MELBOURNE WATERWAY RESEARCH & PRACTICE PARTNERSHIP

Conducting and applying research for the improved management of Melbourne's waterways

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The MWRPP is a collaboration between Melbourne Water and the University of Melbourne to conduct and apply research to improve Melbourne's waterways. The research is focused on the drivers of waterway ecosystem condition and aims to support Melbourne Water's prioritisation and implementation activities.

RESEARCH THEME ONE:	RESEARCH THEME TWO:	RESEARCH THEME THREE:	RESEARCH THEME FOUR:	RESEARCH THEME FIVE:
models of ecological response...will develop large-scale models to identify the factors which drive waterway health in rural and urban areas. (read more).	**flow and water quality management**...will develop and test new techniques that mimic natural processes to improve flow restoration and filtration. (read more).	**catchment-scale interventions**...will test and demonstrate the effectiveness of dispersed, catchment-scale stormwater retention, treatment and harvesting. (read more).	**assessment of stream management activities**...will undertake experiments and develop models to assess the effectiveness of interventions at different scales. (read more).	**community engagement**...identify the most effective ways of engaging community involvement in the protection of waterways in their catchments. (read more).

Theme 1
Ecological response models and prioritization

1.1: High-resolution land cover datasets and rainfall-runoff models

1.2: Ecological response models

1.3: Spatial prioritization of waterway management for biodiversity outcomes

1.4: Refining hydrologic prediction in ungauged catchments

(1.5: Status of baseflows in urban streams)

Spatial planning tools to support river-health investment

1.1: High-resolution land cover datasets and rainfall-runoff models

1.2: Ecological response models

1.3: Spatial prioritization of waterway management for biodiversity outcomes

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Spatial planning tools to support river-health investment

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Spatial planning tools to support river-health investment

1.3: Spatial prioritization of waterway management for biodiversity outcomes

Tools to guide where investment in management actions will provide greatest biodiversity outcomes for least cost

Such tools rely on....

1.2: Ecological response models

Spatial planning tools to support river-health investment

1.3: Spatial prioritization of waterway management for biodiversity outcomes

1.2: Ecological response models

Spatial planning tools to support river-health investment

1.3: Spatial prioritization of waterway management for biodiversity outcomes

1.2: Ecological response models

Existing models (bugs and fish) – ensure scientific validity
– communicate in plain language
– tools to use the models

Develop new models – other values
– better predictor variables

New predictor variables….

Stream temperature, and… variables derived from…

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Stream temperature, and… variables derived from…

1.1: High-resolution land cover datasets and rainfall-runoff models

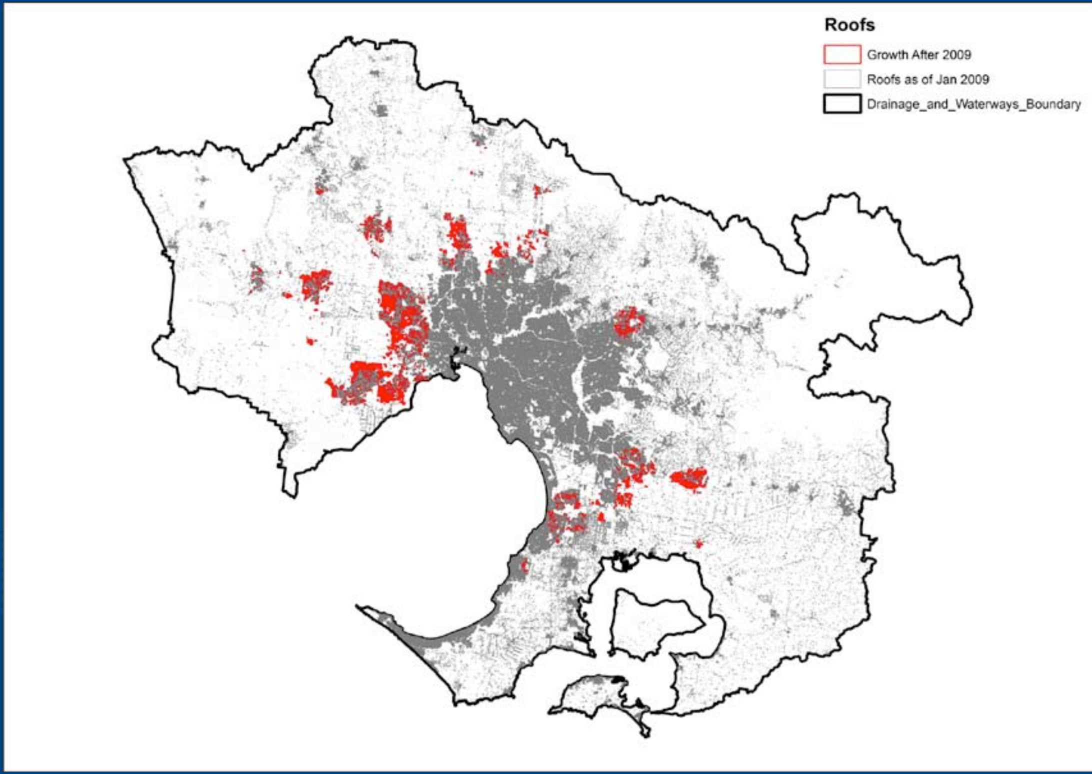
1.1: High-resolution land cover datasets and rainfall-runoff models

