Toxicants: Western Port and surrounding catchments

Western Port Forum
August 31st 2023

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RMIT UNIVERSITY AQUEST

A3P
Aquatic Pollution Prevention Partnership

Melbourne Water

A collaborative research partnership delivering practical management solutions to reduce pollution in our waterways

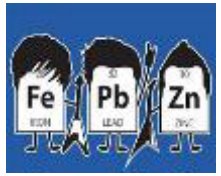
What are toxicants?

"Chemical pollutant that can have toxic effects on biota"


Antifoulants


Pesticides

Hydrocarbons



Heavy metals

Nutrients


Industrial


Cars


Agriculture


Boating


Urban


Roads


Seagrasses


Open water


Mud Flats


Mangroves


Salt marsh

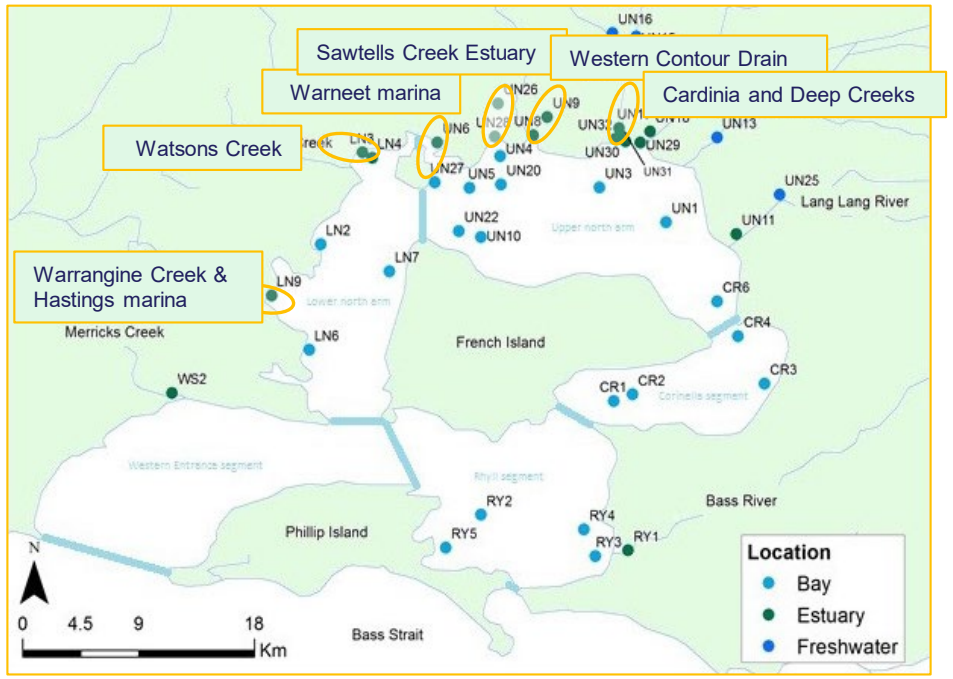
Toxicants

Toxicant sources

Environments at Risk

Summary of Past Work: 2012 - 2018

- Pesticide Monitoring and Sourcing:
  - Major Estuaries, Drains, Creeks and in the Bay

