Exploring Unseen Threats: Contaminant Trends and Impacts in Port Phillip and Western Port Bays

Results Update May 2026

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Acknowledgment of Country

We respectfully acknowledge the Traditional Custodians of the unceded lands and waters on which we conduct this project; the Bunurong, Wadawurrung and Wurundjeri Woi wurrung. We pay our respect to their Ancestors and Elders, past and present and recognise their ongoing connection to lands, waters and culture.

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Patterson Creek Estuary, photo by Daniel MacMahon, Jan 2025

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Executive summary

Estuaries flowing into Port Phillip and Western Port play a vital role in protecting bay health by filtering and processing contaminants before they reach coastal waters. However, these systems are exposed to chemical pollutants from urban, agricultural, and industrial activities across their catchments. Understanding which chemicals are present, how frequently they occur, and how patterns change over time is critical for protecting environmental and recreational water quality and reducing ecological stress.

Throughout 2025, passive-water samples were deployed and collected from estuaries across both bay catchments as part of the Unseen Threats program. Using passive sampling and high-resolution analytical techniques, this study focused on the presence, rather than concentration, of chemicals in surface waters. In total, 98 different chemicals were detected across the program, representing a wide range of chemical groups including herbicides, fungicides, insecticides, pharmaceuticals, and industrial compounds.

Results from multiple sampling rounds show that the presence of chemicals within estuaries is widespread but highly variable across seasons, bays, and individual estuaries. Fungicides and herbicides were consistently detected across both systems and throughout the year, suggesting these chemicals enter waterways on an ongoing basis rather than as isolated events. In contrast, the identity of individual chemicals most frequently detected changed between sampling periods, highlighting strong seasonal influences and reinforcing that no single sampling event captures the full range of chemical pressures affecting estuarine systems.

This update report presents a snapshot of emerging patterns over time, focusing on the most frequently detected chemicals. While it does not provide a comprehensive synthesis of all detected compounds, the findings offer valuable insight into how chemical presence varies across seasons and locations, and how catchment characteristics and land use influence estuarine water quality.

The results provide an important evidence base to support environmental protection and management priorities, including improving water quality for recreation, reducing cumulative ecological stress, and targeting interventions where they are likely to be most effective. By identifying recurring chemical inputs and periods of increased detection, the study supports proactive, catchment-scale management approaches that reduce pollutants before they reach estuaries and bays.

Additional sampling events are planned during 2026. These future rounds will substantially strengthen the dataset, enabling a more robust assessment of seasonal patterns and longer-term trends in the presence or absence of chemicals. This growing evidence base will support future evaluations and help guide monitoring, management, and stewardship of estuarine and bay environments.

Introduction

Exploring Unseen Threats: Contaminant Trends and Impacts in Port Phillip and Western Port is a collaborative program that brings together communities, government agencies, and scientists to better understand how everyday chemical contaminants affect the health of our estuaries and bays. The project directly supports the goals of the Port Phillip Bay Fund, which include improving water quality, reducing pollutant loads, protecting ecological health, and empowering communities to contribute to long-term stewardship of our Bays.

Contaminants of concern include chemicals that can harm aquatic ecosystems and human health due to their toxic, persistent, or bio-accumulative properties. These pollutants originate from a wide variety of everyday sources such as households, vehicles, industrial areas, agricultural activities, urban runoff, and wastewater discharges. Contaminants can enter waterways through both surface flows, stormwater networks and groundwater discharges.

Port Phillip and Western Port bays and their estuaries hold significant ecological, cultural, social, and economic value. These interconnected systems support a wide range of habitats, including mangroves, seagrass meadows, saltmarshes, mudflats, tidal creeks, and freshwater estuaries. Together, these environments provide essential breeding and feeding areas for fish, birds, and other marine life, while also supporting commercial and recreational fisheries, aquaculture, tourism, and boating. They play an important role in community wellbeing by offering spaces for recreation, nature connection, and cultural practices. For the Wurundjeri Woi wurrung, Bunurong, and Wadawurrung Peoples, these waterways and coastlines carry deep cultural and spiritual meaning shaped by thousands of years of continuous custodianship. The ecological functions performed by these connected habitats, such as water purification, carbon storage, shoreline protection, and biodiversity support, underpin both environmental resilience and the long-term sustainability of the region.

Estuarine systems are under increasing pressure from population growth, urbanisation, intensified land use, pollution, and climate change. Urban and catchment development increases the delivery of nutrients, sediments, and chemical pollutants via stormwater while simultaneously reducing the capacity of estuaries to buffer, transform, and retain contaminants. As transitional environments between freshwater and marine systems, estuaries are particularly vulnerable because their mixing dynamics and sedimentary processes can trap, accumulate, and modify contaminants before they are transported to coastal waters. These inputs originate from urban, agricultural, and industrial landscapes and may comprise complex mixtures of both well-known pollutants and emerging or previously unmonitored chemicals. Building on approaches described in Myers et al. (2025), the program uses passive sampling and high-resolution mass spectrometry to generate time-integrated measurements and conduct targeted and non-targeted screening (Figure 1). With additional sampling rounds ongoing, this approach is progressively building a comprehensive and representative picture of the presence of chemical contaminants in estuary waters, strengthening the evidence base needed to support improved water quality management, informed decision-making, and the long-term protection of the ecological values of Port Phillip and Western Port.

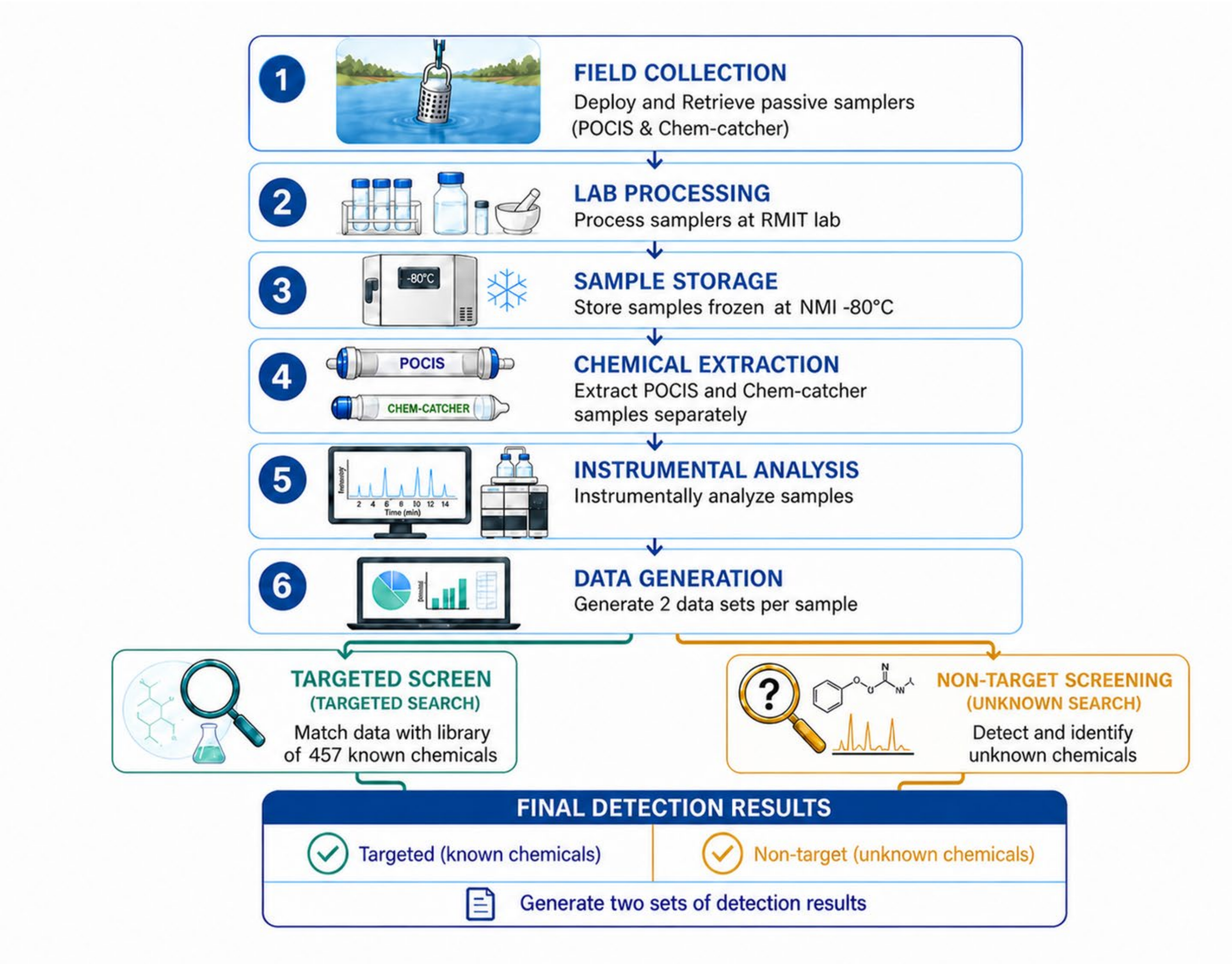


Figure 1 Workflow overview of passive sampler processing for the Polar Organic Chemical Integrative Sampler (POCIS) and Chem-catcher, High Resolution Mass Spectroscopy (HRMS) analysis, and data generation leading to targeted and non-target screening outputs.

