems and humans.

However, monitoring pesticides is usually a complex and costly task, often requiring specialised equipment and expertise. As a result, large-scale monitoring of Australia's waterways has been limited. However, cutting-edge analytical instrumentation has been able to make screening for large numbers of compounds like pesticides possible with minimal tricky sample preparation. This presents an opportunity for community scientists to contribute significantly to this field.

Community science has already played a vital role in Australia, particularly in conservation biology. Yet, its potential in monitoring harmful substances like pesticides in waterways remains largely untapped. That's where Pesticide Watch comes in—a new, innovative project launched by Deakin University for the first time in 2023. This report is a snapshot of what all our 2023 participants worked towards in contributing samples, and is just the beginning of what this immense dataset will be able to tell us.

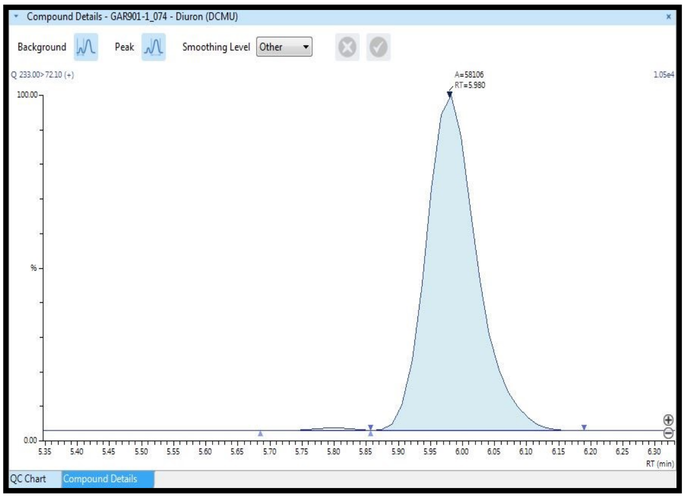


2023 Project reach

Pesticide Watch had an amazing uptake for its first year, with over 100 sites joining the sampling effort. Nearly 400 monthly samples were collected between the months of March and October, arriving from sites stretching across eastern Australia right from Queensland down to Southern Tasmania. There were a wide range of participating groups — primary and secondary schools (including River Detectives Schools), Landcare, Waterwatch, Catchment Management Authorities, private industry, as well as independent samplers who just wanted to give it a go. The rivers, creeks, and lakes that you sampled come from a range of urban, agricultural, and wilderness areas, a diversity of land uses which will be used to generate really interesting data.

What we did in the lab

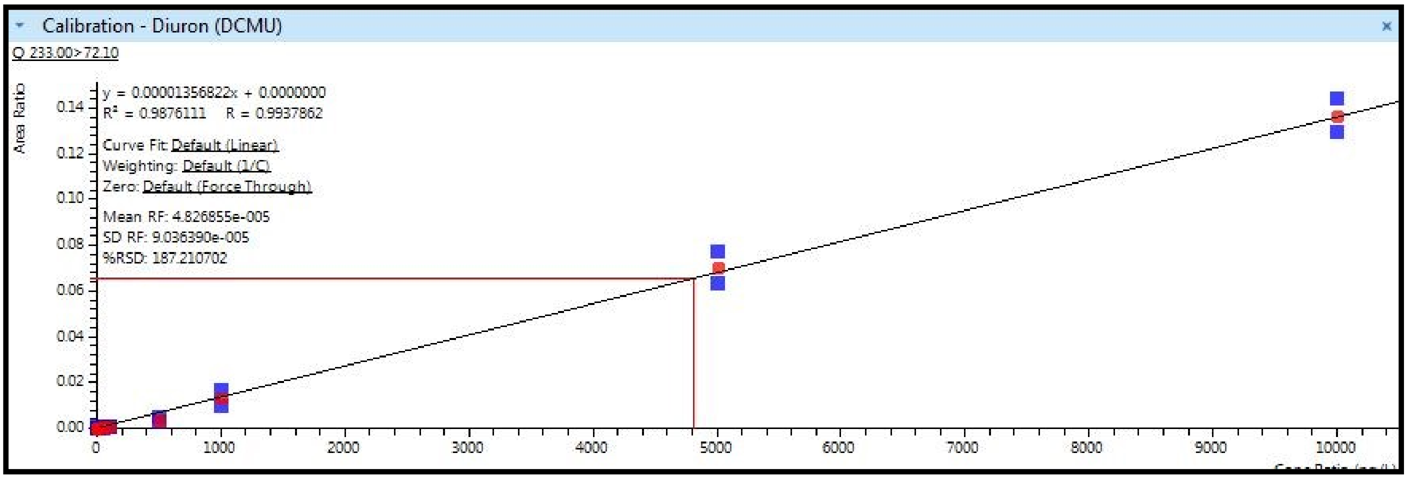
Two analytical techniques were used to detect and quantify pesticides in the samples. Both operate on the same principle — a chromatographic column separated all the pesticides from a prepared injection of a sample. As different pesticide compounds have a specific affinity for the column lining versus the solvent or gas that pushes them through the column, different compounds are retained in the column for different times before they exit and are detected. You can see that in the peak shown below, the pesticide compound Diuron was retained in the column for 5.980 minutes.