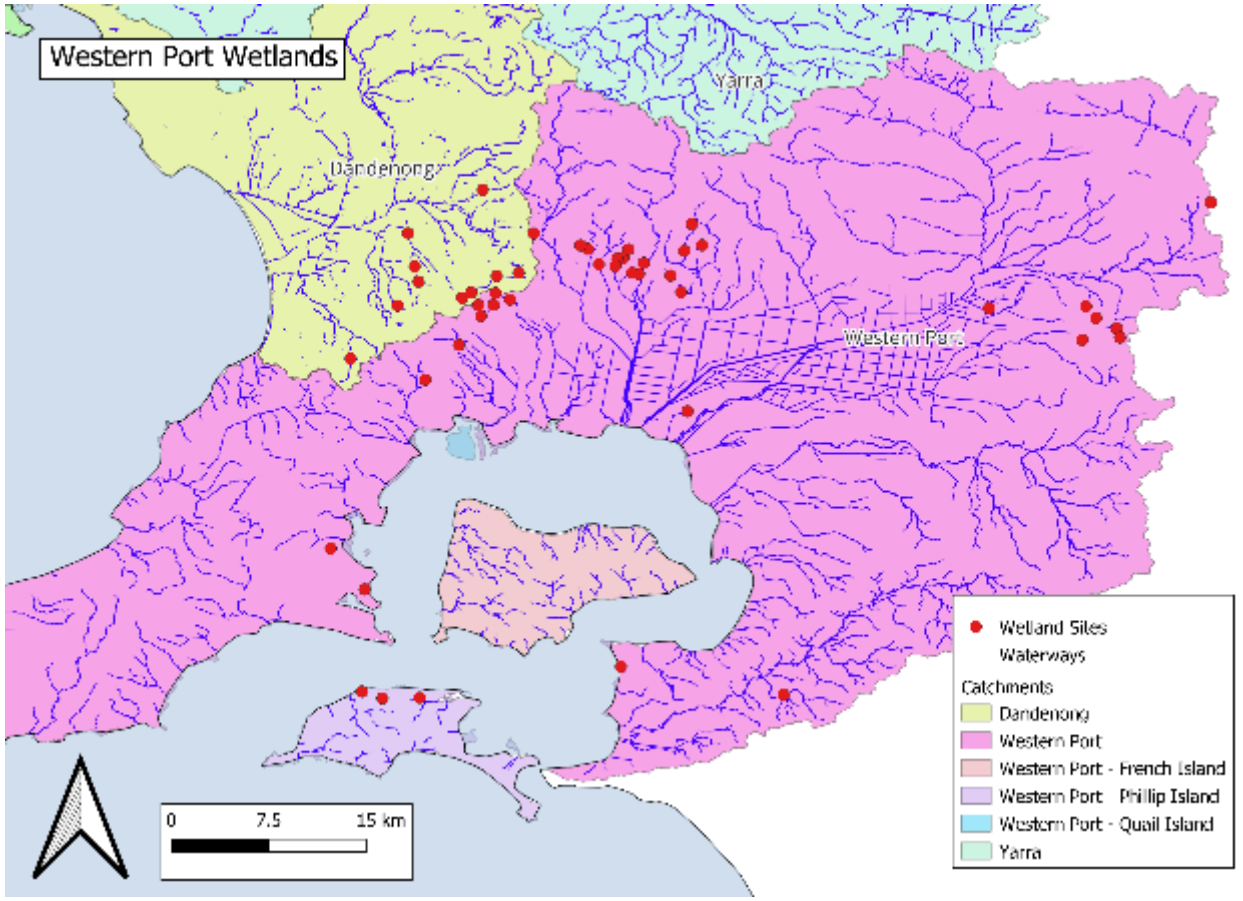


- Levels of heavy metals and hydrocarbons are a low risk
- Pesticide concentrations are of concern and pose a risk to flora and fauna
- Herbicides and fungicides are most frequently detected pesticides and occur at highest concentrations.
- Environmental concentrations of herbicides pose risk of toxicity for seagrasses and mangrove seedlings
- Pesticides are primarily related with agricultural land use

Wetland Monitoring 2019

- To understand the pollutants accumulating in urban land use wetlands.

- Monitoring:
  - 48 stormwater wetlands sampled in the Westernport catchment
  - Passive samplers and sediment samples collected: pesticides, metals and hydrocarbons



Pollutants in Wetlands

Herbicides

10

9

6

Pharmaceuticals

4

Simazine, Propiconazole,Tebuconazole, Carbendazim, Imidacloprid occurred in **>75%** of wetlands