Changes to results interpretation

In the first report[1], chemical identifications from the targeted screening were drawn from two confidence categories - high confidence and tentative - both of which were combined and reported together in the overall results. For this second report, the interpretation and presentation of results (Rounds 1-3) have been refined. Results will now report only high confidence identifications, building on the broader screening baseline established in Round 1. This update prioritises data quality and detection certainty,

[1] Myers, J., et al. (2025). Exploring unseen threats: Contaminant Trends and Impacts in Port Phillip Bay, Round One Results Summary report August 2025, Aquatic Environmental Stress research group, RMIT University, Victoria, Australia.

ensuring that future reporting focuses on the most reliable chemical identifications as the program continues to track changes across sampling rounds

Results update

Scope and purpose of this update report

This update report is not intended to provide a comprehensive summary of all chemical detections identified to date. Across the program so far, 98 different chemicals have been detected using the high confidence approach; however, when presenting results for individual compounds, we focus on the five most frequently detected chemicals in each sampling round. This approach provides a practical overview of seasonal and spatial variability in chemical presence, while broader patterns across chemical groups are addressed separately.

Figure 2 2025-2026 project timeline showcasing field sampling, HRMS instrumental analysis, and HRMS-based data analysis across seven rounds.

Results Volunteer Participation

When the first report was published in August 2025, more than 60 community members had already registered their interest in being part of the project, with many actively contributing. By the time this second report was prepared, that number had grown to an inspiring 89 participants. This enthusiastic response highlights the strong community passion for volunteering in the environment, and the commitment people must have in supporting research that protects the health and resilience of our bays (Figure 3).

Figure 3 Volunteers dedicate their time to the Port Phillip and Western Port Bays Unseen Threats Program

What we found

Throughout 2025, water samples were collected from estuaries flowing into Port Phillip and Western Port (Figure 4; Table 1) to see which chemicals are present, how often they occur, and whether detections change between seasons and locations. The study focused on *presence*, not the concentration of chemicals found in surface waters.

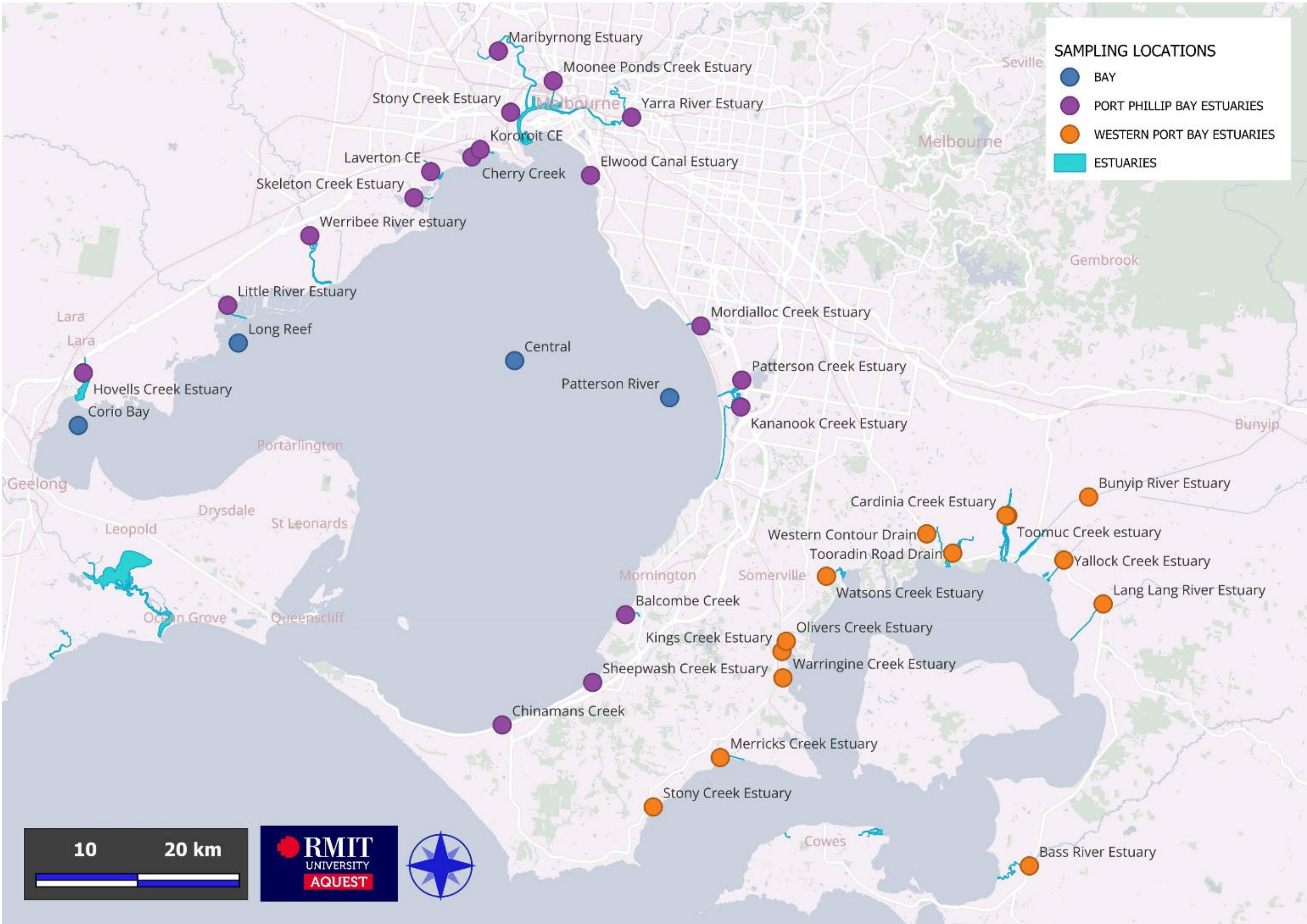


Figure 4 Spatial distribution of estuarine sampling locations across Port Phillip and Western Port included in the Unseen Threats monitoring program.

Table 1 Number of sampling sites analysed per sampling round (January, June, October 2025) in Port Phillip Bay and Western Port Bay. (these figures do not include duplicates, field blanks nor in-bay or estuary samples which were lost).

Bay / Sampling Round	January 2025	June 2025	October 2025
Port Phillip Bay	19	15	15
Western Port	16	4	7

Key messages

A diverse range of chemicals is present across estuarine waterways

Across all sampling periods and locations, with the exception Stony Creek in Western Port - a broad range of chemical groups were detected, including fungicides, herbicides, insecticides, pharmaceuticals, and industrial compounds. In total, 98 different chemicals were identified during the study to date, reflecting the diversity of sources influencing estuaries across both catchments (Figures 5 and 7).

Fungicides and herbicides are widespread and consistently detected

Fungicides and herbicides were the most frequently detected chemical groups across sites in both Port Phillip and Western Port, and across all sampling periods (Figure 6). Their consistent detection suggests these chemicals are regularly entering waterways rather than occurring as isolated or short-term events. It also reflects that the targeted screen focuses on pesticides (herbicides, fungicides and insecticides) more so than pharmaceuticals and industrial chemicals.

Chemical occurrence varies across seasons

The mix of chemical groups detected changed between sampling periods. A broader range of chemical groups were detected in winter and spring (June and October) compared to summer (January), indicating strong seasonal patterns in chemical inputs and transport processes (Figure 5 and Figures 12-14).