Above that peak, you can see that the peak has an area count of about 58,200 in this particular sample. This area count, which represents the integrated area under the peak, is proportional to the concentration of that compound in the sample. So if, along with the sample, we dilute and inject some purchased Diuron at known concentrations ranging from 10-0.001 μg/L, we can construct calibration curve that looks like the one below.

By comparing the area count of the sample peak for Diuron against the area counts for the calibration curve, we can then calculate its concentration.

The sheer scale of the dataset is enormous, with hundreds of samples being screened for 792 pesticide targets, 340 of which could be quantified across both instruments. From the raw instrument data alone, we have been able to generate hundreds of thousands of datapoints, which can be used for many future investigations. Some of the broad trends that we have seen are discussed below.



Only 6 samples

OUT OF 382 HAD ZERO QUANTIFIABLE DETECTIONS. 4 OF THESE WERE FROM TASMANIAN SITES.

This means that the level of the pesticides detected were not high enough for us to make a confident estimate of their concentration. However, all of these samples still had positive detections, and all of these sites also had quantifiable detections in other months.

Every sample

COLLECTED HAD AT LEAST ONE QUALITATIVE DETECTION FOR A PESTICIDE COMPOUND

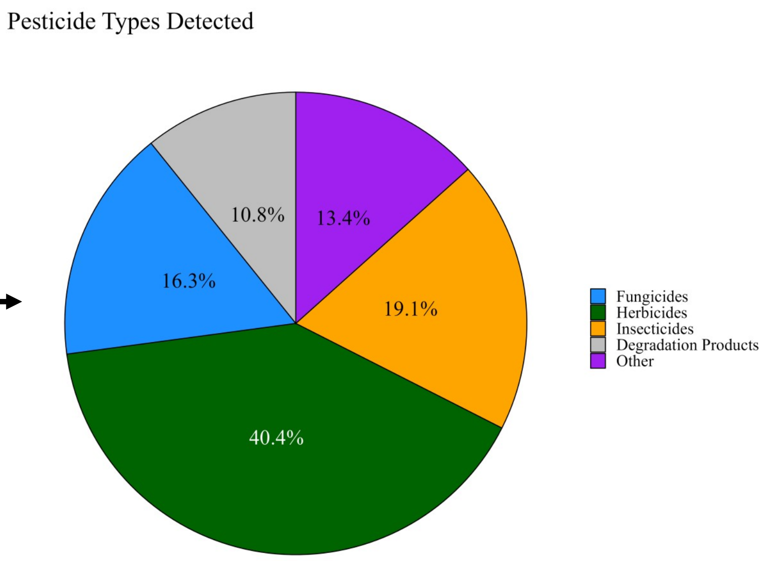
As it happens, the lowest number of positive detections for pesticides in a sample was 4.

OF THE 50 MOST FREQUENTLY DETECTED PESTICIDES IN OUR DATA, **ONLY 9** HAVE BEEN ROUTINELY SCREENED FOR IN PREVIOUS STUDIES*

These 9 pesticides were the herbicides Atrazine, Simazine, Diuron, MCPA, and Metolachlor (plus a few of their degradation products), as well as the insecticide Imidacloprid. This shows us that we have a lot to learn about what's really in our waterways.