Bifenthrin in the sediment occurred in **>80%** of wetlands

Associations with land use

Pesticide	Type	Land use	Registered uses in urban Australia
simazine	Passive Sampler (water)	residential	hard surfaces such as garden paths, driveways, paved areas, tennis courts and houses
tebuconazole	Passive Sampler (water)	residential	turf, wood preservation, carpets and other woollen surfaces
propiconazole	Passive Sampler (water)	residential, ovals, roads	turf, wood preservation, carpets and other woollen surfaces
imidacloprid	Passive Sampler (water)	forests, commercial	lawns, fly baits, termites, flea control
carbendazim	Passive Sampler (water)	residential?	timber treatment
bifenthrin	Sediment	residential, ovals, roads	general household, barrier sprays, lawns, termites, mosquitoes, ants etc

Forest

Ovals

Residential

Potential Sediment Sources during Urban Construction

Insecticide: Bifenthrin

- Affects nervous system
- Hydrophobic
- Many uses
  - e.g. Termite control, pet control, mosquito repellents

New Housing Estates

- What pollutants are associated with sediments coming from new residential estates?
- Are the current sediment control measures adequate?

Pollutants in Wetlands (7 yrs old)

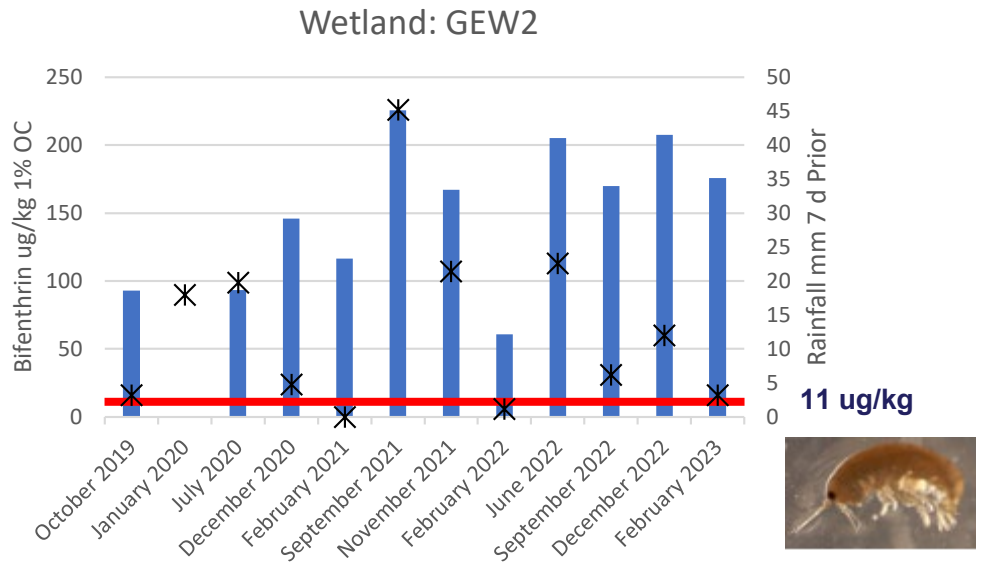
6

6

9

Pharmaceuticals

2



- A number of pesticides detected in the wetland.
- Bifenthrin detected in passive samplers in 2021 and 2022
- Bifenthrin detected in most sampling rounds
- Bifenthrin toxic to invertebrates