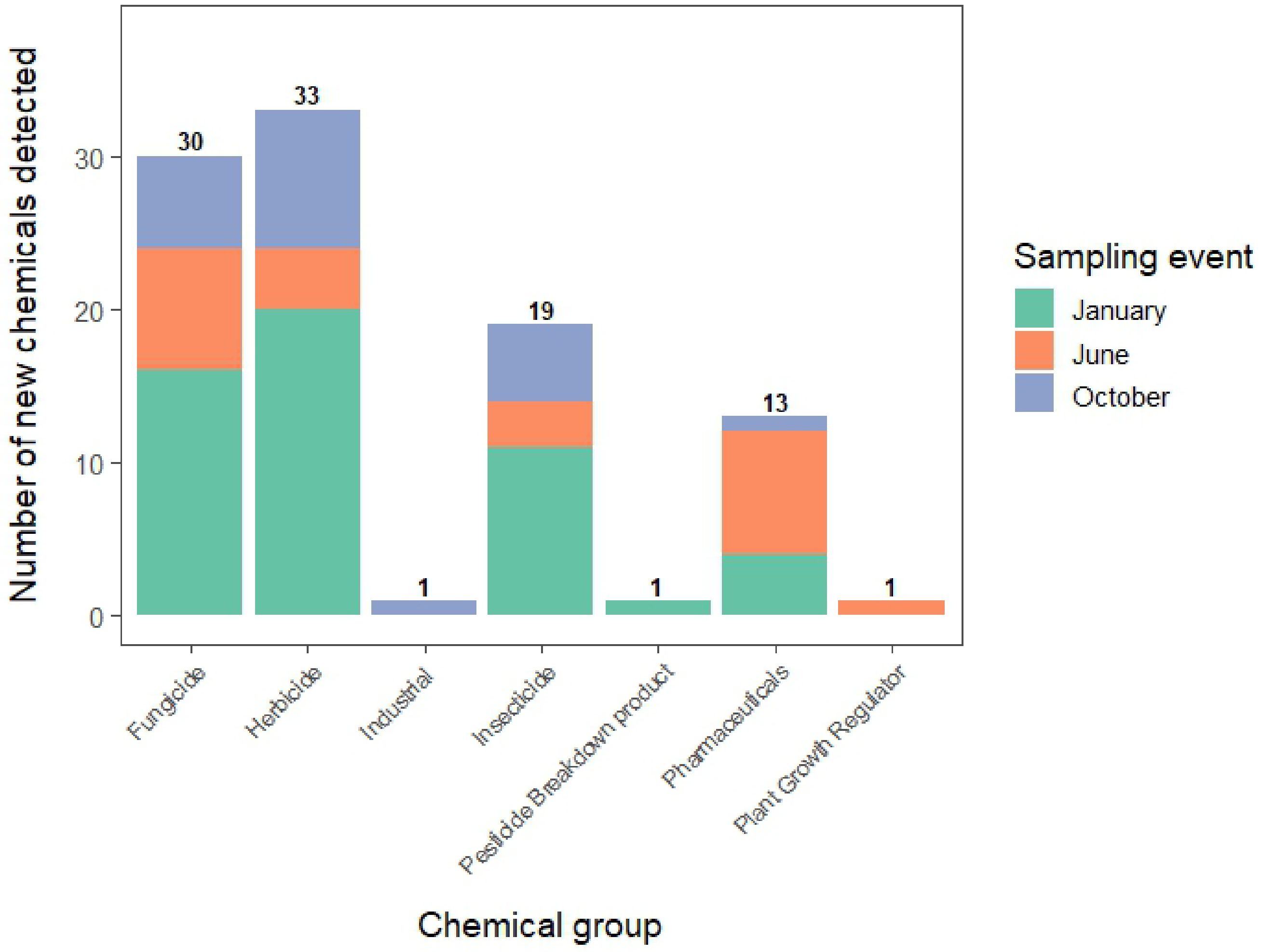
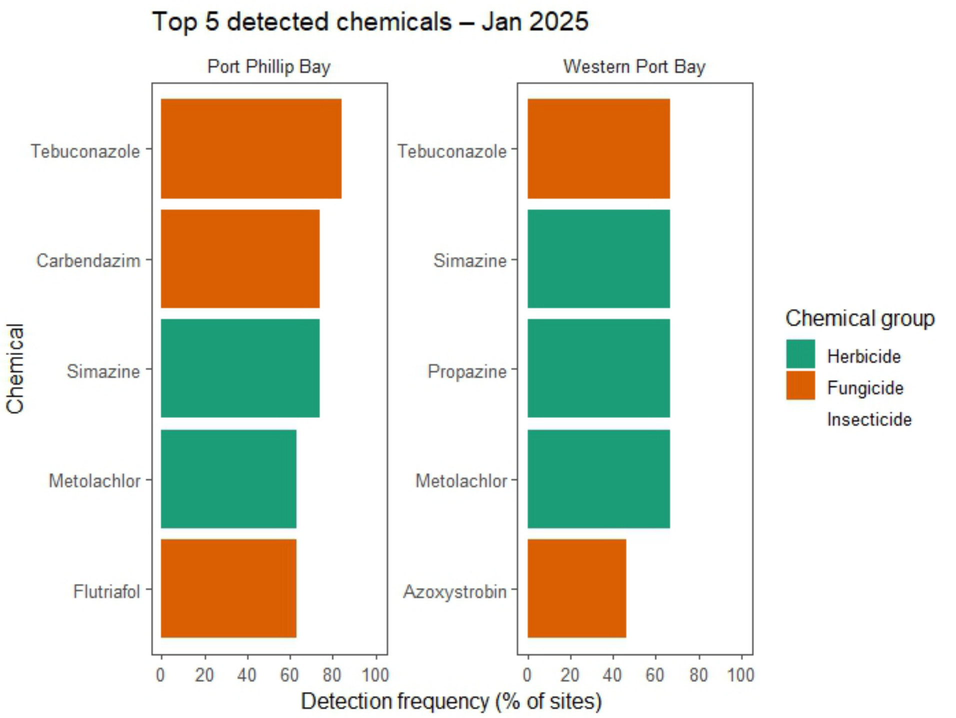


Figure 5 Cumulative number of unique contaminants detected over time by chemical group. Stacked bars show newly detected compounds in January, June, and October 2025, with totals indicating accumulation across successive sampling events. Note: An Industrial chemical was added to the target list in Rd 3 (October) from the non-target screen.

Commonly detected chemicals change over time

The individual chemicals most frequently detected differed between sampling periods. For example, the top five detected chemicals in January were not always the same as those detected in June or October, particularly for insecticides and fungicides (Figure 6). For instance, the herbicide Metolachlor was frequently detected in both bays during all three sampling events, whereas the fungicide Tebuconazole was commonly detected across both bays but occurred less frequently in the October sampling event (Figure 6). This highlights that no single sampling event captures the full range of chemical pressures present in estuaries.

A



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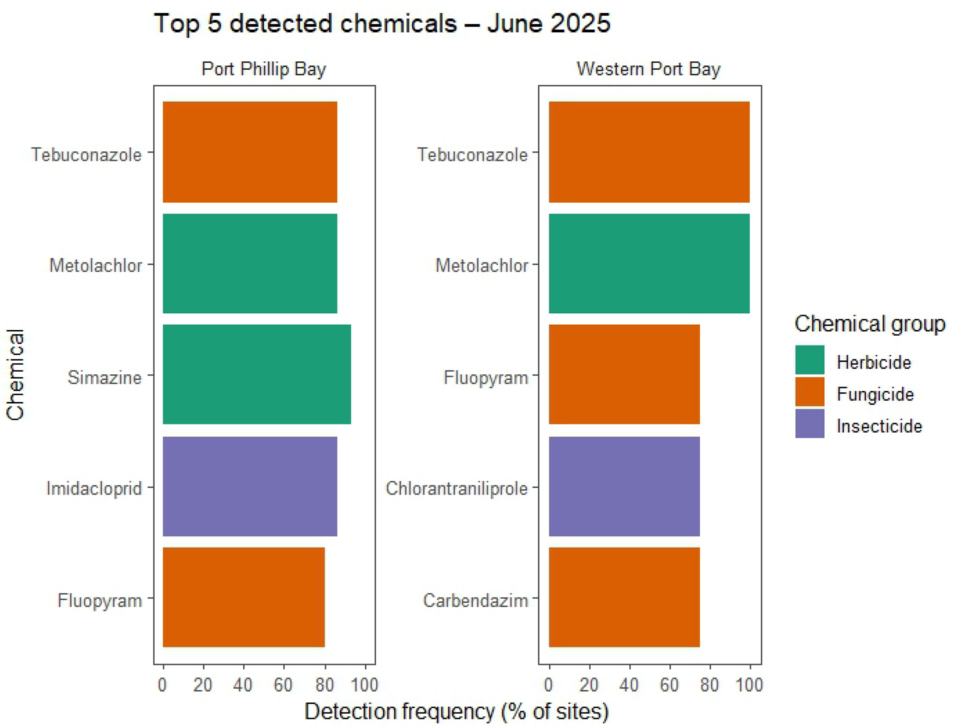