Herbicides

MADE UP 40.4% OF ALL PESTICIDE DETECTIONS, OVER TWICE THE FREQUENCY OF INSECTICIDES, WHICH WERE THE NEXT MOST COMMON

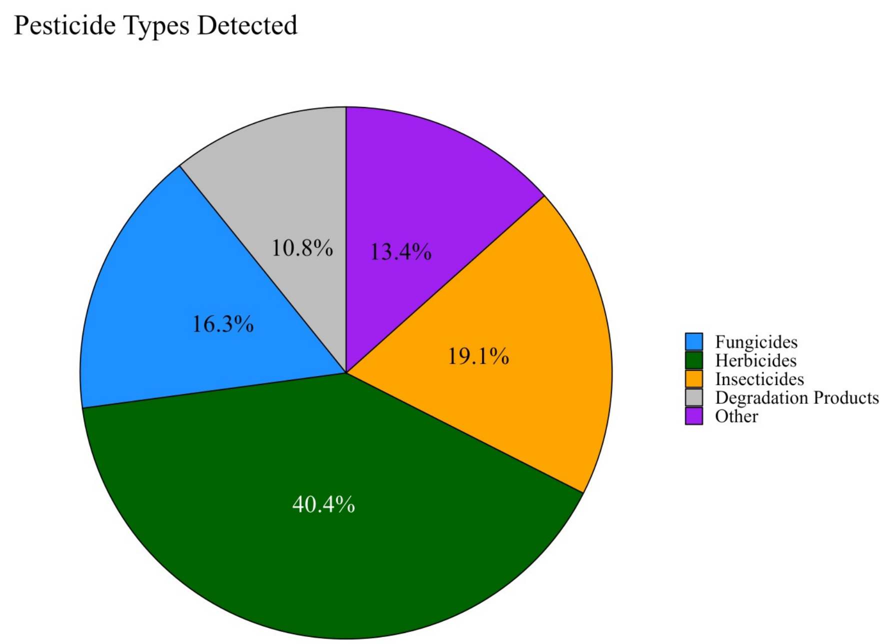


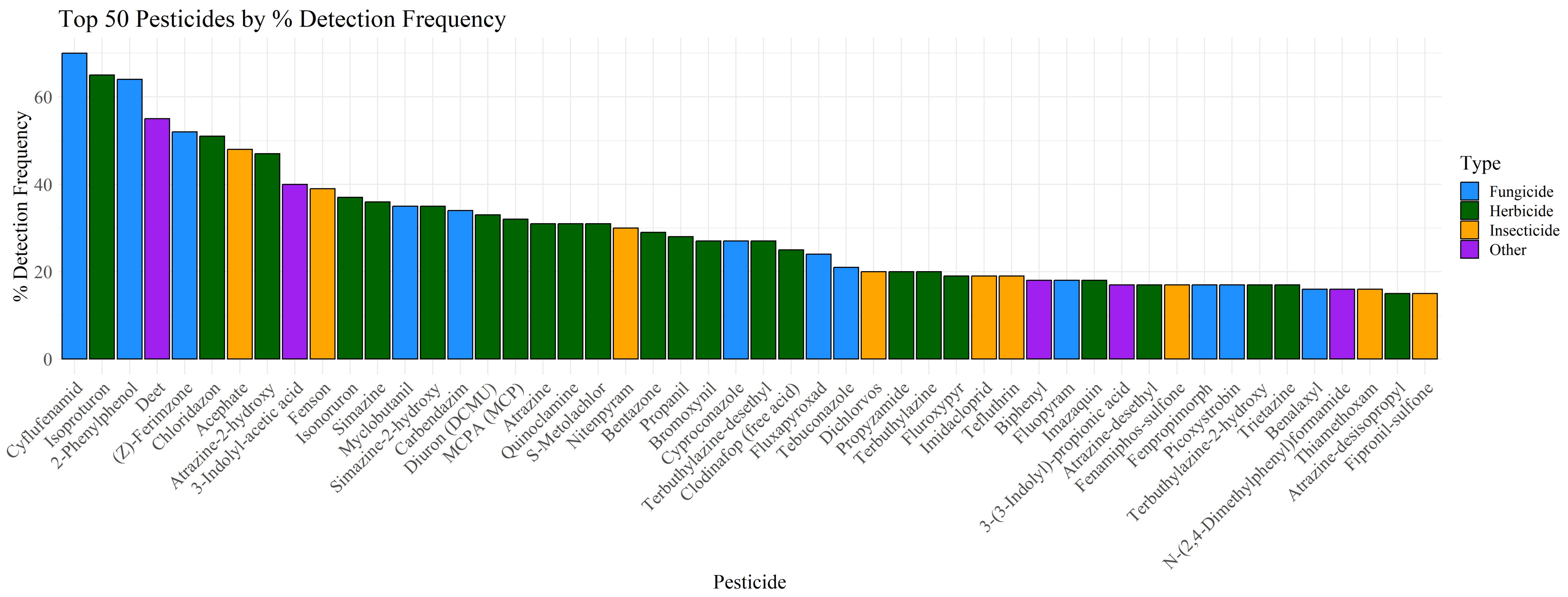
* see Lee-Steere, C., & Rainbow, R. (2022). Sources of Agvet Data (Monitoring) in Australia. https://www.agriculture.gov.au/sites/default/files/documents/sources-of-agvet-data-australia.pdf

