
Stormwater
Australia's great environmental dilemma
Bio2Lab
Environmental Intelligence
Victorian Environment
FRIENDS NETWORK
WCS
Warringal Conservation Society

Bio2Lab
Environmental Intelligence

Delivering innovative solutions to manage the environment

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B App Sci (Plant Biotechnology) - QUT

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Academic Research (Center for Environmental Stress and Adaptation Research: CESAR; Centre for Aquatic Pollution Identification and Management: CAPIM)

- Aquatic ecology and ecotoxicology
- Identifying chemicals of concern impacting waterways

Technical Director - Bio2Lab

Today’s webinar:

- What is stormwater?
- Stormwater impacts on our local waterways

  Water Sensitive Urban Design (WSUD)
  - Catchment level
  - Local level
  - Lot level
- Stormwater pollution
  - Identifying and assessing stormwater pollution
  - Finding major sources of pollution
- What can we do? Linking scientific data to community education and awareness programs

What is stormwater?

High % impervious area

Low % impervious area

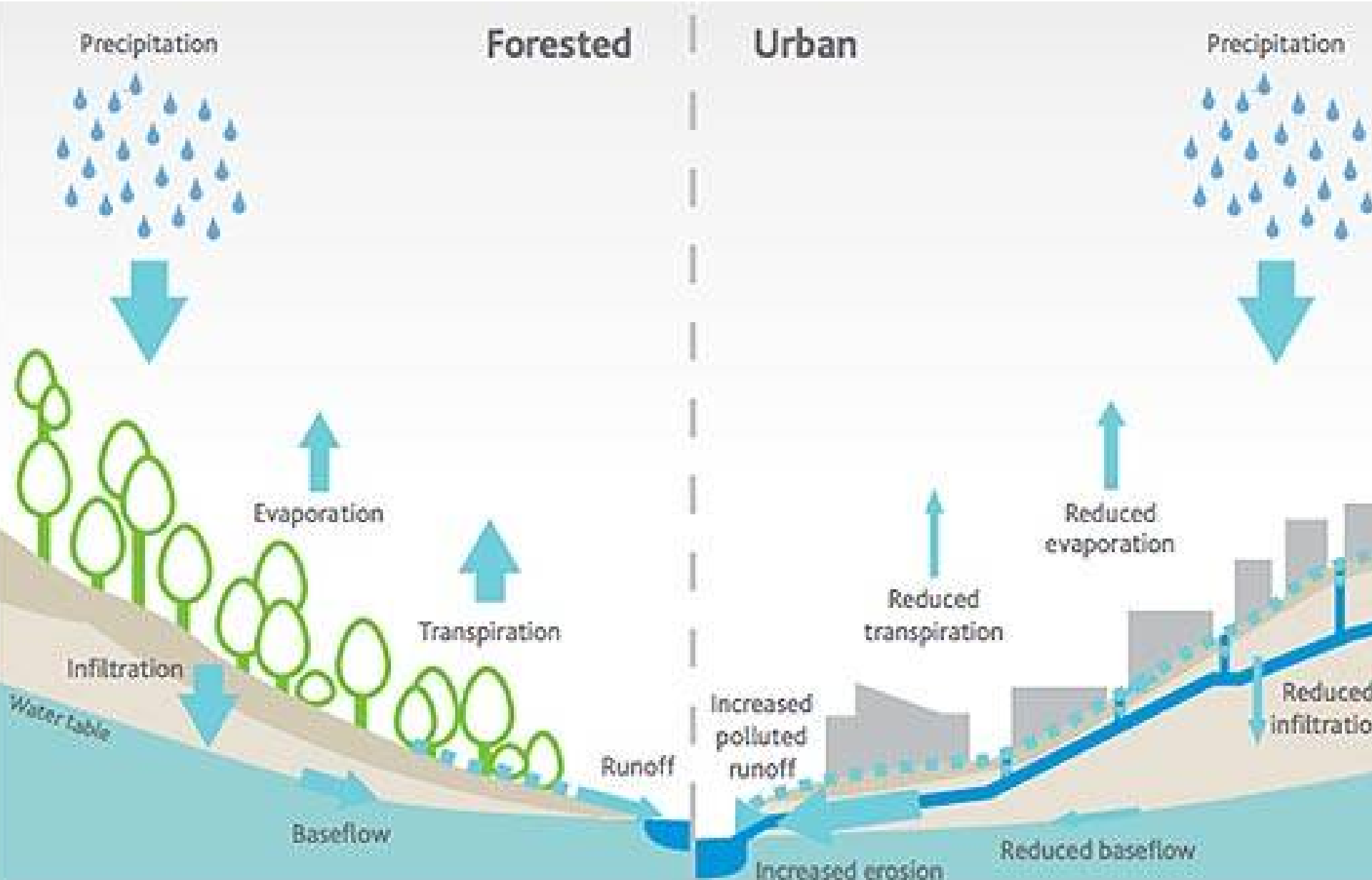
Impervious area

As hard surfaces increase due to urbanisation, so does the volume of stormwater and any associated pollution

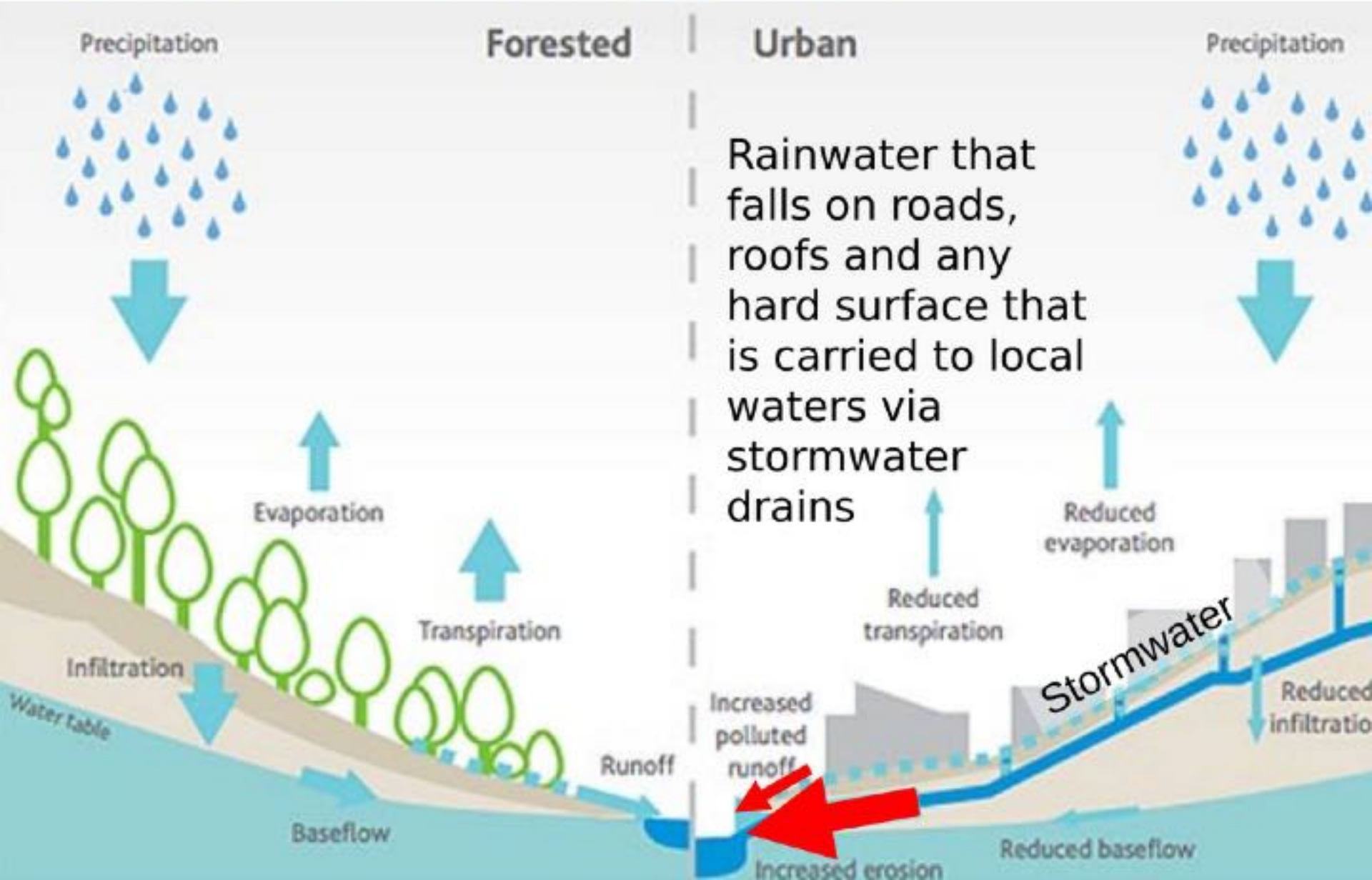
Rain falling on highly impervious areas goes straight down a concrete drain to the waterway → high volumes during rain events

Rain falling on less impervious areas filters into the surface and through the soil before entering waterways → low volumes during rain events

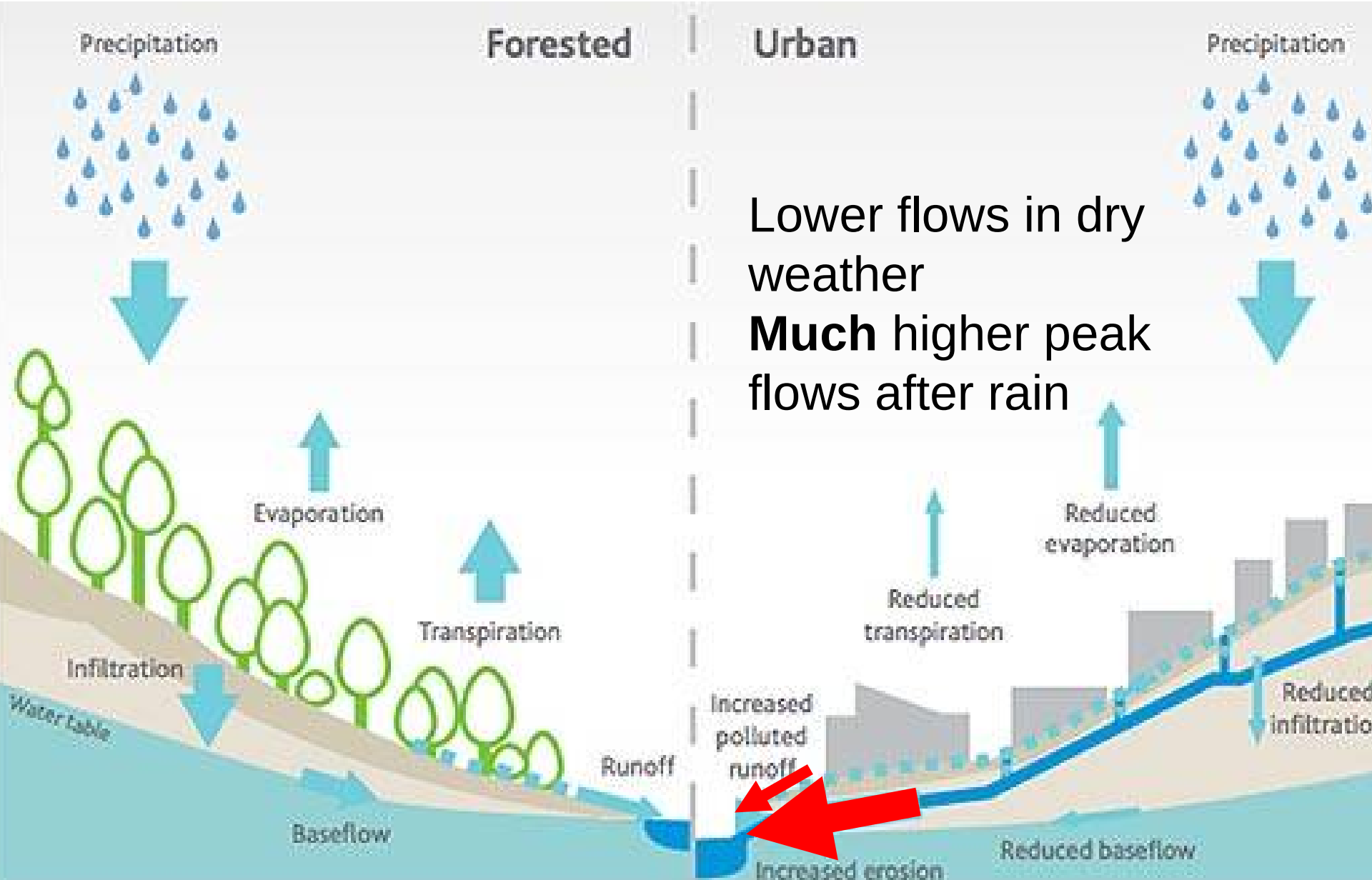
What is stormwater?