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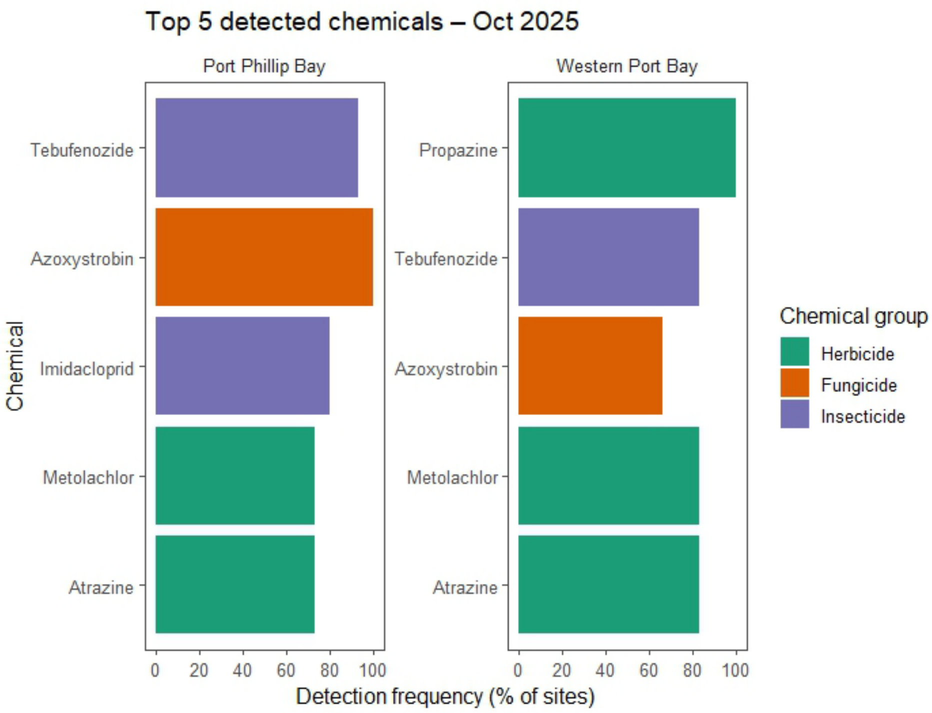

Figure 6 Top five most frequently detected chemicals (% of sites) in Port Phillip Bay and Western Port Bay across sampling events: (A) January, (B) June, and (C) October 2025. Bars show detection frequency for individual compounds, coloured by chemical group, highlighting seasonal and regional shifts in dominant contaminants.

Patterns vary between bays and between nearby estuaries

Differences in chemical occurrence were evident between Port Phillip and Western Port, and among estuaries within the same bay. Although some chemicals were consistently detected across both systems, others displayed distinct spatial and seasonal patterns (Figures 6 and 7). These variations likely reflect the influence of local land use, catchment characteristics, and hydrological processes on the transport, persistence, and detection of chemicals within the study area (Figure 6).

Results reflect sampling effort and design

Fewer estuaries were sampled in Western Port catchments later in the year (Table 1). Detection frequencies are therefore interpreted relative to the number of sites sampled, rather than as direct comparisons between bays or seasons.

Spatial variation across selected estuarine sites

As not all sites are sampled in each round, six estuarine sites have been selected as representative examples from the larger network of 35 sites, with clear spatial differences observed in the number and composition of detected compounds (Figure 8). Mordialloc Creek and the Yarra River estuaries showed the highest overall numbers of detected compounds across chemical groups, whereas Skeleton Creek Estuary consistently exhibited the lowest detection counts, with the remaining sites (Kororoit Creek, Maribyrnong River and Werribee River estuaries) showing intermediate levels of detection.

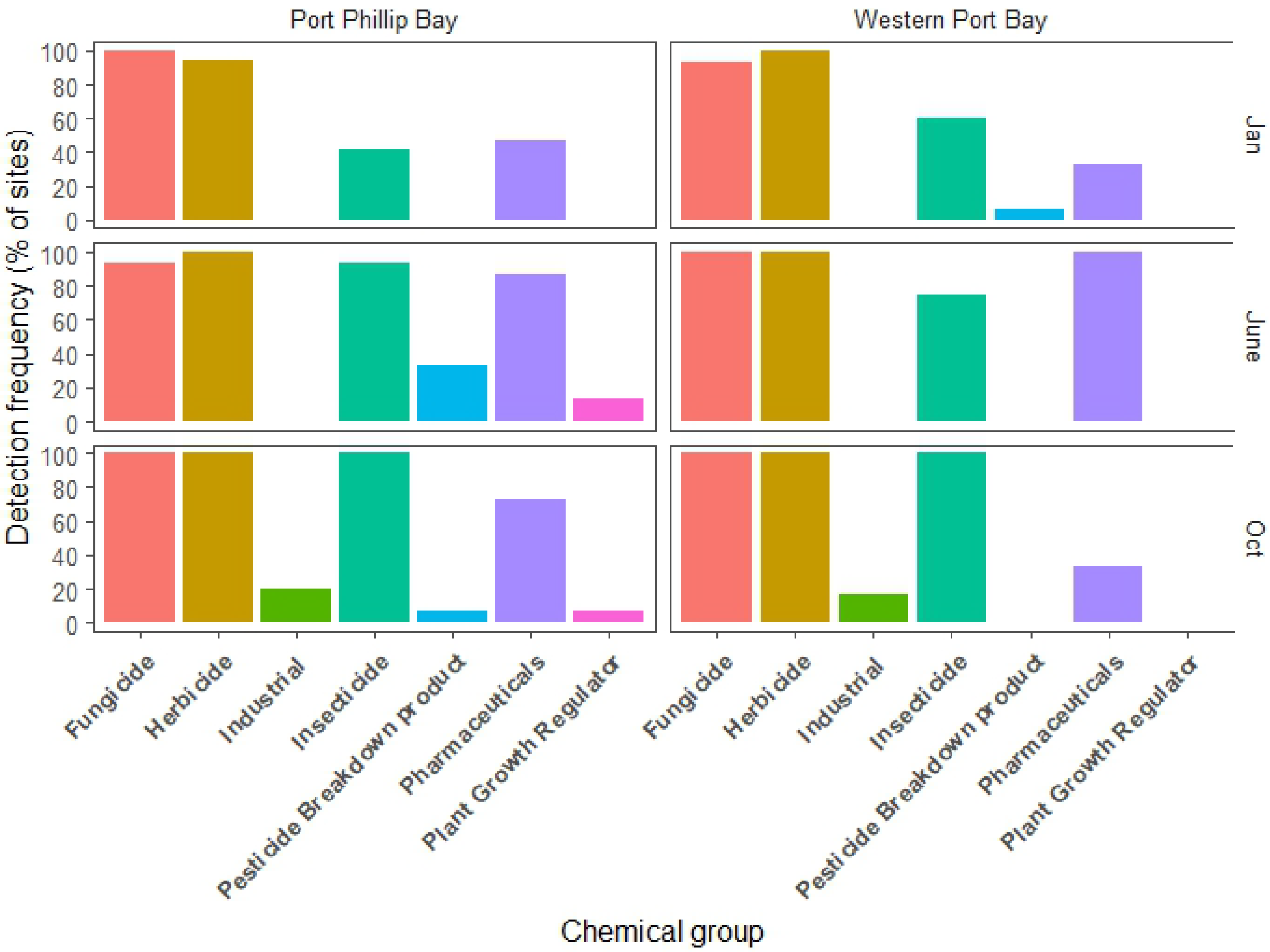

*Figure 7 Detection frequency (% of sites) of contaminant chemical groups across sampling events (January, June, October 2025) in Port Phillip and Western Port. Bars indicate the proportion of sites where each chemical group was detected, highlighting seasonal and regional variability in contaminant occurrence. * Industrial chemicals were added to the targeted screen for Oct, following detection in the non-targeted screen in earlier sampling.*

Overall message

Together, these results show that chemical presence across estuaries is widespread but highly variable over space and time. Seasonal conditions, land use, and local catchment activities strongly influence which chemical groups and individual compounds are present at any given time.