Chris Walsh, Jasper Kunapo,

Zoltan Kelly & Matt Burns

THE UNIVERSITY OF MELBOURNE | WATERWAY ECOSYSTEM RESEARCH GROUP

Melbourne Water



1.1: High-resolution land cover datasets and rainfall-runoff models

Objectives:

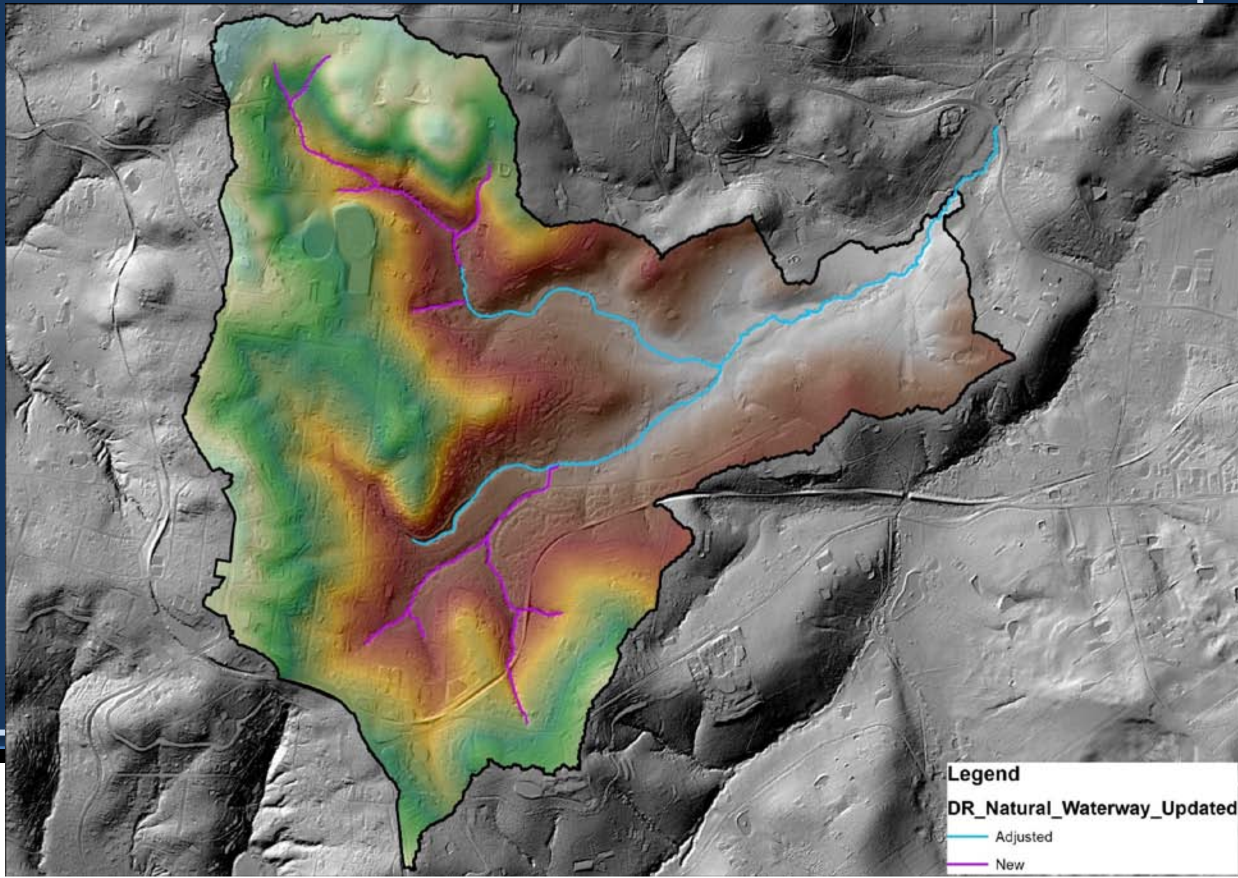
To develop a high-resolution land cover dataset for the Melbourne Water region, linked to spatially explicit hydrologic models