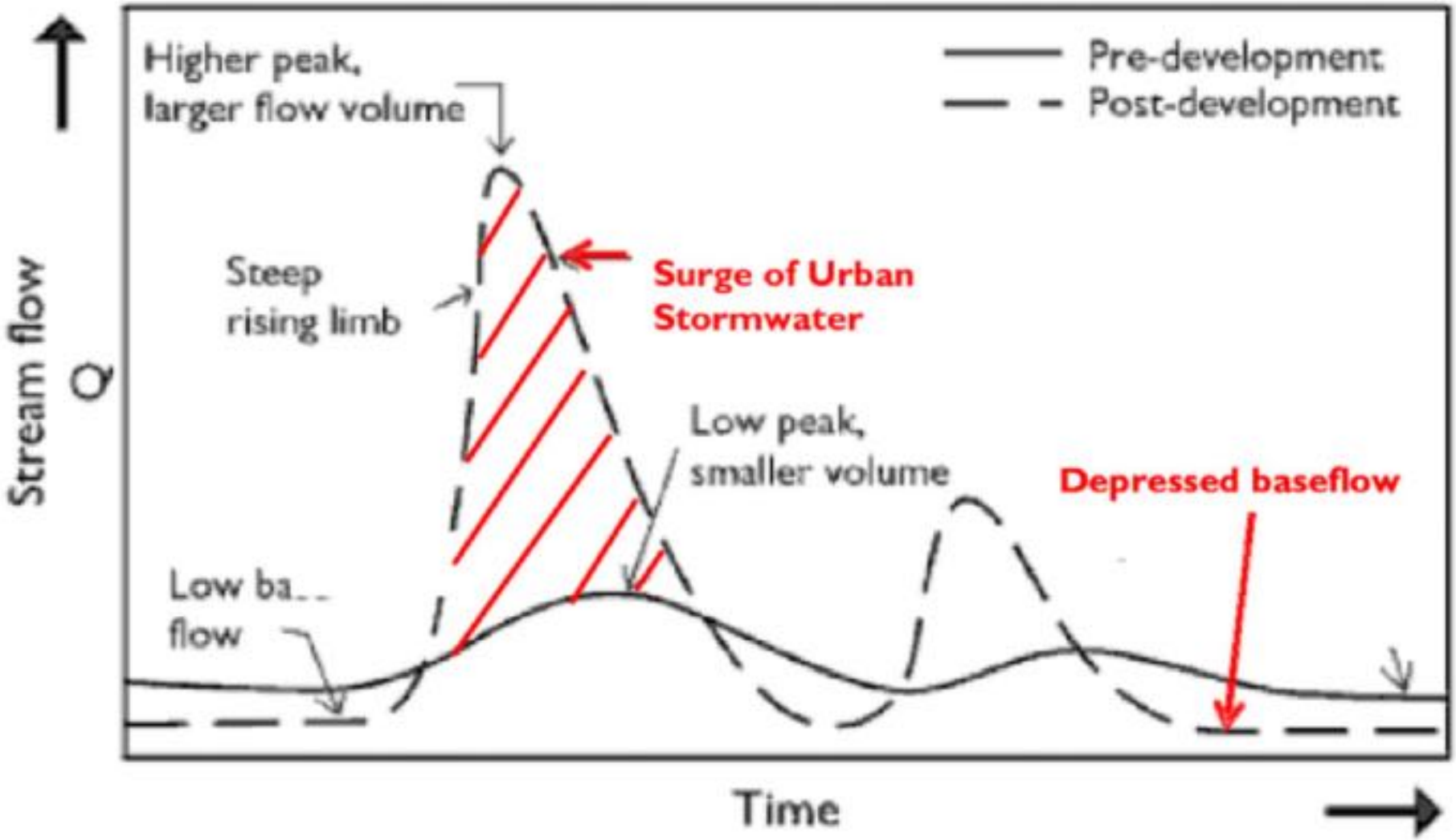
What is stormwater?



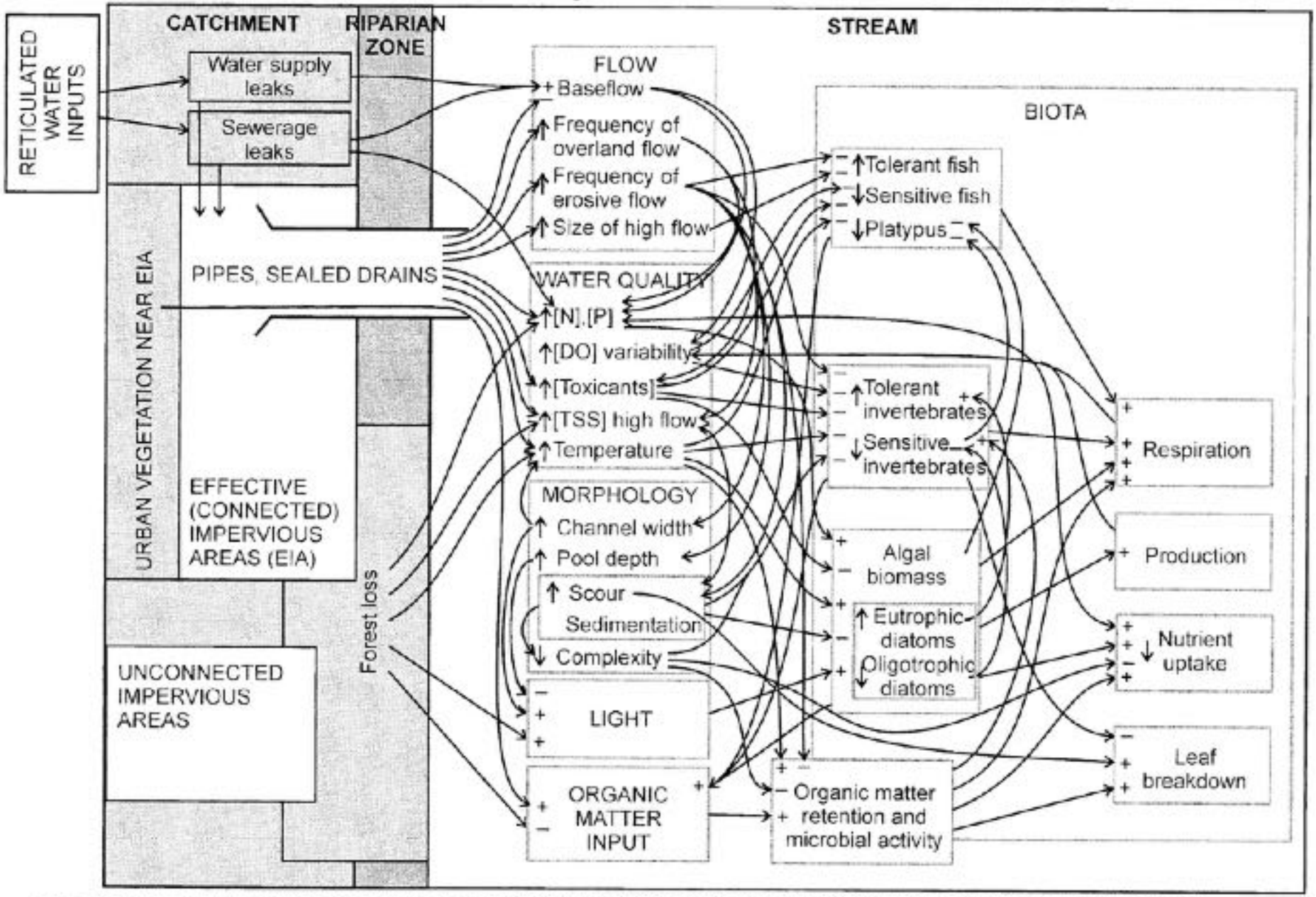
Impacts of stormwater



Compare pre- and post-development hydrographs



The "Urban Stream Syndrome"



Walsh, C. J., Roy, A. H., Feminella, J. W., Cottingham, P. D., Groffman, P. M., and Morgan, R. P. (2005). The urban stream syndrome: Current knowledge and the search for a cure. Journal of the North American Benthological Society 24, 706–723.

Impacts of stormwater

Increased peak stream flows:

- Eroding stream banks and physically degraded streams

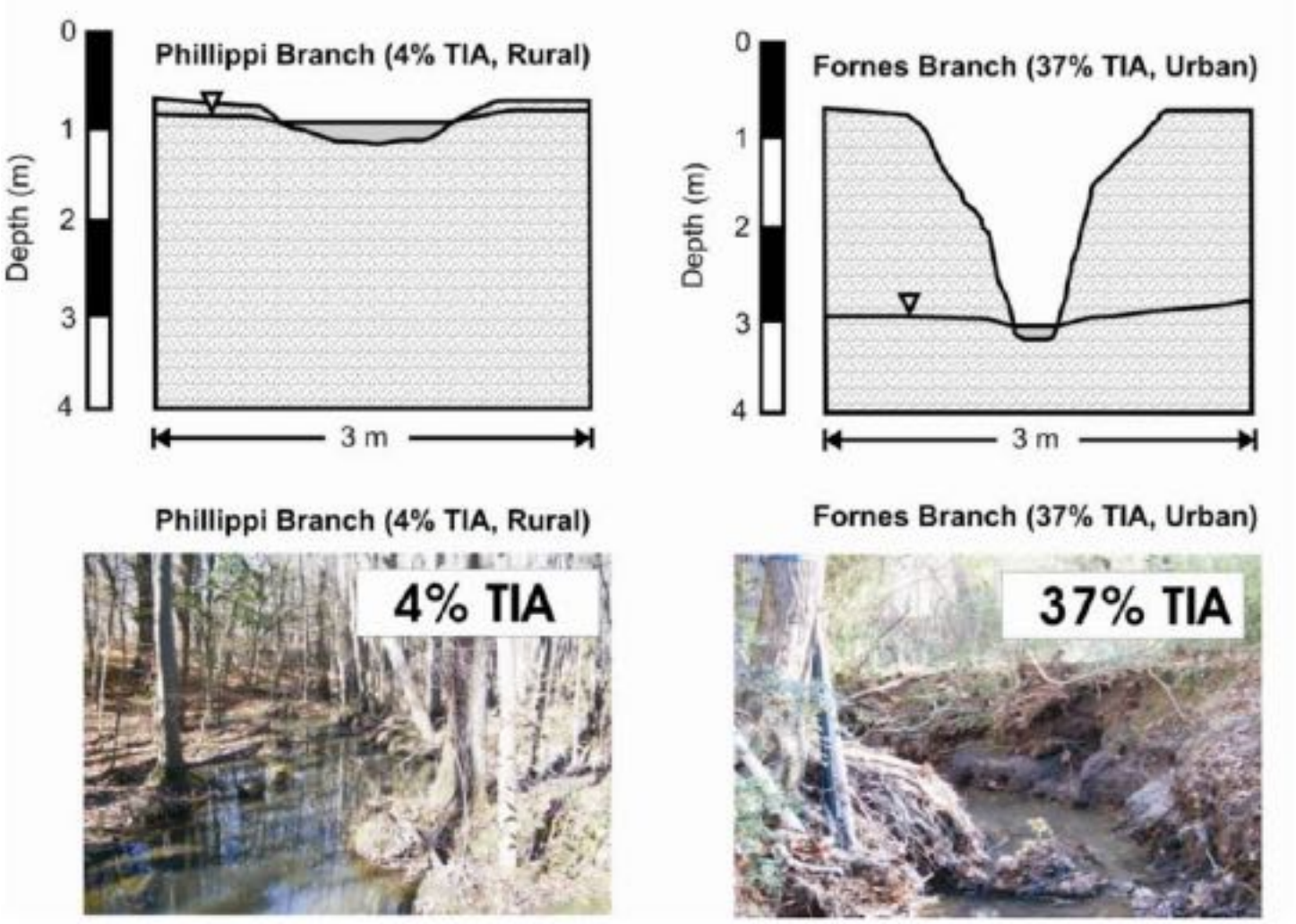
Decreased dry weather stream flows:

- Degraded habitat for dolphins, platypus, fish and aquatic animals. Affects access to food, shelter and breeding habits.

Efficient transport of pollution to streams:

- Beaches unsuitable for swimming for 1-2 days after heavy rain
- Affects access to food and breeding habits.

Physical impacts - Incised Stream Channel



O'Driscoll, M., Clinton, S., Jefferson, A., Manda, A., and McMillan, S. (2010). Urbanization Effects on Watershed Hydrology and In-Stream Processes in the Southern United States. Water 2, 605–648. doi:10.3390/w2030605.

Physical impacts - Incised Stream Channel

Diamond Creek below Eltham Township.
Photo by D. Sharley, 2019

Water Sensitive Urban Design

Water Sensitive Urban Design

- Managing stormwater quality,
- Mitigating flooding risk,
- Harvesting rainwater and stormwater for potable and nonpotable use,
- Greening the urban environment to reduce the heat island effect generated by intensive urban development and increased pavements, and;
- Improving the aesthetics of the urban environment to encourage a feeling of well-being in the community.

Water Sensitive Urban Design

- USA: Low Impact Development (LID): response to Clean Water Act, 1972
- UK: Sustainable Urban Drainage Techniques (SuDS)
- EU: Water Management Directive
- AU: Water Sensitive Urban Design (WSUD): Legislation varies widely by State and local Govt.
- China: Sponge Cities, 2013
- Africa: Water Sensitive Settlements

Guiding Philosophy of Total Catchment Management:

Aim to retain precipitation on the area where it falls

Water Sensitive Urban Design

- Point: Bioretention cells, rainwater tanks, constructed wetlands, dry
- ponds, infiltration basins, rain barrels, sand filters (surface), and wet ponds
- Linear: Grassed swales, infiltration trenches, and sand filters (nonsurface)
- Area: Green roofs and porous pavements

Point

Infiltration basin

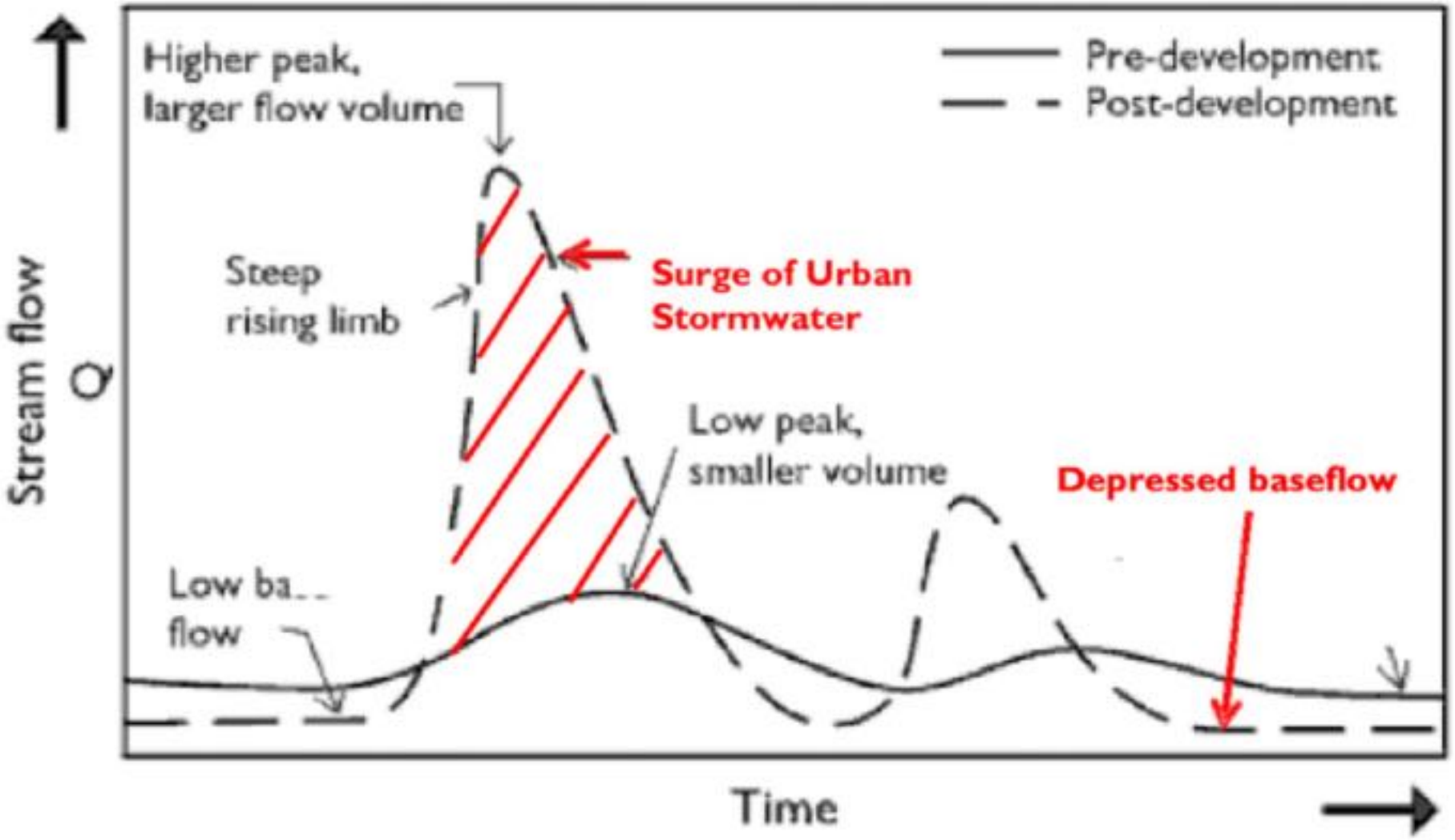
Linear

Biofiltration trench

Area

Permeable pavement

Aim to make the post- development hydrograph more like pre-development



Water Sensitive Urban Design

Port Phillip Bay Environment Study 1996 (CSIRO)

- Most toxicants immobilised in sediments, and tend to stay there
- Nitrogen has a rapid turnover due to marine and benthic phytoplankton,
- But, the bay has a finite capacity to metabolise nitrogen
- If this is exceeded, the consequences could be dramatic and irreversible
- => Special focus on reducing nitrogen inputs to the bay

Water Sensitive Urban Design

Vic Guidelines for Stormwater management require:

- 80% reduction in TSS
- 45% reduction in TP
- 45% reduction in TN
- 70% reduction in gross pollutants (litter)

Melbourne Water operates a stormwater offset service, priced at $6,645.00/kg N pa

https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/drainage-schemes-and-contribution-rates-2-0

Ecological impacts - Pollution

What is stormwater pollution?

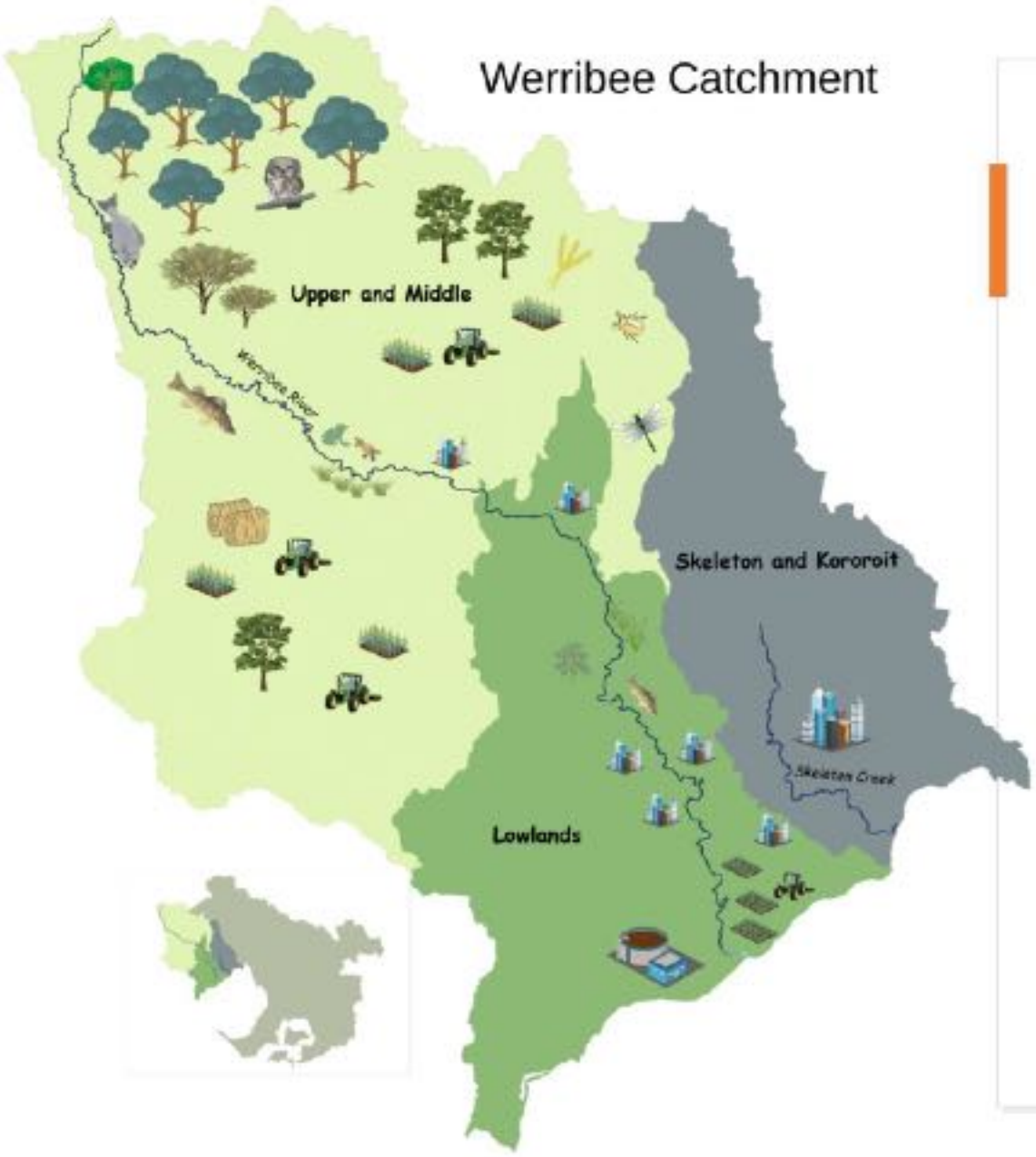
As stormwater travels across hard surfaces it picks up various types of pollutants from:

- Driveways and roads
- Industrial discharges
- Urban discharges
- Dumping of toxicants

Ecological impacts - Pollution

Stormwater Pollution Categories:

- Sediment and turbidity
- Nutrients
- Oxygen depleting substances
- Hydrocarbons, oil and grease
- Bacteria, viruses and pathogens
- Heavy metals
- Synthetic organics (pesticides)
- Persistent organics (e.g. PCBs, PFAS)



Land use change and pollution generation

Different land uses can generate different pollution profiles

Important to match the stormwater management strategies to pollution profiles

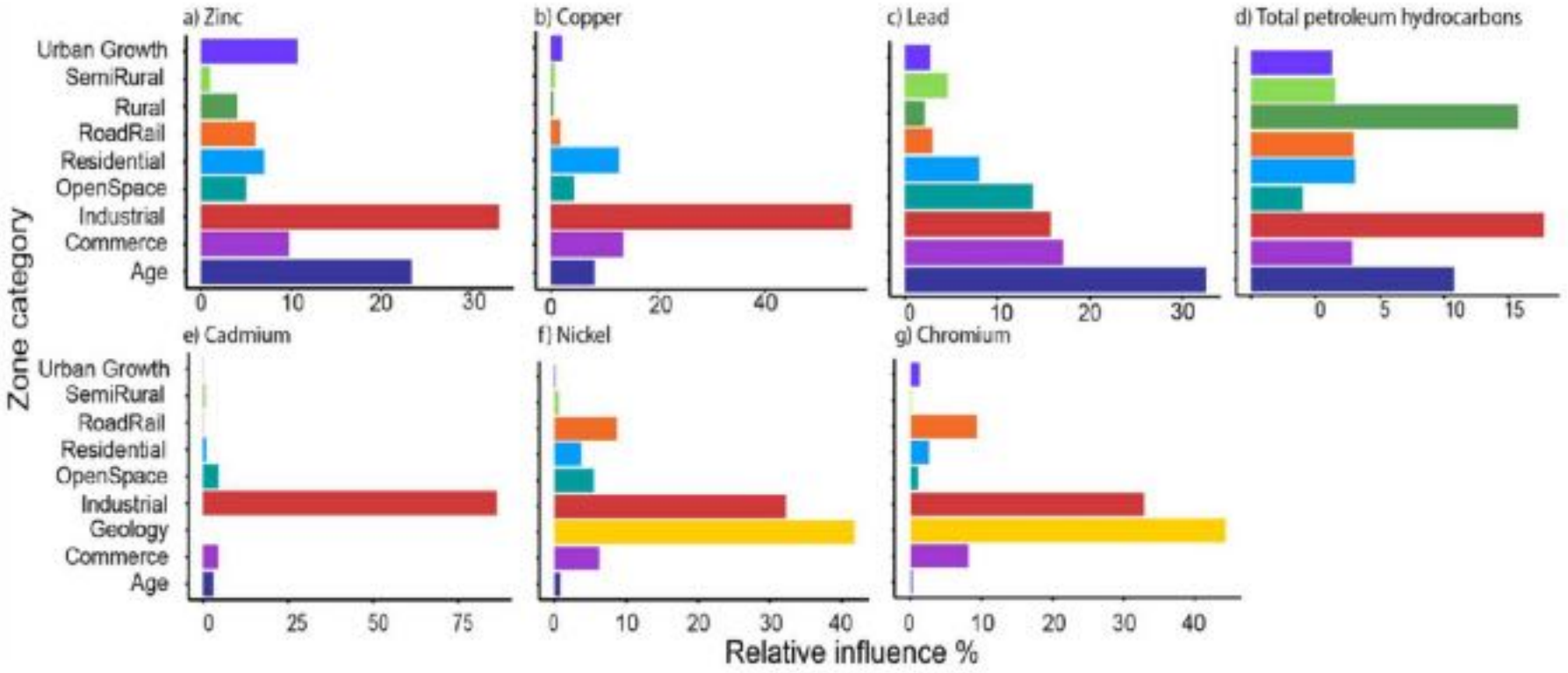
As urbanisation increases so does pollution levels in aquatic ecosystems

Industrial pollution is a major problem

Pollution from industrial areas can be through:

- Lack of awareness
- Poor business practices
- Lack of trade waste arrangements
- Deliberate dumping

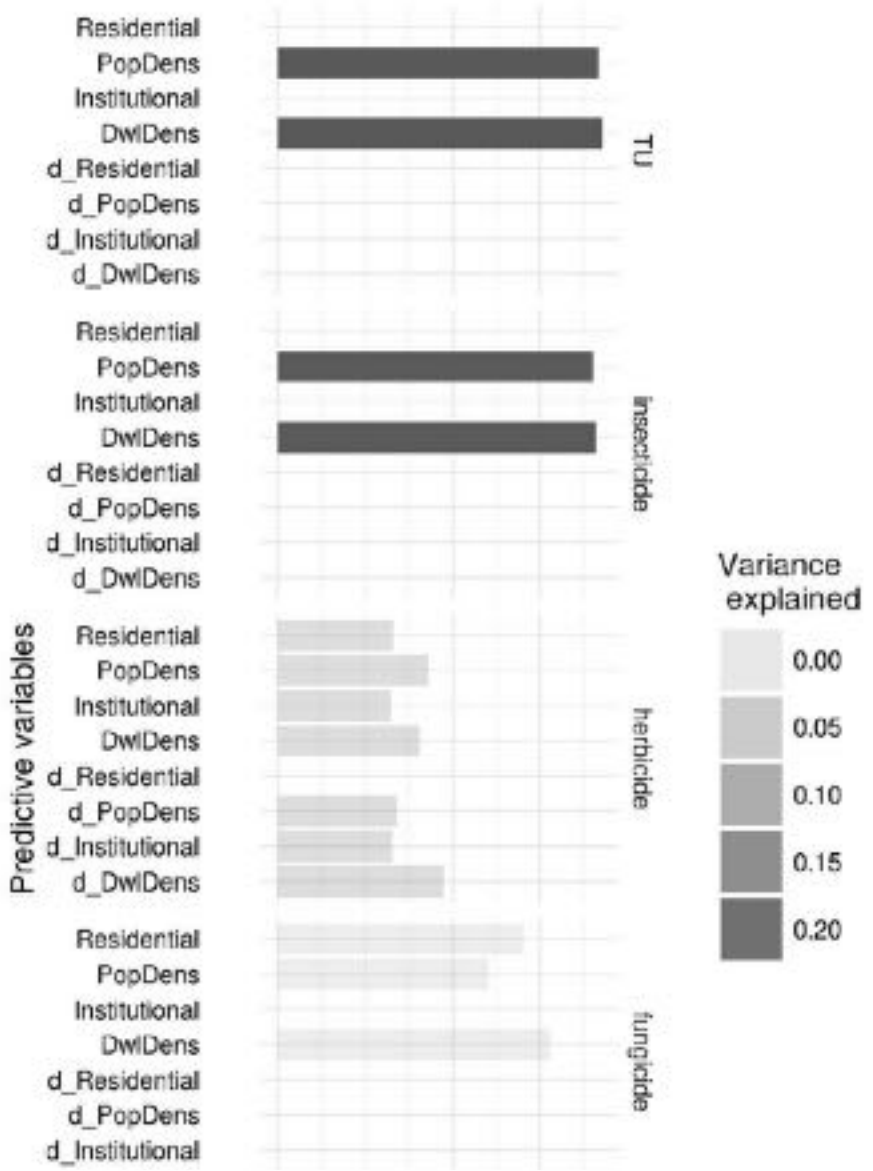
Sediment Pollution ~ Land Use changes 2011 - 2016

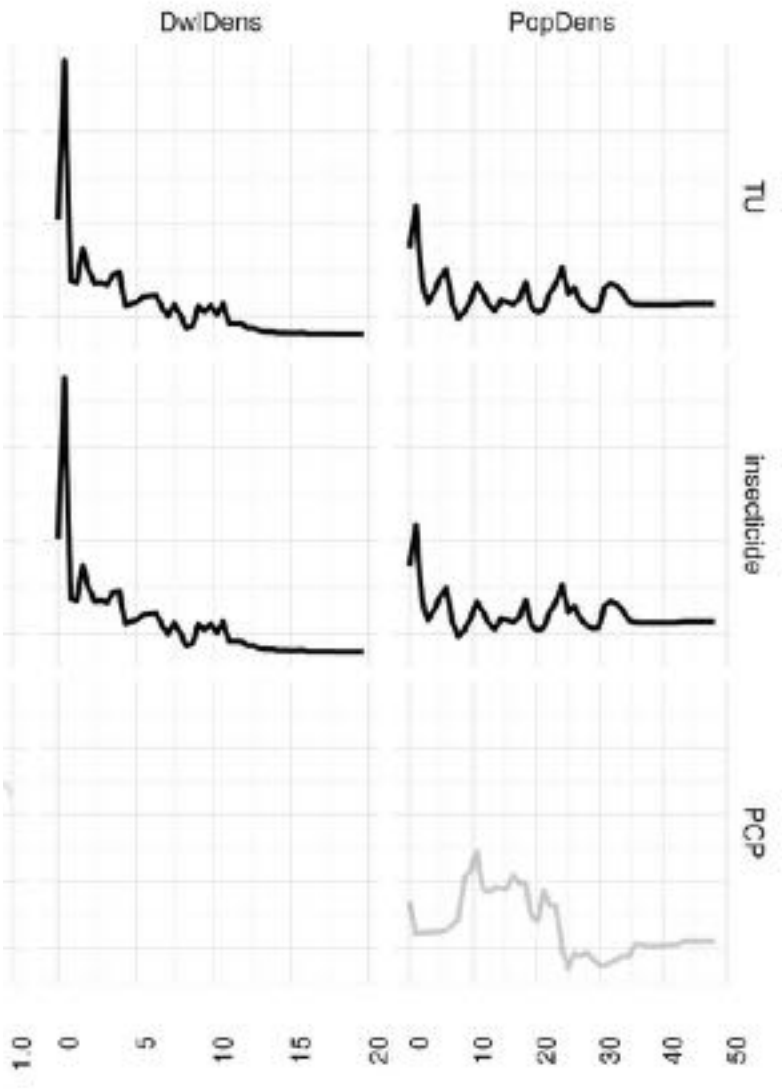


Predictive modelling

As industrial area exceeds 10% of a catchment, pollution significantly increase in waterways - Sharley et al 2017.