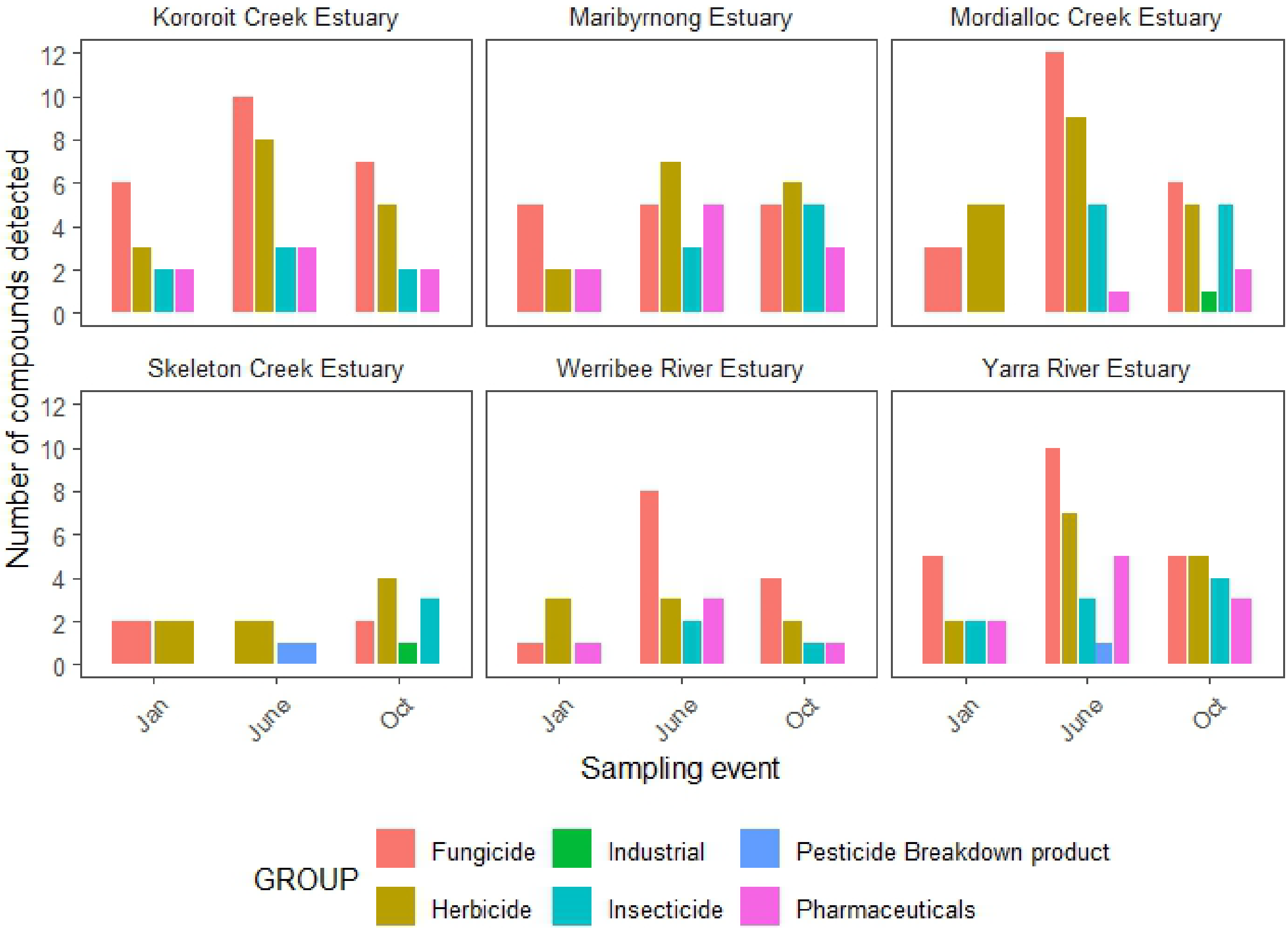

Figure 8 Number of chemicals detected within each chemical group across three sampling events at six selected estuarine sites in Port Phillip. Bars show the total number of compounds detected during each sampling event (January, June and October 2025), with colours indicating the chemical group detected. Panels represent individual sites.

How These Results Inform Environmental Protection and Management Priorities

1. Protecting the Environment and Water Quality for Recreation

By combining information from multiple sampling rounds, this report strengthens confidence in understanding chemical pressures affecting estuarine waters. Rather than relying on single event snapshots, the findings support a more robust view of ongoing chemical inputs that may influence water quality, including conditions relevant to recreation and amenity. This evidence informs proactive management approaches focused on protecting water quality before contaminants reach estuaries and bay environments. The results so far also throw a spotlight on how everyday activities carried out by industry and the community may be contributing to chemical detections in estuaries across greater Melbourne.

2. Reducing Ongoing Ecological Stress

The results provide important context for evaluating potential cumulative pressures on estuarine ecosystems. Evidence of recurring chemical presence highlights the need to consider chronic exposure pathways alongside other stressors, such as habitat modification and nutrient enrichment. This information supports precautionary decision-making aimed at reducing long-term ecological stress, even where direct toxicity thresholds or concentration data are not yet available.

3. Supporting Targeted and Effective Management

The patterns observed across seasons and locations help managers identify when and where intervention is likely to be most effective. Rather than treating chemical pollution as a uniform issue, the findings enable more targeted strategies - such as timing runoff controls, prioritising specific catchments, or refining land use and stormwater management practices — to reduce chemical inputs at their source.

4. Enabling Informed Decision-making and Shared Stewardship

Presenting results in a clear, accessible format supports informed decision-making by agencies, practitioners, and the wider community. The findings help clarify how everyday activities across catchments can influence estuarine water quality, reinforcing the shared responsibility for protecting waterways. This understanding underpins collaboration between managers and communities to support long-term environmental protection.

Non-Target screening update

Non-target analysis is a comprehensive approach to water quality assessment that screens water samples for thousands of chemical signals simultaneously. Unlike targeted analysis, which searches only for a specific list of known chemicals, this method acts as a wide-angle lens, allowing us to screen for up to 40,000 potential contaminants. This approach helps us detect both well-known substances and previously unmonitored compounds, providing a much more complete picture of the chemical landscape in our waterways.

This powerful screening generates a vast amount of data, often detecting up to 10,000 potential signals per sample. To manage this information effectively, we employ a strategic prioritisation process to focus our efforts. We concentrate our detailed analysis on the top 200 signals identified in each sample. These signals represent the most abundant substances, which are typically those of the greatest environmental relevance. By prioritising these key findings, we ensure our monitoring is both scientifically robust and focused on the substances that matter most to the health of our environment.

Key findings

Across multiple estuary sites and sampling rounds, dozens of chemicals were detected (Figure 9). The number of detected chemicals varied between sites and sampling rounds, with the later round identifying a greater range of chemicals. Detected substances were associated with a mix of common sources, including:

- Household and personal care products
- Pharmaceuticals and insect repellents
- Industrial chemicals
- Agricultural herbicides