382 monthly samples

83 unique sites

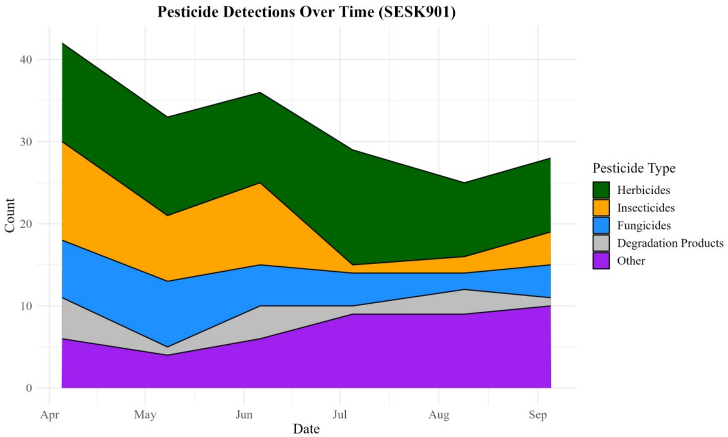
792 pesticide targets

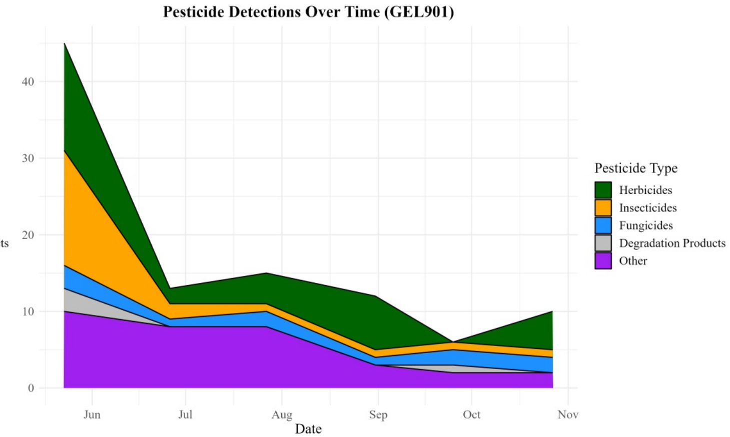


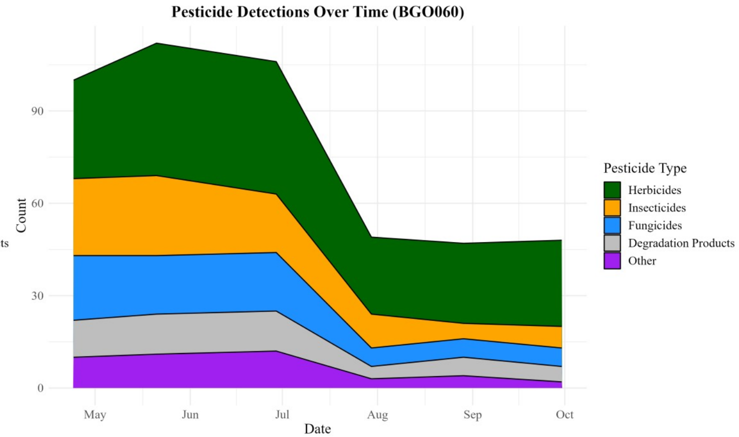


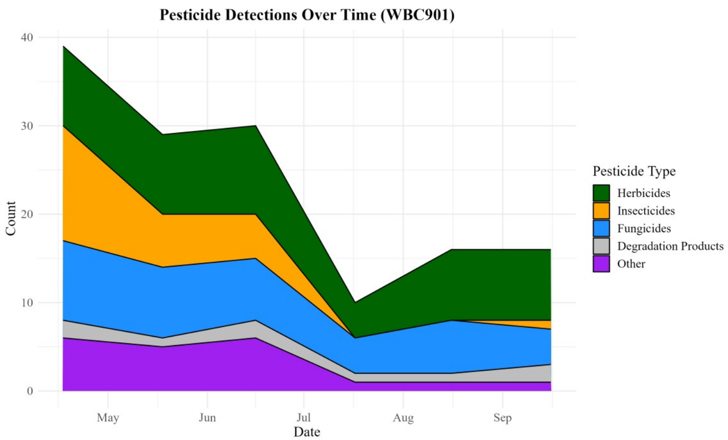
Changes over time

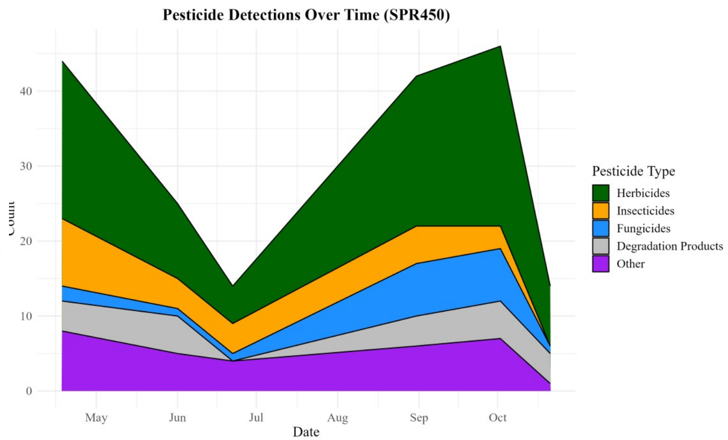
An important feature of Pesticide Watch is that we collect samples over multiple timepoints. This means that we can monitor the changes in pesticide profiles over time. Pesticide profiles can be affected by rainfall and temperature which influence runoff and flow characteristics of streams. Profiles can also be affected by seasonal increases in the volume of pesticides applied to pests threatening certain crops. The 2023 program included monthly samples collected over a six month period.