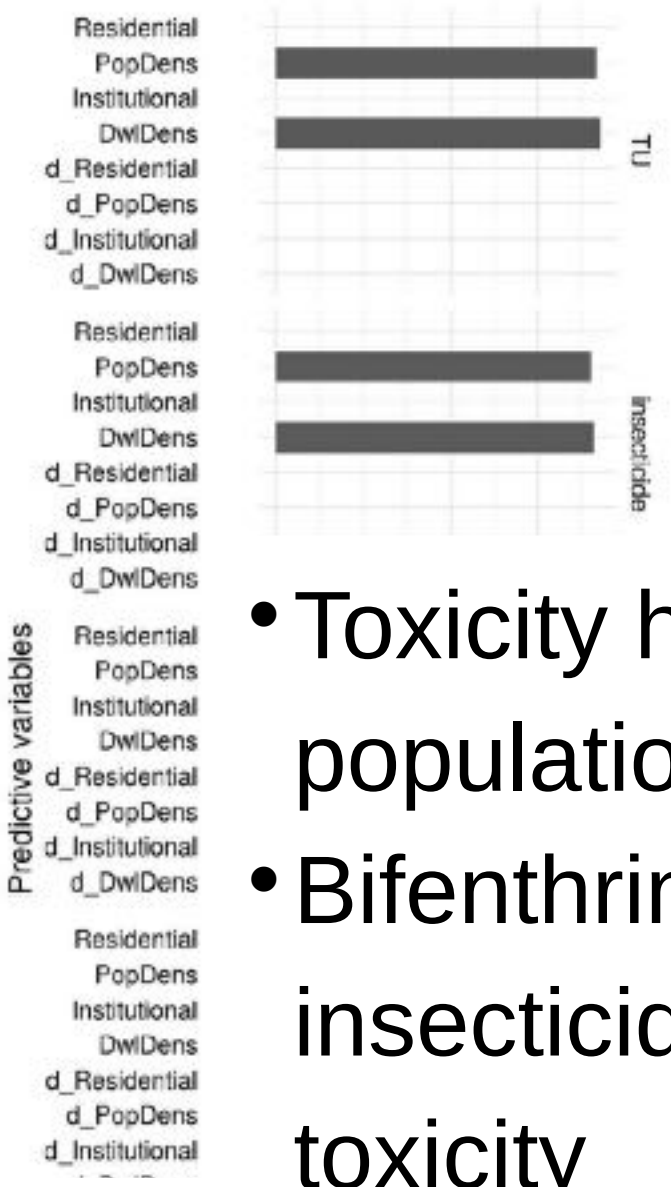
Sediment Toxicity ~ Population Demographics 2011 - 2016

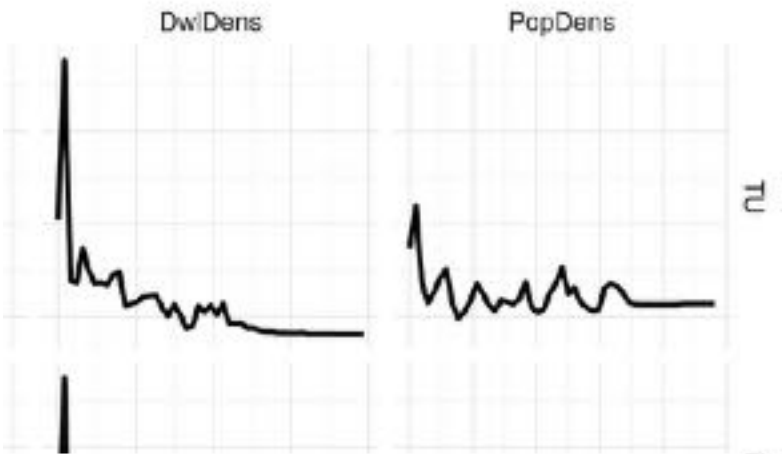




Marshall, S., Sharley, D., Jeppe, K., Sharp, S., Rose, G., and Pettigrove, V. (2016). Potentially toxic concentrations of synthetic pyrethroids associated with low density residential land use. Frontiers in Environmental Science 4, 75.

Sediment Toxicity ~ Population Demographics 2011 - 2016





- Toxicity highest in low-density, low population catchments
- Bifenthrin (synthetic pyrethroid insecticide) was the major cause of toxicity

Marshall, S., S
pyrethroids as

Stormwater pollution profiling

- Stormwater can be profiled for several common pollutants
- Specialised samplers can be deployed into the stormwater at numerous locations
- Allows high risk drains to be identified, and point sources to be investigated
- Education and enforcement programs can then target areas responsible for the pollution

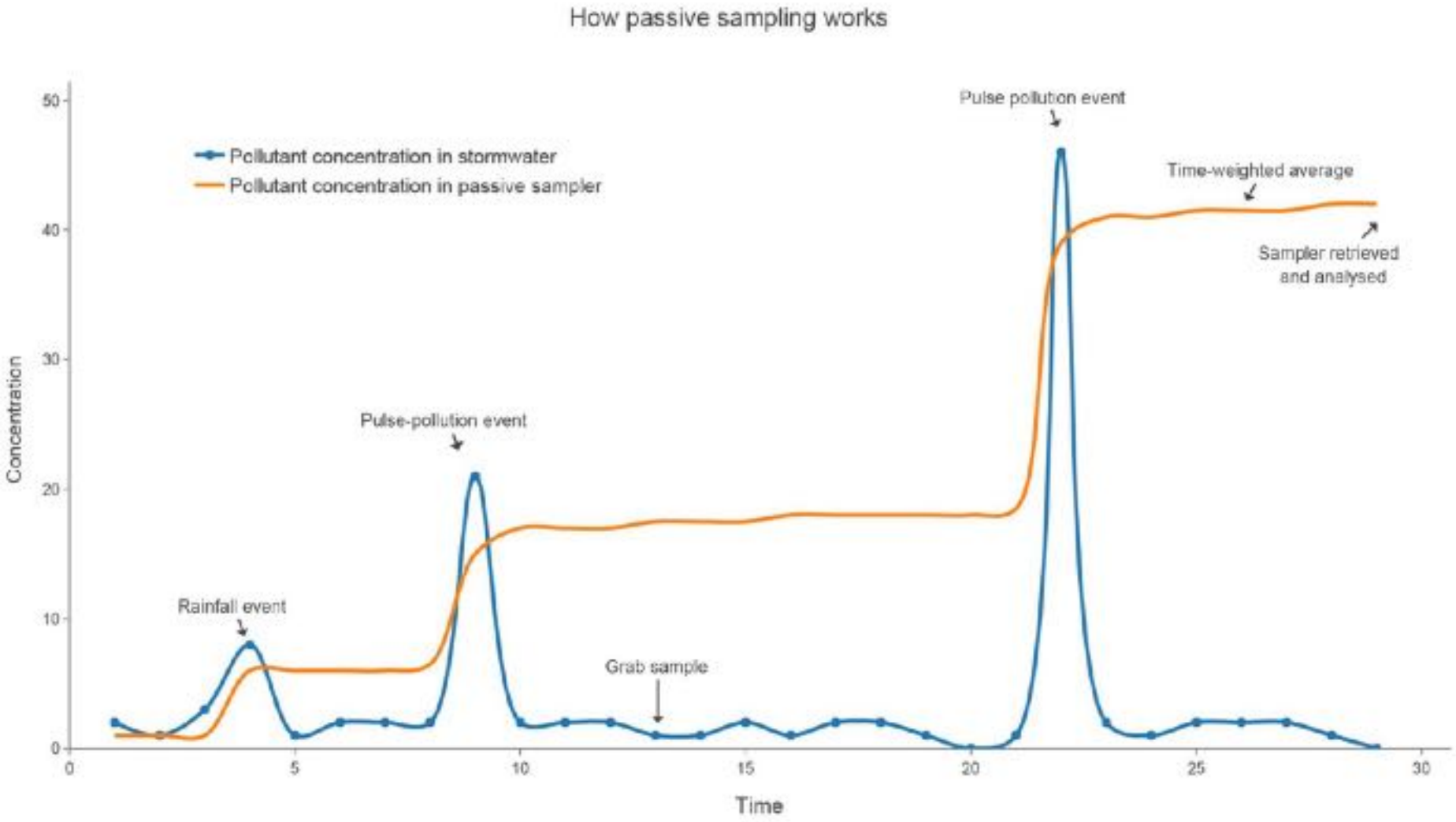
The problem with traditional stormwater sampling

- Contaminant concentrations vary over time – pulse pollution events
- Analysis of many grab samples to characterise water quality is very expensive.
- Pollutants are often not dissolved, but are attached to fine particles suspended in the water
- Auto-sampling is expensive and requires power at every site.

ISCO battery-powered automated water sampler

StormScout Technology

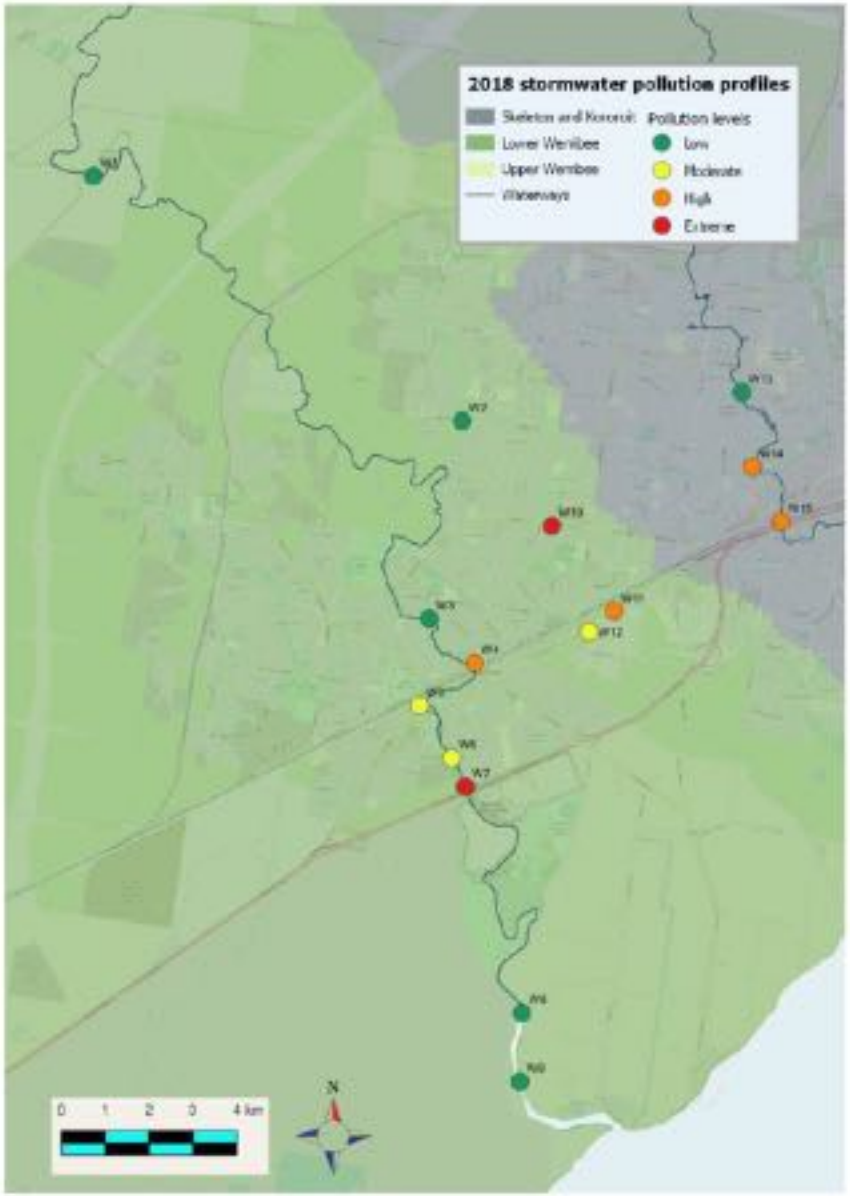
- StormScout samplers allow:
  - Episodic events to be captured
  - No power required
  - Very cost-effective
  - Allow multiple samplers to be deployed across a catchment at the one time