To develop a library of historic and predicted future maps

1.1: High-resolution land cover datasets and rainfall-runoff models

Progress to date: Methods for classification of streams developed for LSC

Gridded rainfall compiled and rainfall-runoff models being prepared



1.1: High-resolution land cover datasets and rainfall-runoff models

Progress to date: Methods for classification of streams developed for LSC

Gridded rainfall compiled and rainfall-runoff models being prepared

Roofs and trees mapped (from LiDAR data)

for the whole region –

for 2009 and

(an unplanned bonus) 2013.

Water bodies also mapped

1.1: High-resolution land cover datasets and rainfall-runoff models

Rest of year 1:

Mapping of roads and other impervious surfaces to be completed by end June.
Mapping of other pervious surfaces to be completed by end July
Classification of the regional stream network by September

Next:

Delineation of new subcatchments, and distance attributes applied to all surfaces (required for next gen weighted land-use mapping)

Library of historic and future maps

1.1: High-resolution land cover datasets and rainfall-runoff models

Outputs and adoption

Final product is eagerly awaited by diverse teams within MW (e.g. pricing and regulation, water supply resourcing) and outside (e.g. CAPIM, OLV).

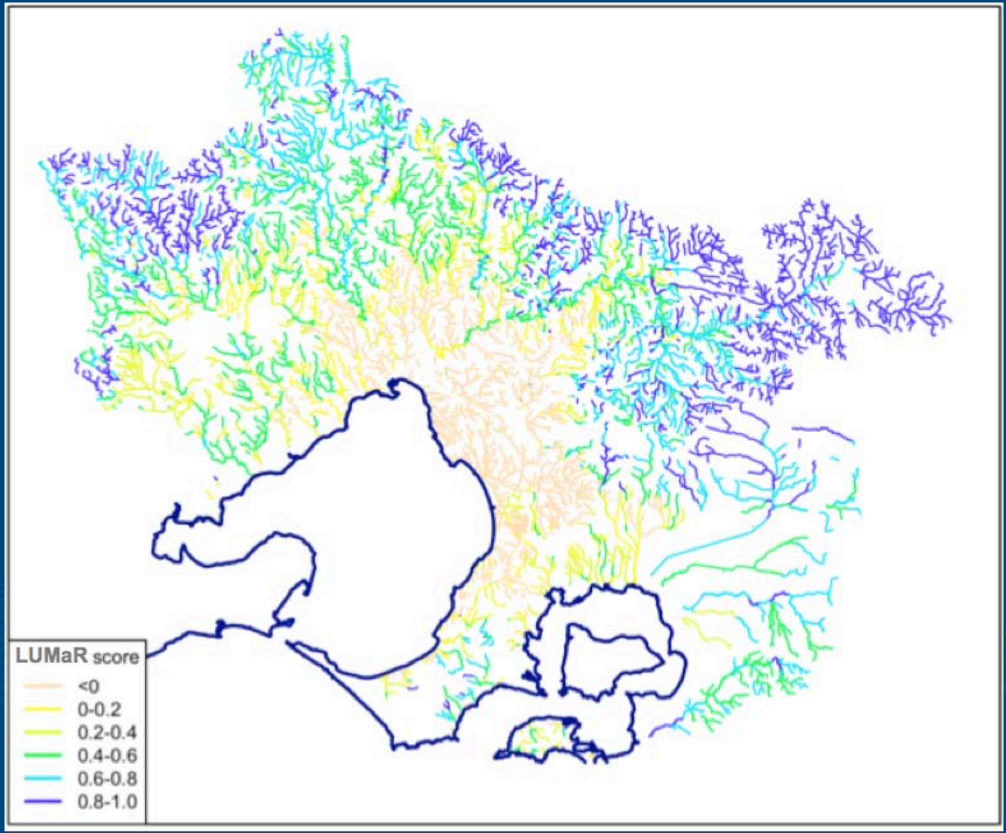
1.2: Ecological response models

Chris Walsh, Nick Bond,

Joe Greet & Sharyn Rossrakesh

WATERWAY ECOSYSTEM RESEARCH GROUP

Melbourne Water



1.2: Ecological response models

Objectives:

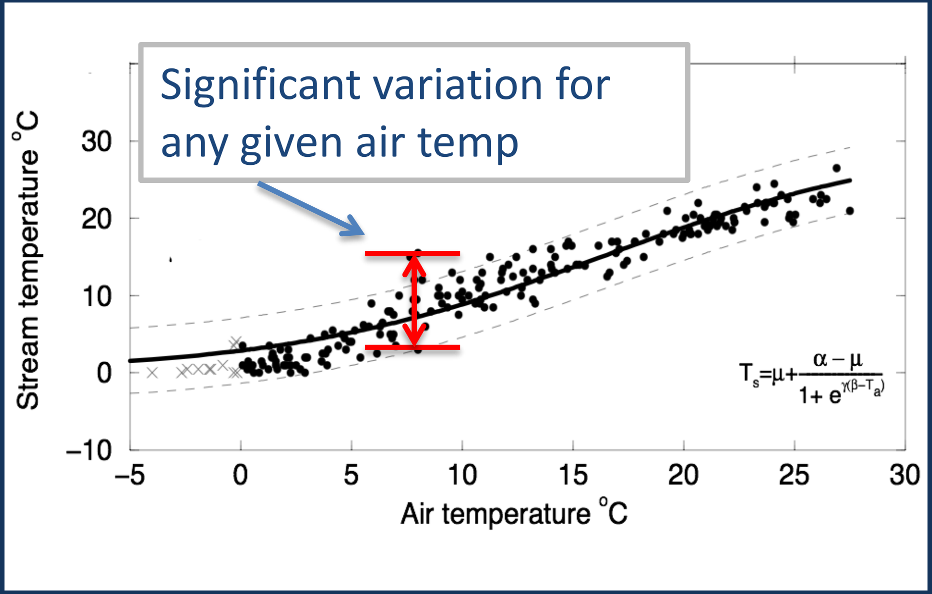
a) predictive models for stream temperature across the region
b) communication products from the macroinvertebrate, fish and temperature modelling work that has been conducted in the last year (web-based tools, peer-reviewed publications)

Next:

a) new spatial weighting methods and predictor variables as the new spatial data becomes available
b) New models incorporating new variables
c) New models for other species

Enhanced prediction of stream temperature

- Thermal tolerances a major constraint on species distribution patterns.
- Typically rely on coarse climate layers that ignore factors such as flow, riparian cover etc.
- Goal of this work is to develop improved predictive capacity of local water temperature to support biological predictions