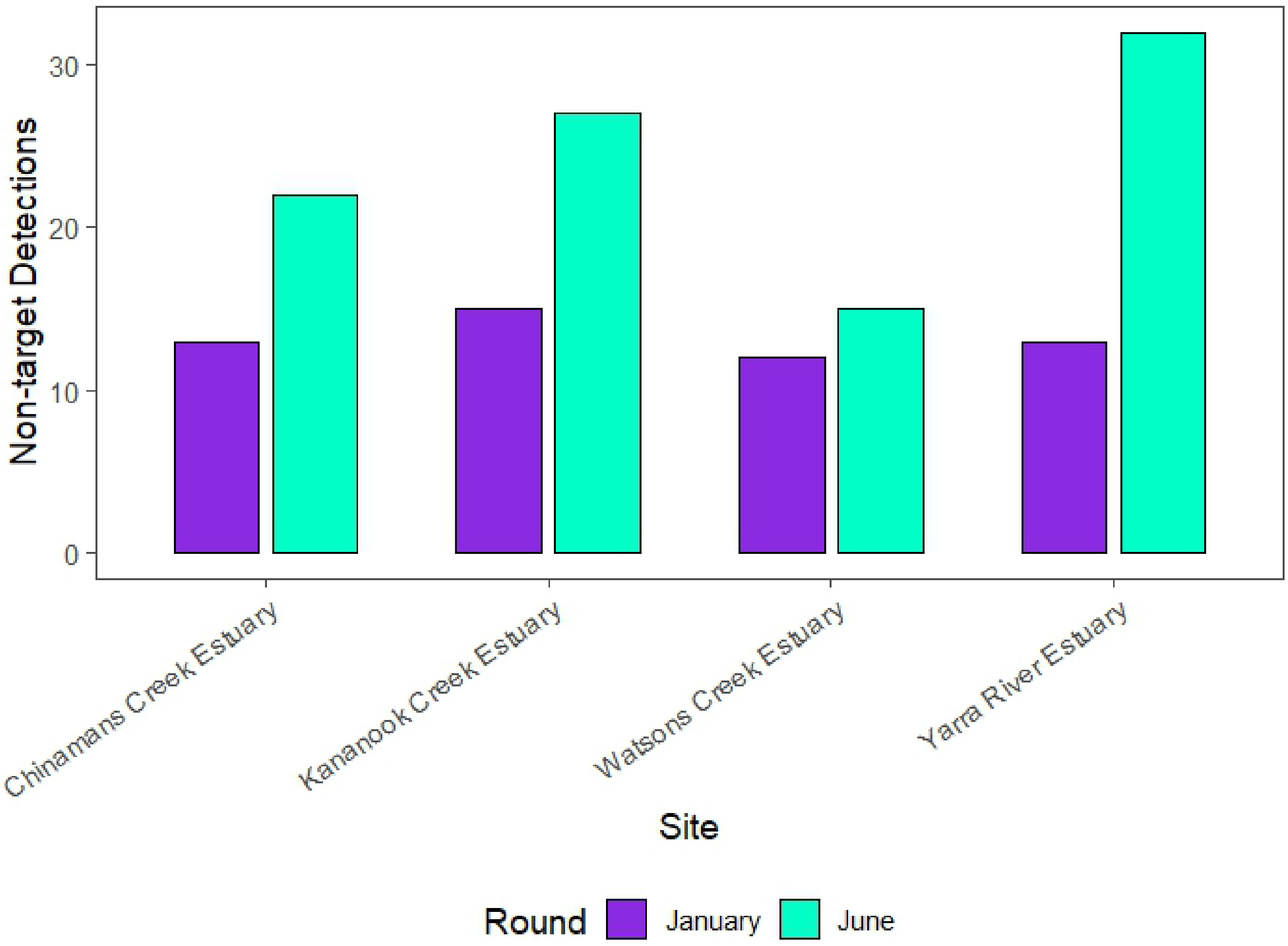

Figure 9 Non-target detections recorded at four estuarine sites in January and June, showing consistently higher detections in June across all sites, with the highest counts at Yarra River Estuary.

How the information is being used

Results from non-target analysis are used to inform and strengthen ongoing monitoring programs. Seven chemicals identified through this broad screening process (Figure 10), have been added to the targeted screening list, which from October 2025 contained 460 chemicals, bringing the total number of chemicals to the targeted screen to 467. This will allow these chemicals, including selected pharmaceuticals, industrial chemicals, insect repellents, and herbicides - to be measured more routinely and tracked over time.

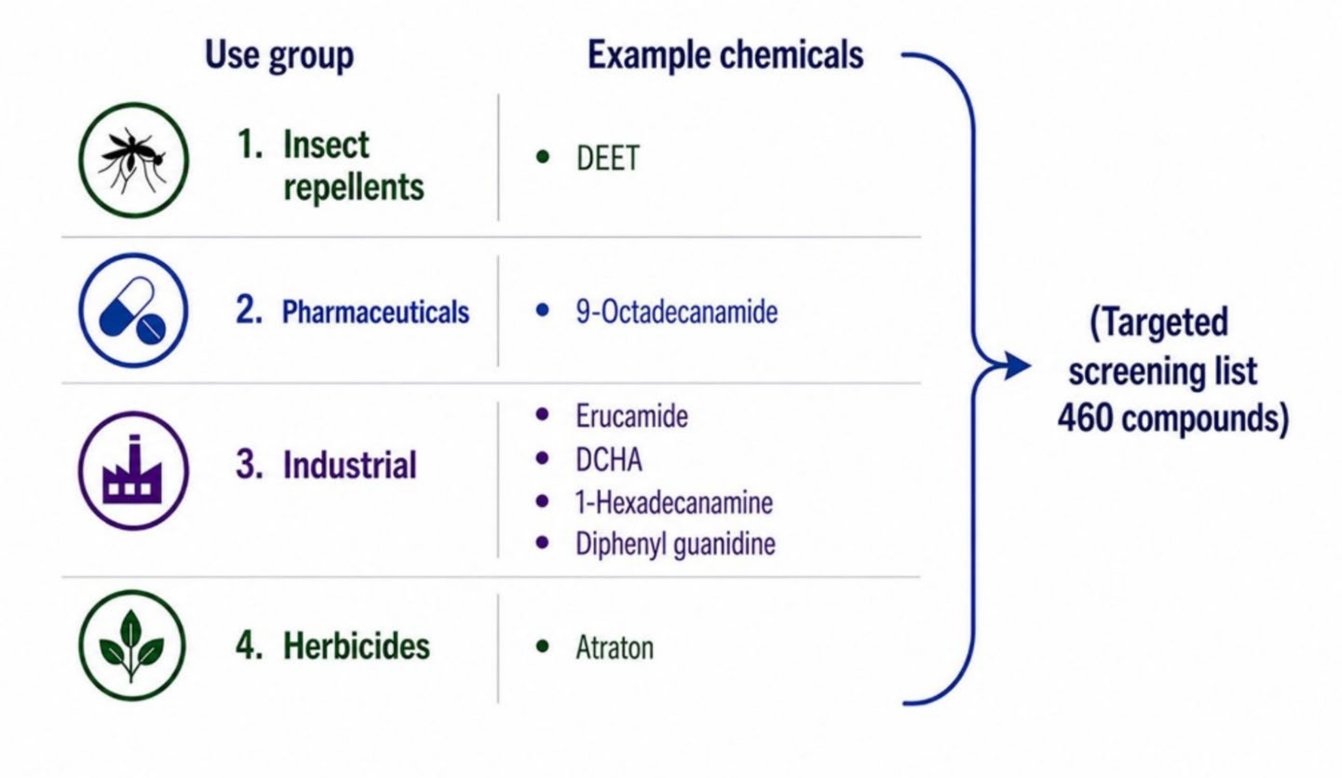

Figure 10 Chemicals identified through non-target analysis and their subsequent inclusion in the targeted screening list

Why this approach is important

Non-target analysis helps identify emerging or previously overlooked chemicals and supports a better understanding of chemical pressures in catchments and bays. By guiding which chemicals are prioritised for future monitoring, this approach ensures that water quality programs remain responsive to real-world chemical use and environmental conditions, supporting informed management and protection of local waterways.

Ecotoxicology update

Ecotoxicological tests are important in this project as they provide the link between what contaminants are being detected and if they have the potential to affect the health of our estuaries and bays.

Two ecotoxicological tests were carried out on site water from selected sites

- Microtox assay
- Amphipod survival test

Microtox Assay

Water samples from 23 locations were screened for short-longer-term toxicity using the Microtox® test. This test uses naturally glowing bacteria (*Aliivibrio fischeri*), which reduce light output when exposed to harmful substances. Changes in light provide an early indication of potential short-term stress to living organisms. It is the global standard in accurate toxicity testing; quick, highly accurate and repeatable, with documented performance, verified by the US EPA's Environmental Technology Program. Samples were tested at 5 and 15 minutes across four dilution levels (approximately 6–45%), and results were reported as percentage change compared with clean controls.

What was observed

Across all sites, no strong toxic effects were detected. None of the samples reached levels associated with moderate toxicity, and standard toxicity thresholds could not be calculated because responses were low. Some small changes were seen at higher concentrations, but these are likely due to natural variation in the test or natural characteristics of the water, rather than harmful effects. Overall, the results show no clear signs of short-term toxicity based on this screening test. In the next round of Ecotoxicology testing, we will investigate the use of additional toxicological techniques.

Marine Amphipod 5-Day Assay

A five-day survival test was conducted using *Allorchestes compressa*, a marine amphipod. Animals were placed in beakers containing water collected from each site and monitored over five days. Survival in site water was compared with control water to assess whether the samples could support amphipod survival under the test conditions.

The test performed as expected, with all animals surviving in the control samples. In contrast, nearly all amphipods exposed to site water died over the 5-day test period, except at one location (Site 12) (Figure 11). Further analysis indicated that electrical conductivity (EC), a measure of salt concentration, was very low at most sites but higher at Site 12 (Figure 11). These low EC levels are unsuitable for this species and are the most likely cause of the observed mortality. For future testing, a freshwater amphipod species will be used. In addition, water quality data are currently being collected through the volunteer network to support the design of the next study.