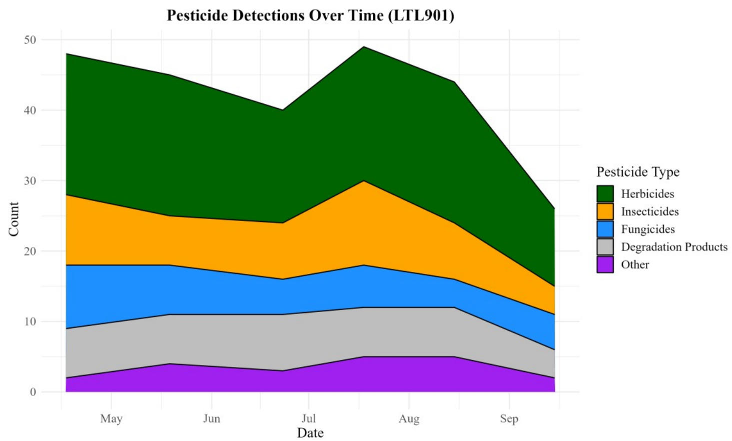


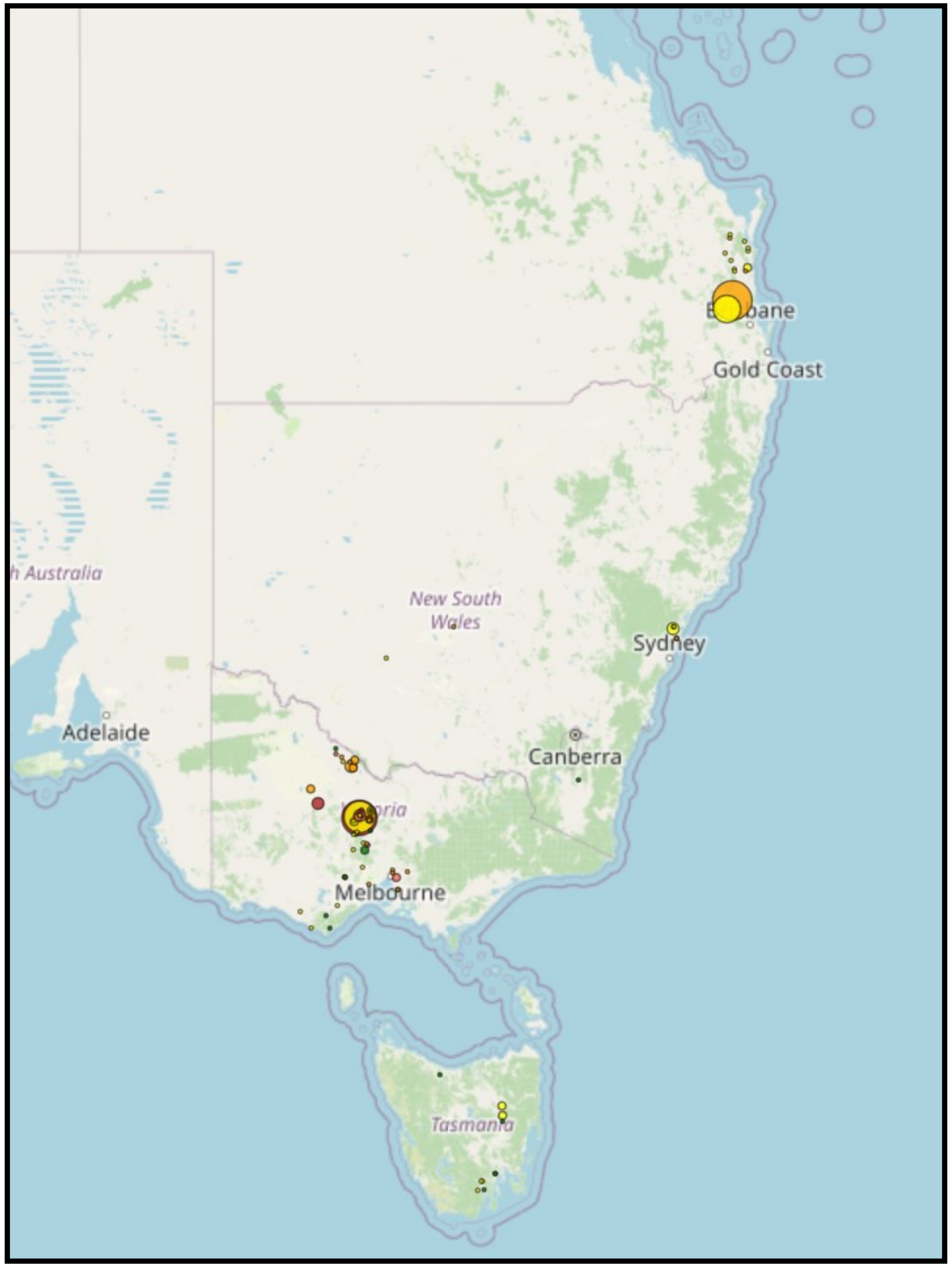


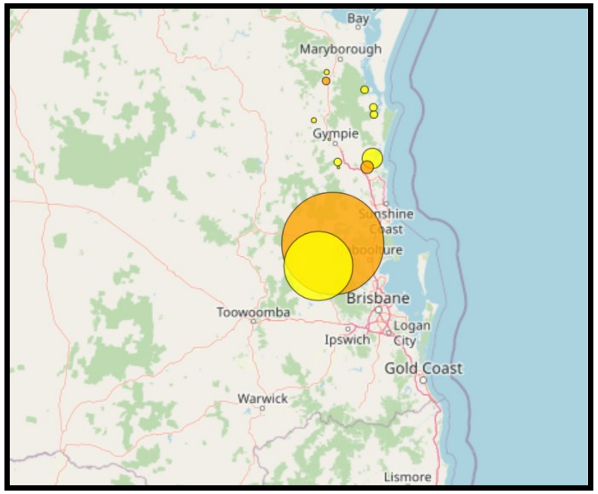




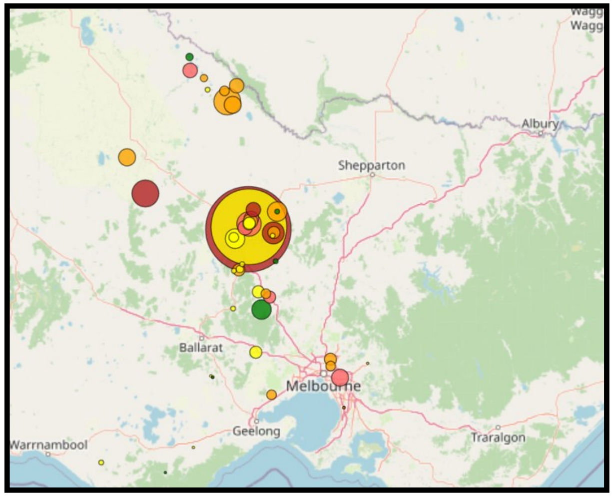


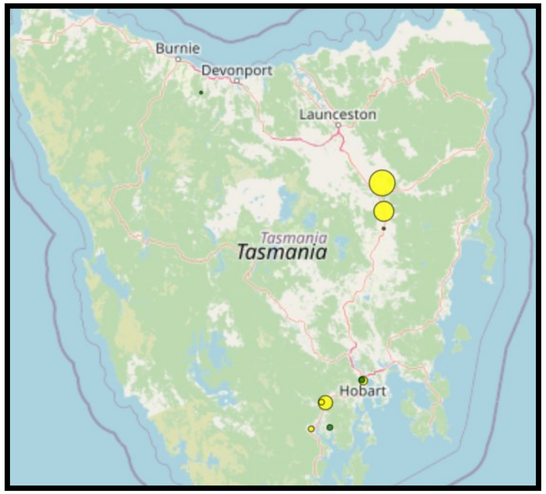






Average detections and concentrations at each sampling site: *The colour indicates the average number of quantitative pesticide detections at each site (green <5; yellow 5–9; orange 10–14; light red 15–19; and dark red ≥ 20). The size of the bubble indicates relative average cumulative concentration of pesticide residues (total sum of all calculated pesticide concentrations recorded at each site averaged across every sampling month).*





Next Steps

2023 was Pesticide Watch's first sampling year, but by no means the last. Our vision is to turn this program into a multi-year, comprehensive pesticide monitoring program that engages with waterway communities at every step.

So where to from here?

Analyse samples for Glyphosate

Glyphosate is the most widely-used herbicide on the planet, and it has been in the headlines quite a lot at the moment. However, glyphosate requires a special sample preparation procedure so that it can be analysed. We will develop this protocol for our program so that we can analyse the existing and future Pesticide Watch samples for glyphosate.