Pollutants in the Creek

Herbicides

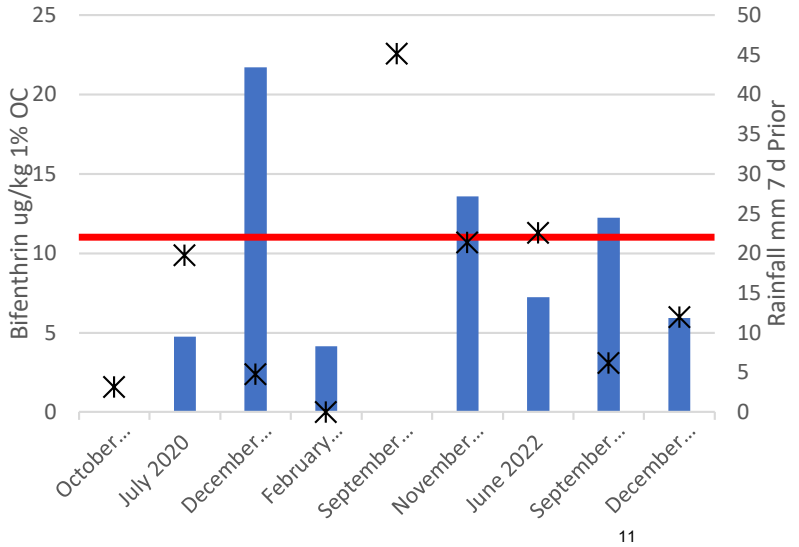
FUNGICIDE

INSECTICIDE

Pharmaceuticals

Herbicides	Fungicide	Insecticide	Pharmaceuticals
Rural: 1	QC1: 0	QC1: 2	QC1: 1
Urban: 5	QC2: 4	QC2: 4	QC2: 1

- More pesticides detected downstream of the housing estate
- Pesticides commonly found in urban areas



- Bifenthrin detected from July
- Highest concentrations of bifenthrin detected in December

Urban Construction: Summary

- Contamination of bifenthrin in newly constructed estates
- Bifenthrin potentially toxic 1 year post construction at some sites
- Contamination appears to be associated with:
  - Dust
  - Rainfall events
  - Flooding of wetlands

PhD: The toxicological effects of bifenthrin on urban aquatic organisms.

PhD Student: Madara Ranatunga
Supervisors: Vincent Pettigrove, Claudette Kellar

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Toxicological impacts of synthetic pyrethroids on non-target aquatic organisms: A review

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ARTICLE INFO

Keywords:
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ABSTRACT

Synthetic pyrethroid (SP) insecticides are used extensively around the world in both agricultural and non-agricultural applications. Their toxicity to mammals is low, however, they have a high toxicity to invertebrate, fish and amphibians, including threatened species, affecting the health of the ecosystems and their biodiversity. This paper reviews the current global research on SP toxicity on non-target aquatic organisms and looks at the current biomonitoring approaches to detect their effects on aquatic ecosystems. Over the past decade, the toxicological effects of SPs on aquatic macroinvertebrates have been documented in laboratory, mesocosm and field studies. Toxicity of SPs for aquatic organisms can vary greatly between species and highlights the importance of assessing toxicity in all major aquatic groups. However, little data exist, and more research is needed on how sediment bound SPs affect less studied aquatic groups like zooplankton, amphibians and fish. Detecting stress caused by toxicants in aquatic ecosystems can indicate how SPs are affecting individual organisms and the community. Development of toxicity thresholds for all aquatic groups like invertebrates, fish and amphibians, should assist in assessing the biological risks of SPs to inform regulations and management actions to protect aquatic ecosystems.

1. Introduction

Synthetic pyrethroids (SPs) are widely used as insecticides in residential and agricultural areas and, also for landscape maintenance in parks for pest control in animal husbandry (in pet shampoo and veterinary medicine to treat crustacean parasites), ornamental plants and in public health to control mosquito-borne diseases. They have been incorporated in over 3,500 registered products, including personal care products such as shampoo and mosquito repellents and pet-care products (Thatheyus and Selvam, 2013, Spurlock and Lee, 2008). Their use has increased during the past decade with the declining use of more damaging and persistent pesticides like organophosphate and carbamate pesticides (Anwerg et al., 2005), which are more acutely toxic to birds and mammals compared to SPs (EPA, U.S.A. 2020). They have become one of the three major kinds of pesticides used globally (Xiao et al., 2012), with the global SP market valued at $1,633 million in 2016 (QYResearchGroup 2017).

A variety of pest control products contain SPs (Hintzen et al., 2009) that are used for termite control in Australia (Smith et al., 2002) and, Argentine ant (*Linepithema humile*) control in the United States (Jiang et al., 2014). They are also used in several mosquito eradication programs (Nkya et al., 2013) and many African countries use pyrethroids as a malarial control measure by treating mosquito nets (WHO 2023, Tang et al., 2018). Synthetic pyrethroids are also used in controlling dengue viruses by using it in a fog application and in mosquito repellents (Tang et al., 2018, Narendra et al., 2008, Hassan et al., 2019). However, the efficiency of these compounds is now declining as there is a rapid spread of resistance developing among mosquitoes (Amelia-Yap et al., 2018, Chen et al., 2020).