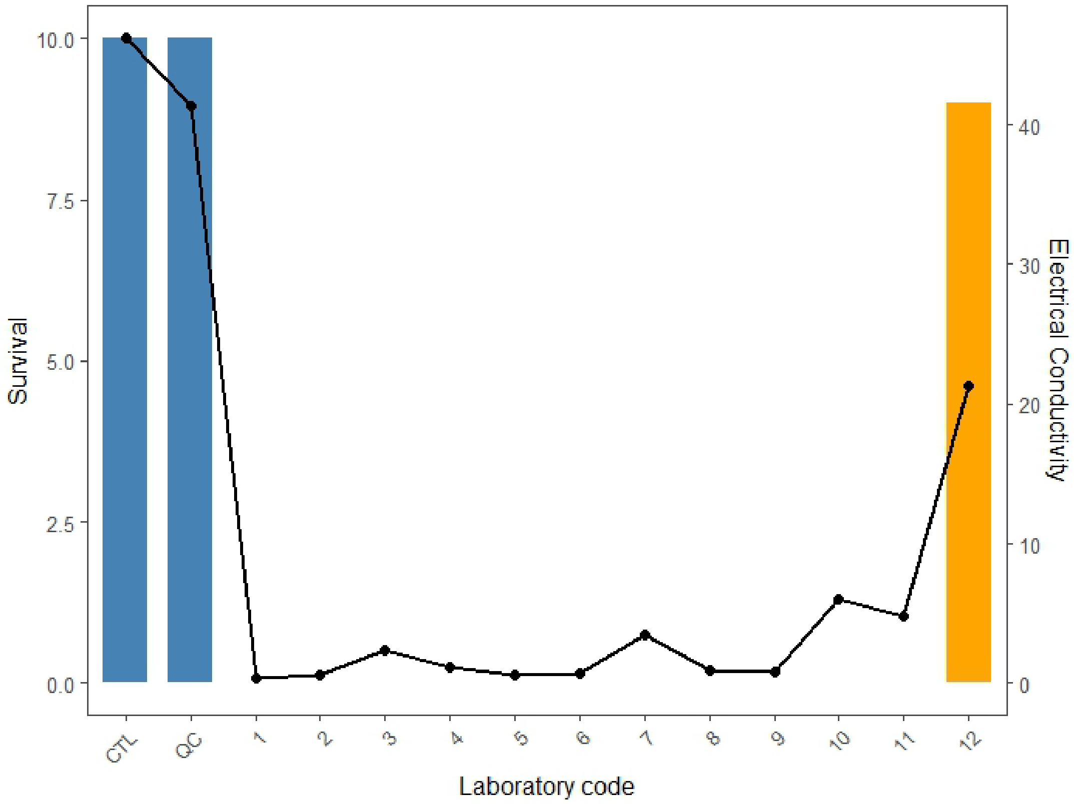

Figure 11 Five-day survival assay of the marine amphipod Allorchestes compressa exposed to site water samples (orange bars) compared with control water (blue bars) and electrical conductivity mS/cm (black line). NOTE: Poor survival is expected to be driven by levels of salinity rather than the concentration of contaminants.

What do these results mean?

The Microtox test results suggest that we are finding minimal effects from the suite of contaminants currently detected, however, this needs to be validated with further ecotoxicological techniques. In additional, the Amphipod test was inconclusive due to salinity effects. As previously mentioned, the next amphipod tests will be undertaken using freshwater species.

Conclusion

Overall, this update reinforces that there is a diversity of chemicals present in estuaries flowing into Port Phillip and Western Port. The presence of these chemicals is also dynamic and strongly influenced by seasonal and catchment-specific factors. While fungicides and herbicides are consistently present, the specific compounds detected vary across sampling rounds, underscoring the importance of repeated monitoring to capture changing chemical pressures over time. Over the coming months we will strengthen our approach to ecotoxicological testing to provide greater confidence regarding whether the presence of various chemicals are at levels that have the potential to be impacting ecological health. By combining community-supported sampling with high confidence analytical methods, the Unseen Threats program continues to build a robust evidence base to inform proactive water quality management. The results so far also throw a spotlight on how everyday activities carried out by industry and the community may be contributing to chemical detections in estuaries across greater Melbourne. As additional sampling is undertaken in 2026 and beyond, the growing dataset will improve understanding of longer-term trends, support targeted mitigation efforts, and contribute to ongoing stewardship of estuarine and bay environments.

Next steps

Additional rounds of sampling are planned throughout 2026, extending the presence/absence of chemicals dataset beyond the three sampling events reported here, coupled with additional ecotoxicological assessments. Ongoing engagement with volunteers and community participants will continue, supported by a stakeholder workshop scheduled for Saturday 24 October 2026 10am- 2pm, where results from six completed sampling rounds will be presented and discussed. A subsequent update report will incorporate these additional data, enabling a more robust assessment of spatial and temporal patterns in chemical occurrence. With the project expected to conclude in mid-2027, future efforts until then will focus on detailed data interrogation to support an *identify* → *source* → *solutions* framework, informing practical actions for, environmental regulators, catchment managers, industry, and the wider community to reduce pollutant inputs into estuarine environments.

Beyond this project, subsequent work should move to quantifying frequently occurring contaminants at priority locations to determine concentrations of these chemicals to more confidently understand ecological risks and the need for management responses.

Supplementary Material

Figures 12-14 show the spatial distribution of chemical detections across estuarine sites for three separate sampling events conducted in January, June, and October 2025. Each map represents an individual monitoring round, noting that sampling locations vary between events. Point symbols indicate the number of chemical detections recorded at each site during the respective sampling period, while estuary extents are shown to provide spatial context. Together, the maps illustrate temporal variability in detections across the estuarine network despite differences in site coverage.

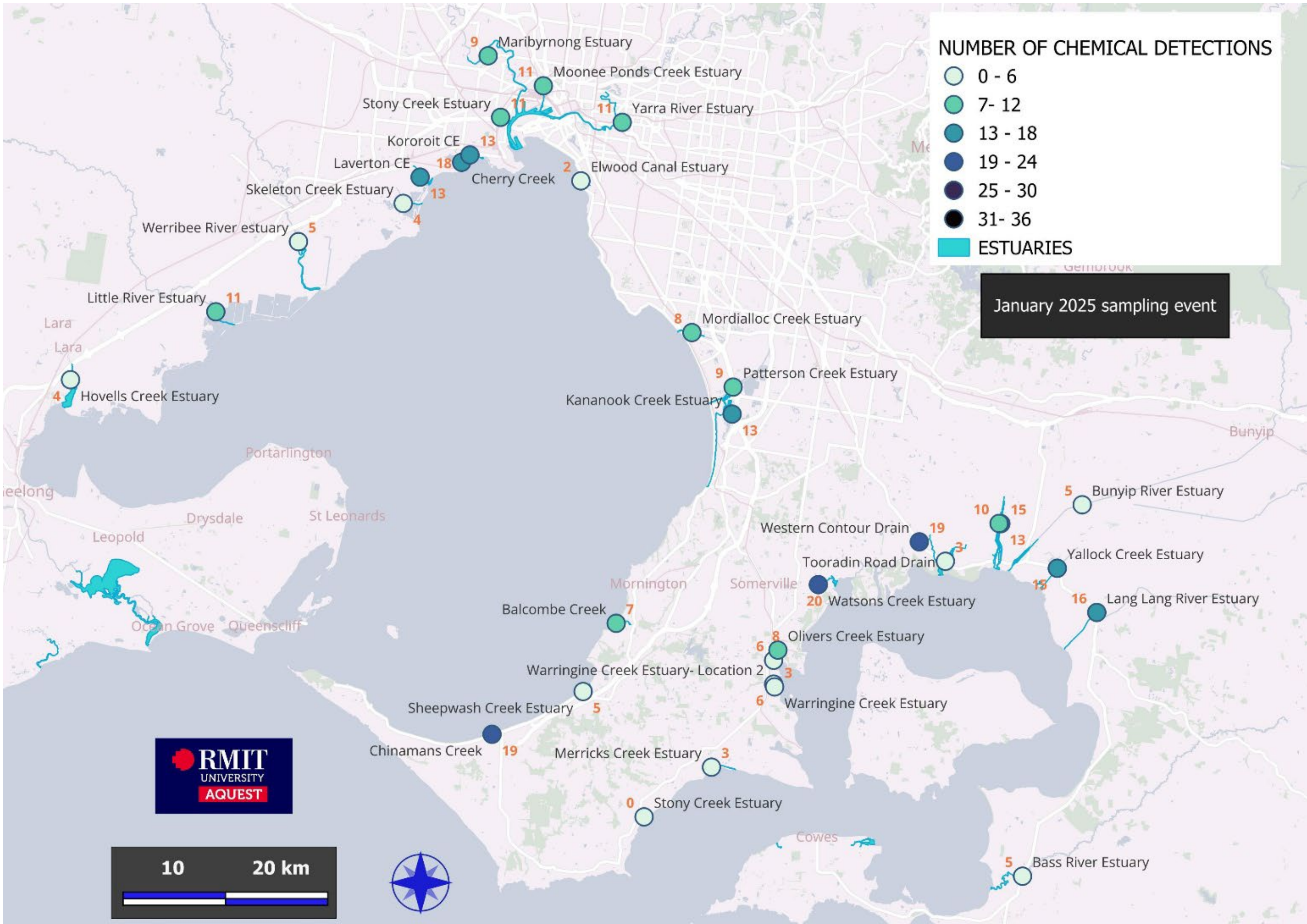

Figure 12 Map of Port Phillip and Western Port showing the number of chemical detections recorded at estuarine sampling sites during the January 2025 sampling event. Circles represent individual sites, with symbol colour indicating the total number of detected compounds across all analyte groups.