Link to other abiotic factors

We could link our pesticide concentration data with variables such as rainfall, pH, salinity, turbidity, and nitrates and phosphates. This could help us identify any relationships that could predict when pesticide exposure is at its worst for freshwater ecosystems.

Expand the network

As we learn more about the risks posed by certain pesticides to ecosystems and human health, it is increasingly important to have robust, wide-reaching data showing pesticide occurrence over time. This monitoring data can help model risk through space and time. The best way to gain meaningful data is to have a big network across Australia with as much coverage as possible.

Education and resources

Pesticides are emerging contaminants, meaning that much still remains unknown. Our vision for Pesticide Watch is not only to create a long-term community science project for collecting samples, but also to provide education and resources around pesticides and the risks they pose so that we can learn together as new knowledge comes to light.

To all those who got involved so early

— I say a huge thank you. We owe so much to you out there in Australian communities who care so much about your local waterways that you were willing to join Pesticide Watch as it made its first steps towards a long-term pesticide monitoring program. The dataset that we have gained from your samples already is enormous and there is much work to be done with it. Without your enthusiastic uptake of our program, achieving this would have been impossible.

Your samples are all in storage at Deakin University, forming the beginning of a library of freshwater samples which may be used for future analyses. I encourage you to stay involved in Pesticide Watch by joining our 2024 program, which will launch very soon.

Want to get involved in 2024?

— We will be launching the 2024 Pesticide Watch program in the coming weeks. Keep an eye out for information and sign-up forms either through the Pesticide Watch Facebook page or through a facilitating Catchment Management Authority. If you have questions about the program at any time, you can contact us via the Facebook page or contact me directly at the email address below.

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