How passive sampling works
Pollutant concentration in stormwater
Pollutant concentration in passive sampler
Pulse pollution event
Time-weighted average
Sampler retrieved and analysed
Pulse-pollution event
Rainfall event
Grab sample
Concentration
Time
0
10
20
30
40
50
0
5
10
15
20
25
30

Werribee Stormwater pollution profiling

Results

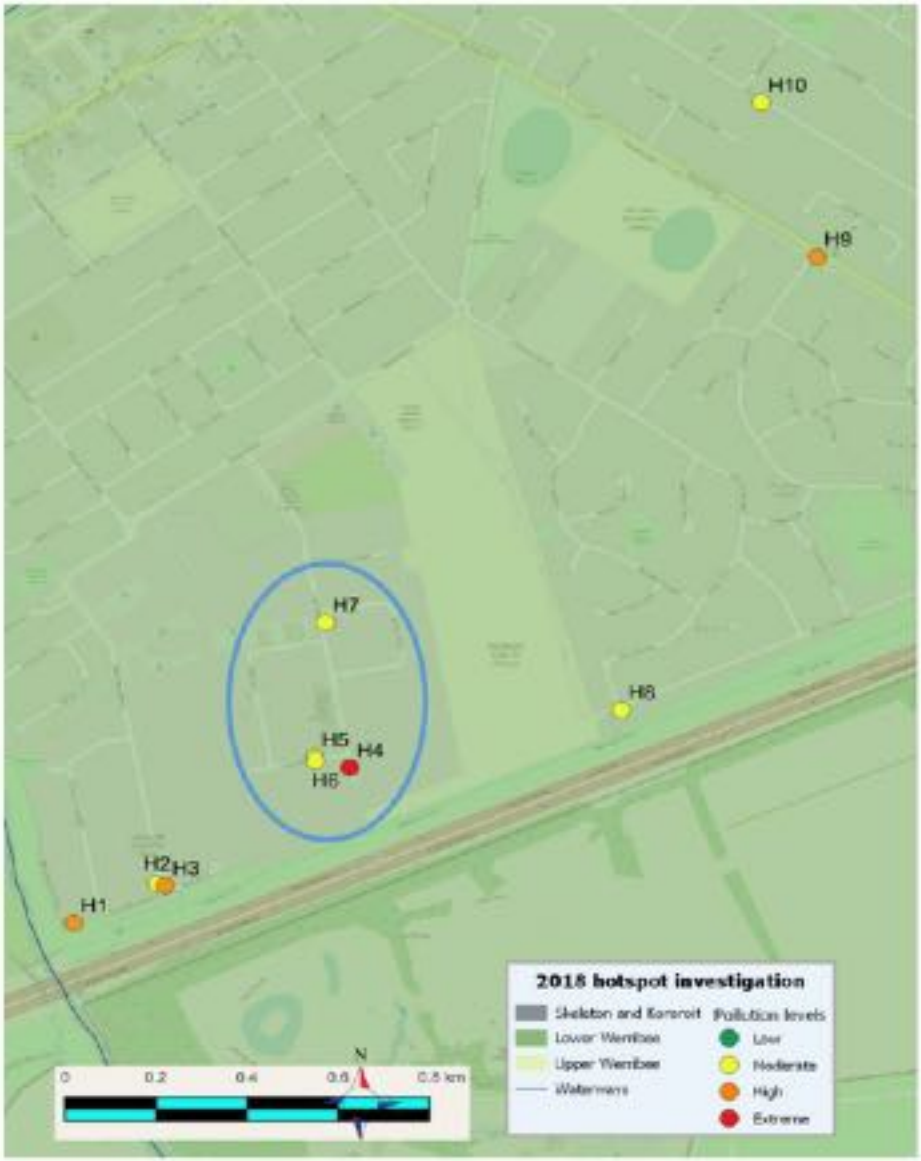
- Pollution levels varied throughout the catchment
- High levels of pollution followed a similar pattern to sediment pollution
- Urban and industrial areas had the highest levels of stormwater pollution
- The Maltby Industrial area had the highest pollution levels



Hotspot investigation with EPA Victoria and WRA

Results

- Ten stormwater drains in the Maltby Industrial catchment were profiled to identify high pollution risk areas
- Heavy metals and hydrocarbons were identified as the major chemicals of concern



Hotspot investigation with EPA Victoria and WRA

Results

- EPA (OPLE program) and the Werribee River Association conducted an education program throughout the pollution hotspot area
- Response from business owners was positive
- Many business owners indicated they would try to do better in reducing runoff from their premises

WERRIBEE RIVER ASSOCIATION

EPA VICTORIA Environment Protection Authority Victoria

Dear Business Owner / Manager

Re: Pollution of stormwater entering Werribee River

The Werribee River Association (WRivA) is a local not-for-profit organisation, which works with the community to improve the health of the Werribee River. We have been conducting a project to find where contaminants are entering the Werribee River.

The monitoring has revealed that the stormwater coming from the northern section of Lock Avenue (including Merchants Court and the northern section of Geres Court) is high in Total Petroleum Hydrocarbons (TPH) and contains moderate levels of zinc and lead.

WERRIBEE RIVER ASSOCIATION

EPA VICTORIA Environment Protection Authority Victoria

Werribee River Association is therefore partnering with the Victorian EPA to provide education and information to businesses such as yours. Please make sure that all your employees follow requirements in the attached guidelines.

Your willingness to participate in this program is very much appreciated.

We will be undertaking further testing of the stormwater drain in the next six months and will let you know the results if interested. If further testing shows that hydrocarbons and metal levels continue to be high EPA will be undertaking formal inspections of premises in this area.

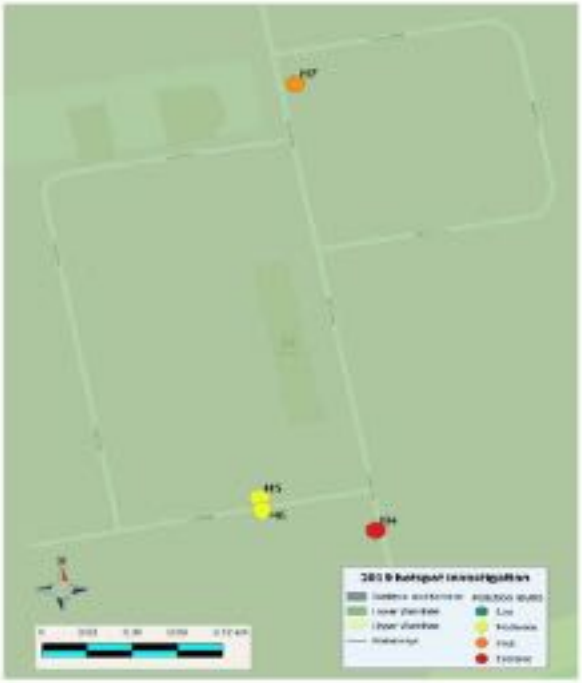
If you have any further questions or would like some advice please feel free to contact Teresa Mackintosh on 0432 478 033 or teresa.mackintosh@werribeeriver.org.au or Michelle Walker at michelle.walker@epa.vic.gov.au

The Werribee River is a valuable natural asset, providing an important habitat for many animals and plants. Reducing pollution from stormwater inputs into the river, will help us protect this important waterway for generations to come.

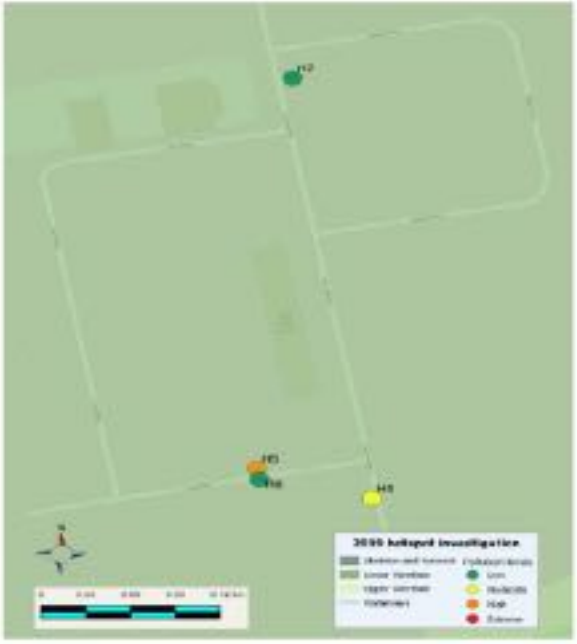
EPA and WRA education program was successful

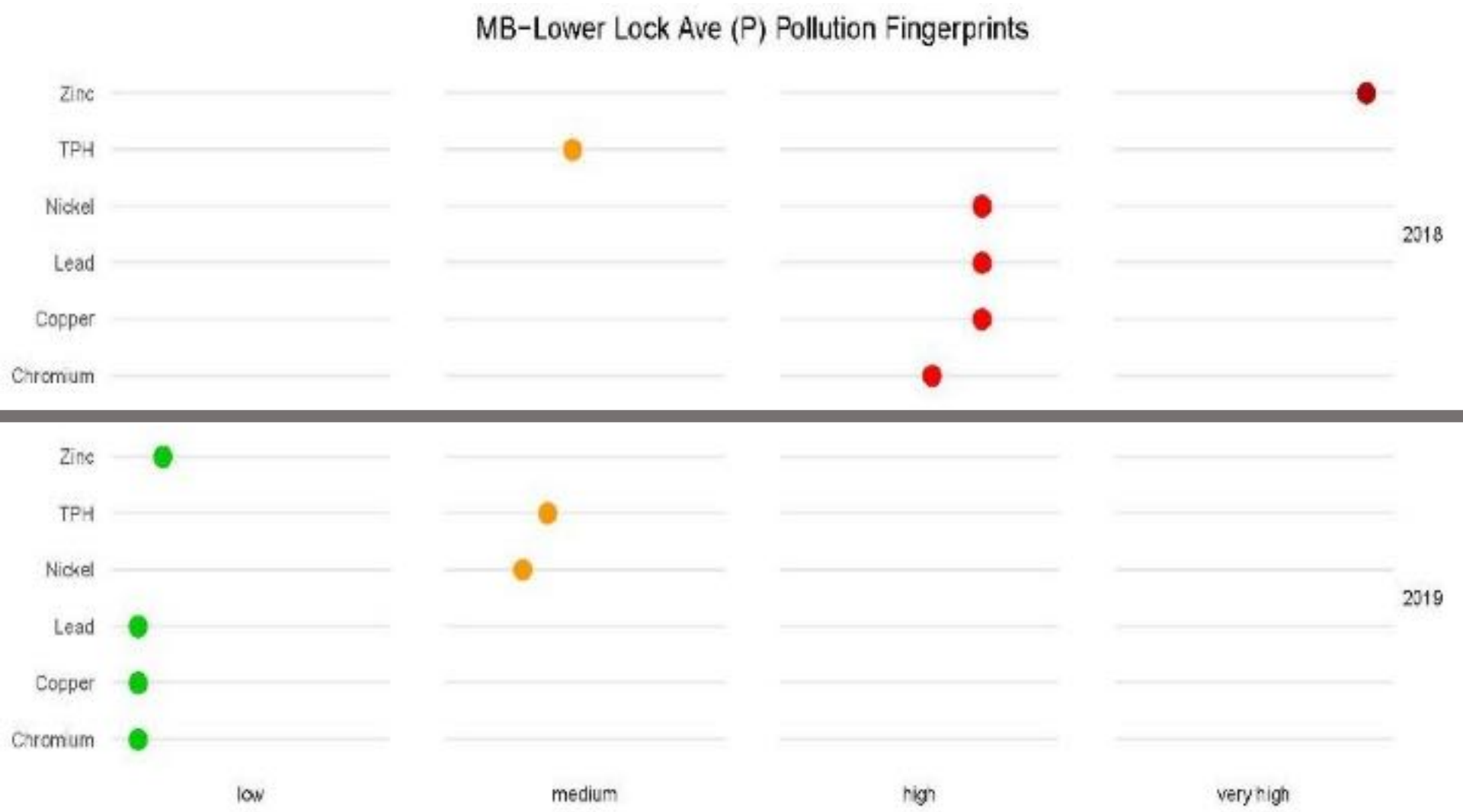
- Stormwater was profiled again six months after the education program
- Stormwater pollution significantly decreased after the education program
- On-going stormwater education is critical in reducing long-term stormwater pollution