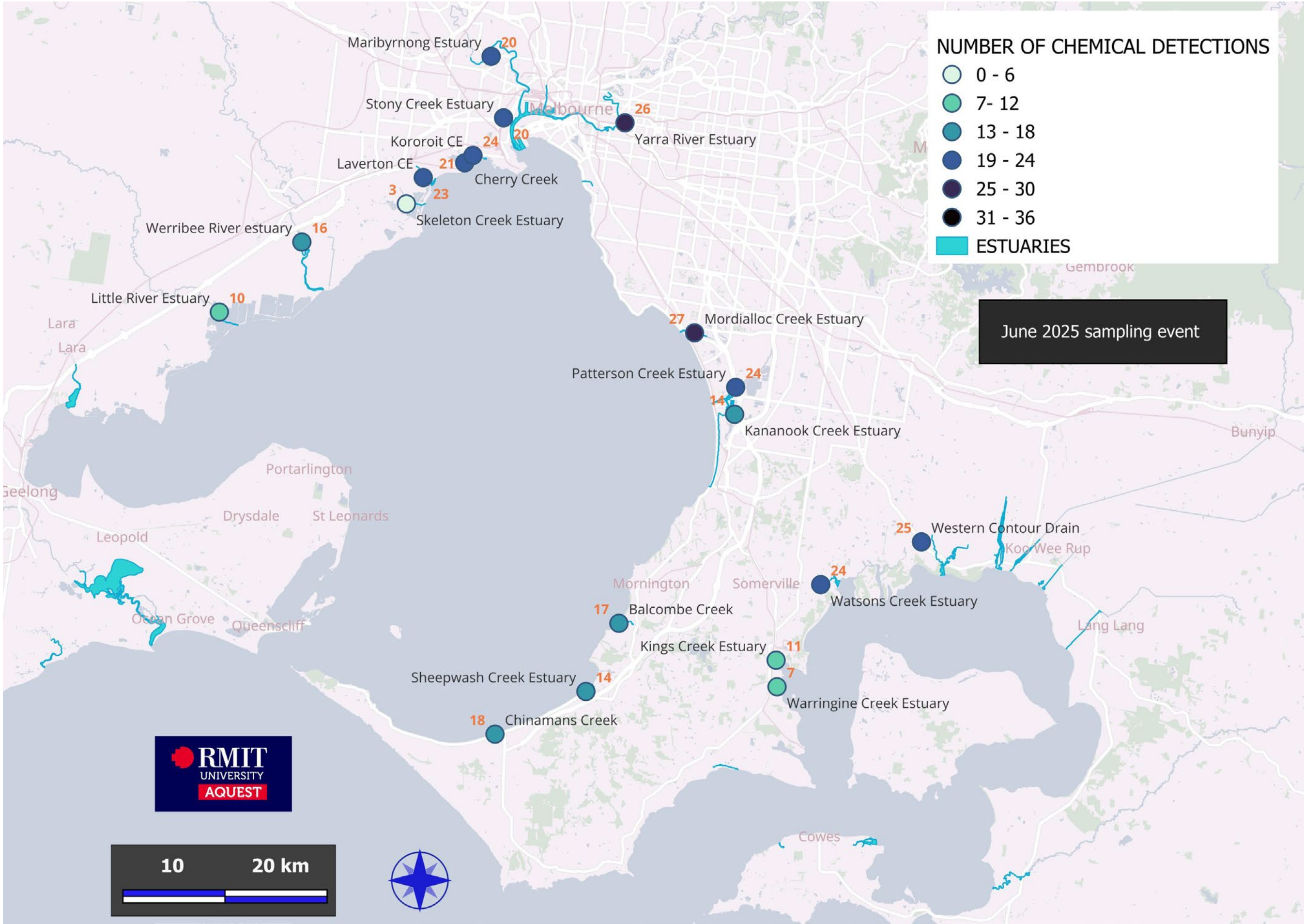

Figure 13 Map of Port Phillip and Western Port showing the number of chemical detections recorded at estuarine sampling sites during the June 2025 sampling event. Circles represent individual sites, with symbol colour indicating the total number of detected compounds across all analyte groups.

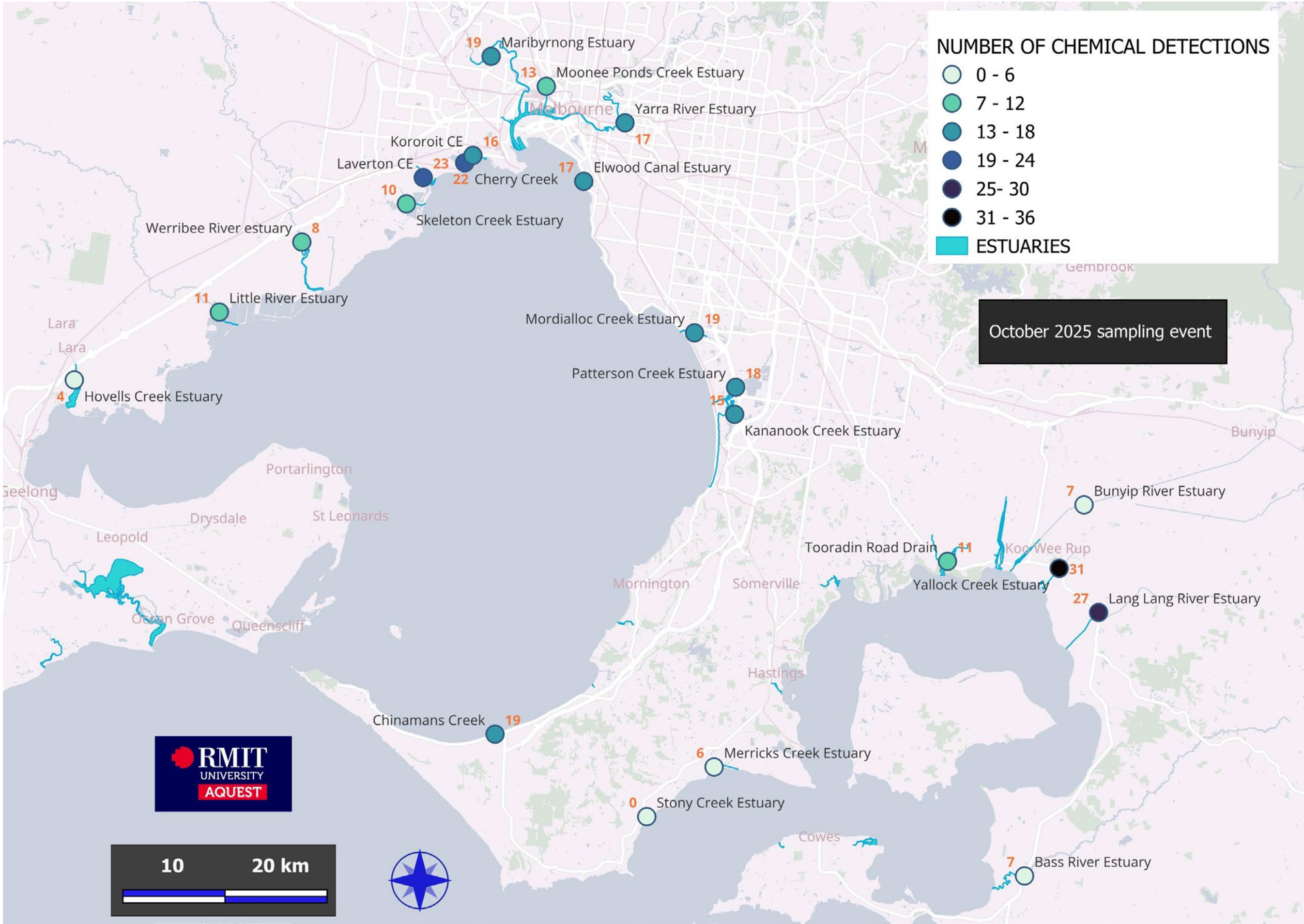

Figure 14 Map of Port Phillip and Western Port showing the number of chemical detections recorded at estuarine sampling sites during the October 2025 sampling event. Circles represent individual sites, with symbol colour indicating the total number of detected compounds across all analyte groups.