China has the largest production and use of pesticides in the world and SPs were detected in high frequency as a common environmental contaminant, used in agricultural and livestock industries (Tang et al., 2018). In Brazil, pyrethroids are used as an insecticide in soy production regions (Hunt et al., 2016). Synthetic pyrethroids, particularly cypermethrin, are used as a pesticide in rice cultivation in the Philippines (Bliman et al., 2011). In Australia, SPs are used as an insecticide in various crops including wheat, barley, grain legumes, oilseeds, pastures, pome and stone fruits, trees and ornamentals, tobacco and vegetables and to control ticks and flies in cattle farming (APVMA 2011). As per the Food and Agriculture Organization of the United Nations (FAO), Fig. 1

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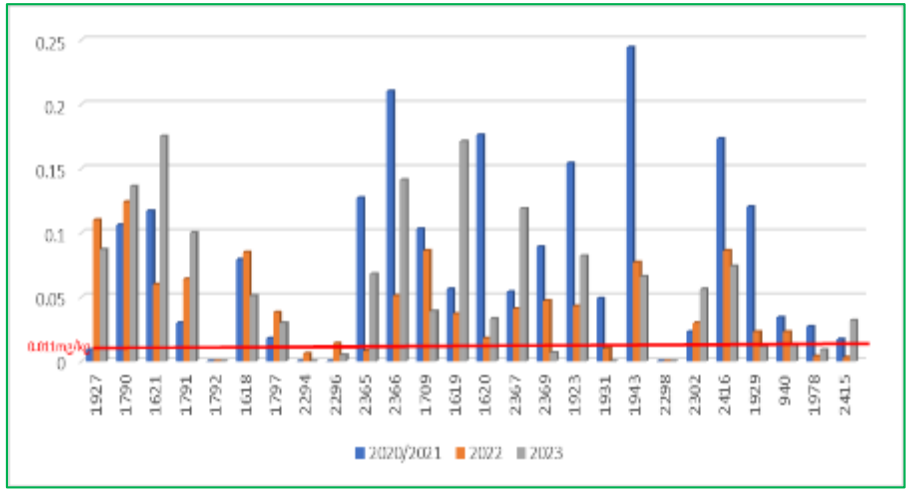

Growling grass frog (*Litoria raniformis*)

Daphnid (*Daphnia carinata*)

- High concentrations of bifenthrin in wetlands across Greater Melbourne, including Western Port.
- Both zooplankton and tadpoles are sensitive to bifenthrin in the water.
- Current concentrations in our wetlands are above toxic values for both species.

PhD: Development of toxicity tests with early life stage fishes using waters and sediments from Westernport Catchments

PhD Student: Tehmina Yaqoob
Supervisors: Vincent Pettigrove, Kathryn Hassell, Rhys Coleman

AIMS AND OBJECTIVES

To establish standard protocols for assessing water and sediment toxicity using Australian estuarine and freshwater fish embryo tests.

- Effects of pesticides on fish embryo development
  - Is toxicity affected by changes in temperature and salinity?
- Effects of contaminated sediments and water (from WP) on fish embryo development

Murray rainbowfish (*Melanotaenia fluviatilis*)

Purple-spotted gudgeon (Southern) (*Mogurnda adspersa*)

Male guarding eggs

PhD: Sources, fate and transport of microplastics in Western Port

PhD Student: Anuradha Athawuda
Supervisors: Vincent Pettigrove, Jackie Myers

AIMS AND OBJECTIVES

1. Identify the sources and types of Microplastics (MPs) present across Western Port

2. Identify the factors leading to fate and transport of MPs through Western Port

3. Identify the spatial and temporal distribution of MPs across Western Port - waterways and the Bay

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