Before



After





https://bio2lab.shinyapps.io/WerribeeRiverCatchment/

Pollution did increase at one site (H5)

- Increased pollution linked to poor business practices and illegal discharges in the area
- EPA was notified and enforcement action commenced with a **pollution abatement notice** issued

Community Engagement: 1. Biological Monitoring

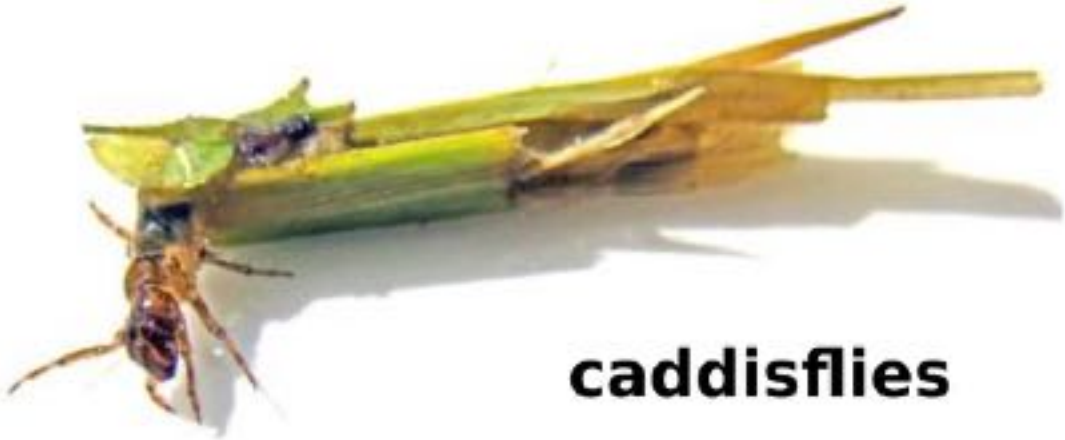
Biological monitoring to assess ecological condition of waterways

- Invertebrates are great indicators of waterway health and ability for ecosystems to support fish and playtypus
- Invertebrates are abundant
- Widespread – can compare across sites
- Range of sensitivities to pollution
- They respond to environmental changes

Invertebrate diversity

Biodiversity survey

- Sensitive



caddisflies

stoneflies

mayflies

Invertebrate diversity

Biodiversity survey

- Tolerant

midge larvae

waterboatmen

Biological monitoring to assess ecological condition of waterways

- Macroinvertebrate surveys were conducted at sites where sediment was collected
- Numerous indexes were assessed
  - SIGNAL
  - No. of families

Macroinvertebrate health

Identifying chemicals of concern

Sediment Ecotoxicology

In situ Microcosms

Ecological Impact of Pollutants

- Death
- Population changes
- Loss of species
- Reproduction

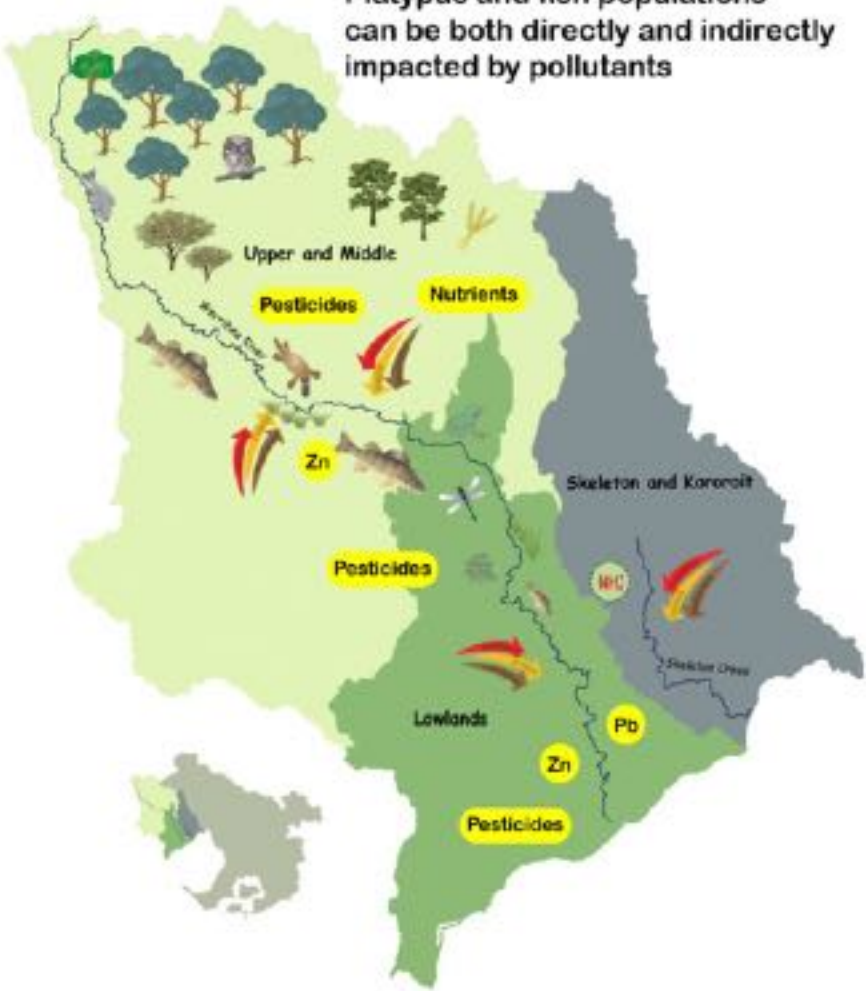
- Death - Oil and litter
- Liver damage
- Loss of food (insects)
- Reproduction

- Death - chemicals
- Liver and gill damage
- Loss of food (insects)
- Reproduction

- Liver damage
- Loss of habitat
- Loss of food (fish)
- Reproduction

Foodweb impacts

Platypus and fish populations can be both directly and indirectly impacted by pollutants



Community training in biological assessments

- Community members were trained to conduct macroinvertebrate surveys
- Volunteers were also trained in insect identification
- On-site training also included information on how biological assessments can be used to identify pollutants of concern

School education and awareness programs

Reducing litter impacts on our waterways

- Drone technology to identify litter hotspots in the Werribee Catchment
- On-ground litter surveys and community collection days

Improve business practices

Solutions to a cleaner waterway

- Capture all waste
- Use spill kits

- Use waste trays
- Dispose of waste through EPA approved contractor

- Store drums with lids on and undercover
- Permanent Bunding for long term storage
- Covered work areas

- Wash vehicles and parts away from stormwater
- Use registered waste disposal service
- Use portable bunding when spills occur

- Recycle where applicable
- Segregate waste
- Trade waste?
- Have MSDS available for all chemicals

Education and awareness programs are essential

Lets reduce our reliance on expensive stormwater management and stop pollution at its source

We can all do our bit to stop pollutants from entering aquatic ecosystems

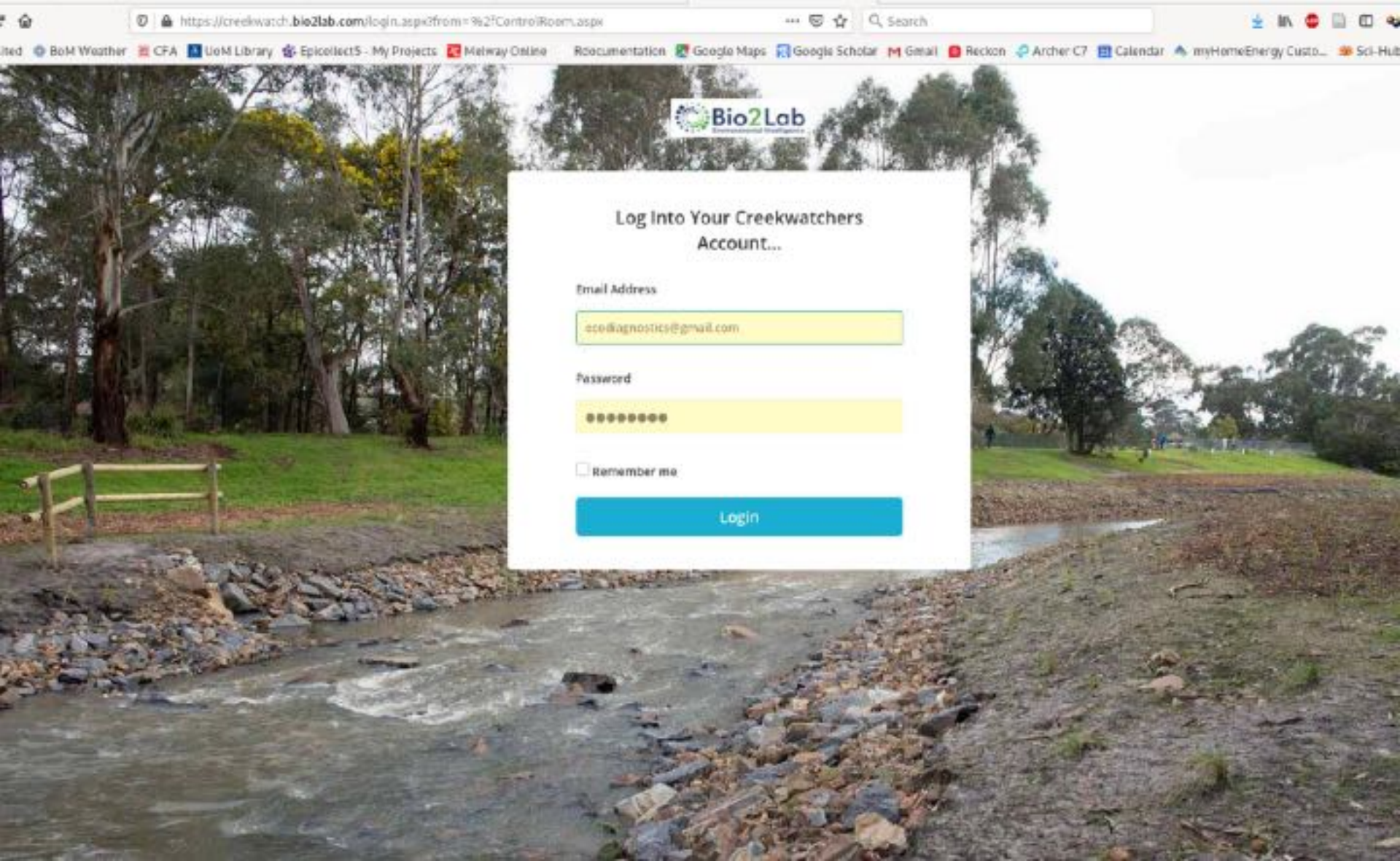
Here are some of the things we can all do to prevent stormwater pollution:

- Dispose of rubbish properly and pick up litter
- Reduce pesticide use and follow directions
- Don't dump chemicals into stormwater or waterways
- Scoop poop
- Clean spills immediately
- Reduce our reliance on cars

Bio2Lab

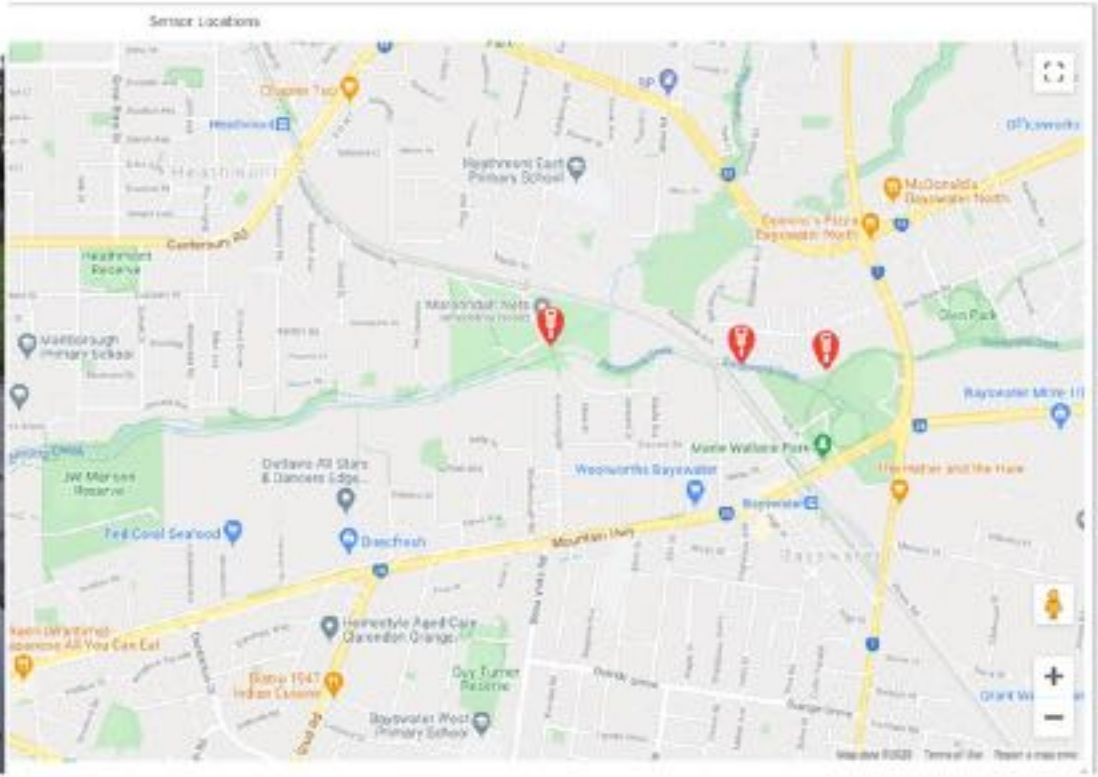
For more information on stormwater pollution visit bio2lab.com.au

Community Engagement: 2. Water Quality Monitoring: https://creekwatch.bio2lab.com

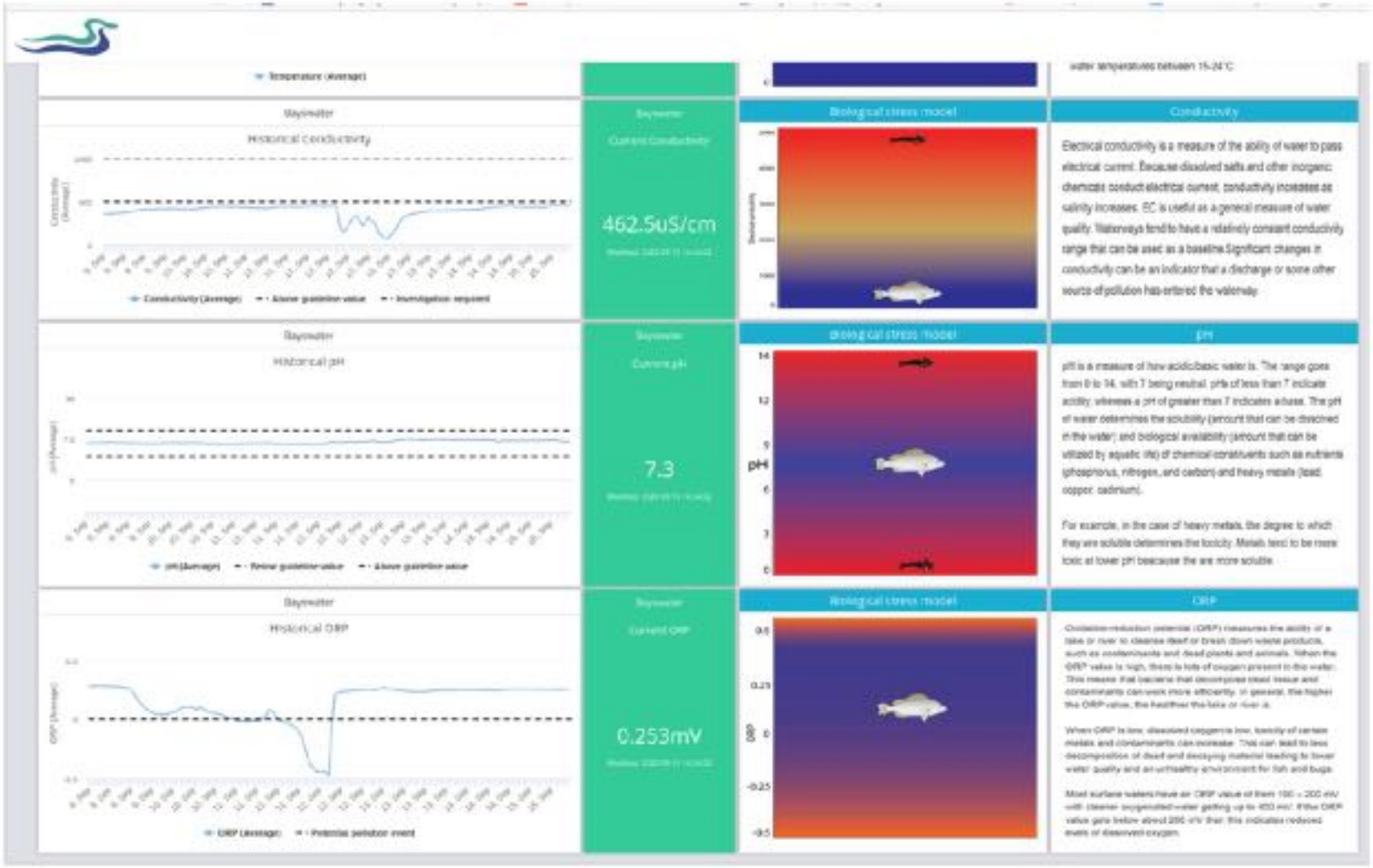


An interactive water quality monitoring program along Dandenong Creek

First Friends of Dandenong Creek, via a federal funding grant for community environment groups

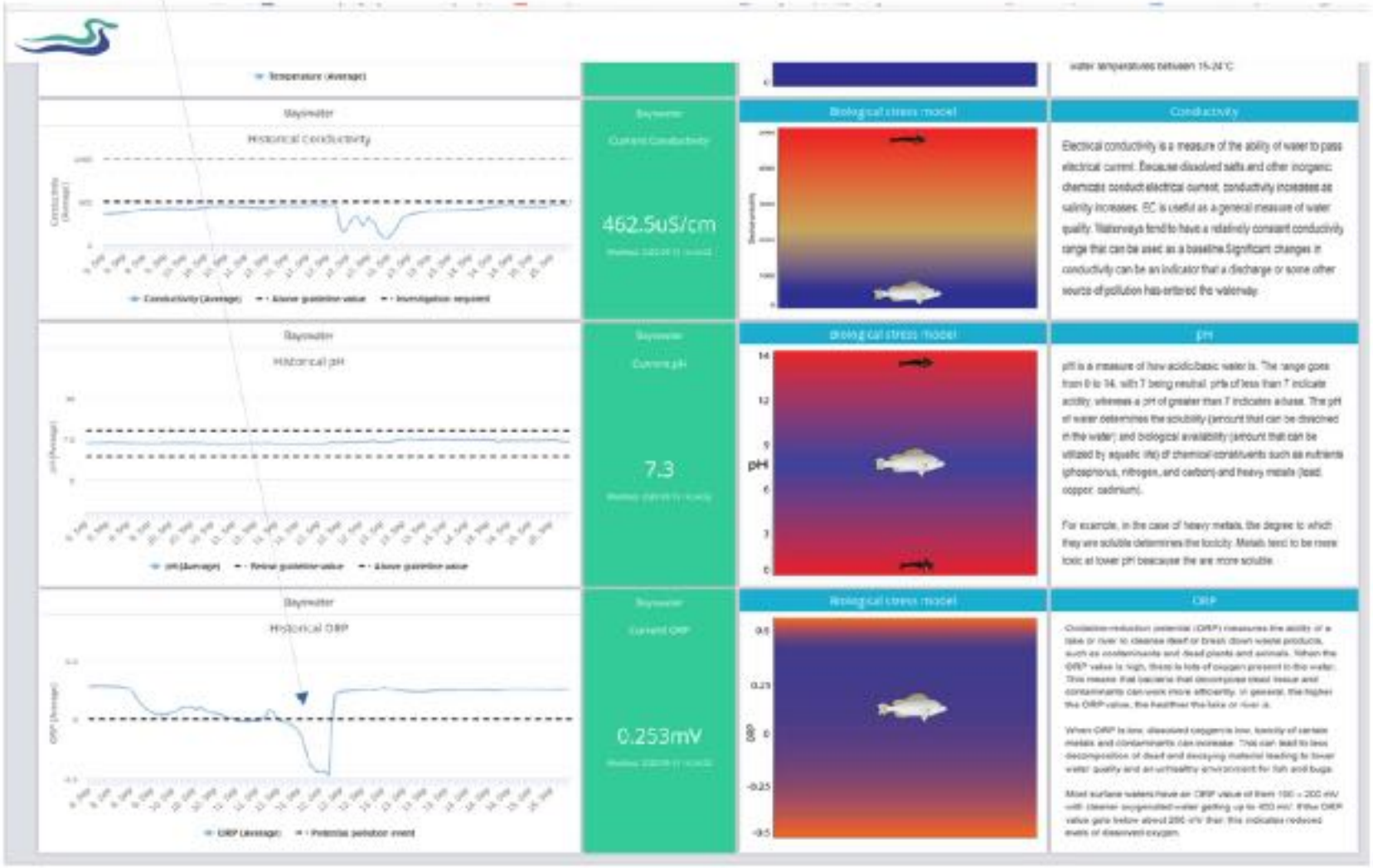


Bayswater Monitoring Station – just below Old Joes Creek



Friday night – possible pollution event

Bayswater Monitoring Station – just below Old Joes Creek



QUESTIONS?

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