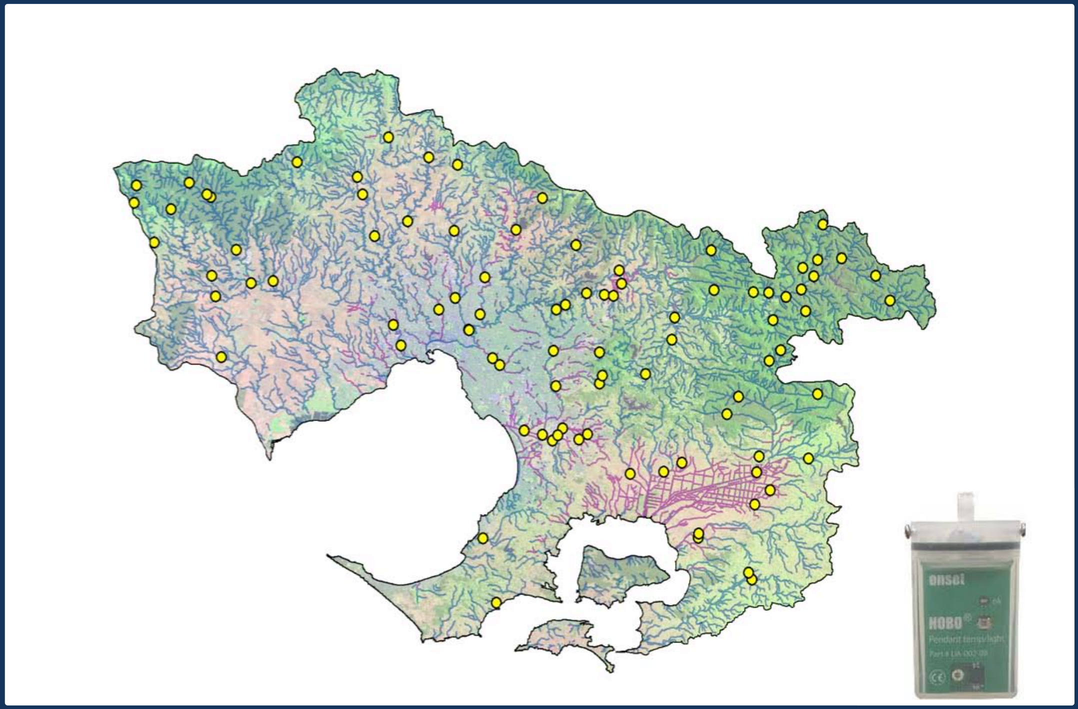


Morrill et al. 2006

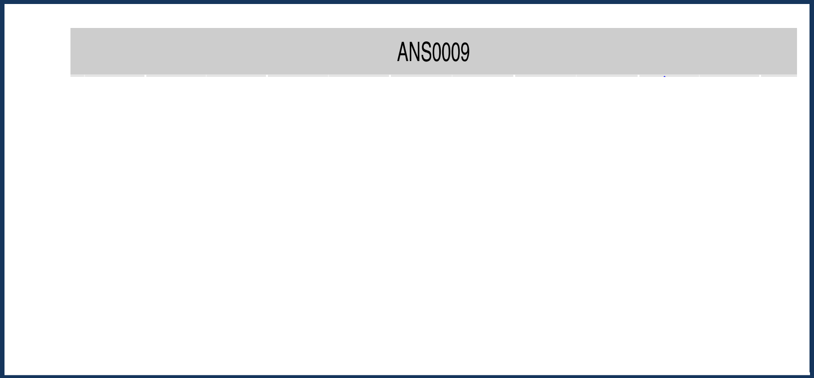
Temperature logging network

- 70 loggers deployed across Melbourne
- 15 minute logging interval
- Sites selected using sophisticated 'spatially-balanced' survey design algorithm
- 18 months of continuous data

Logger locations



Data wrangling!



- Challenging data management exercise (several million data points)
- Currently cleaning data (missing values, spikes etc)
- Almost ready to develop predictive models

Longer-term potential

- Loggers now deployed for another 12 months.

- Total cost of field program and data curation ~$30K pa

- Potentially very cost effective complement to other monitoring programs, especially over the longer-term in addressing thermal pollution, climate-change impacts etc.

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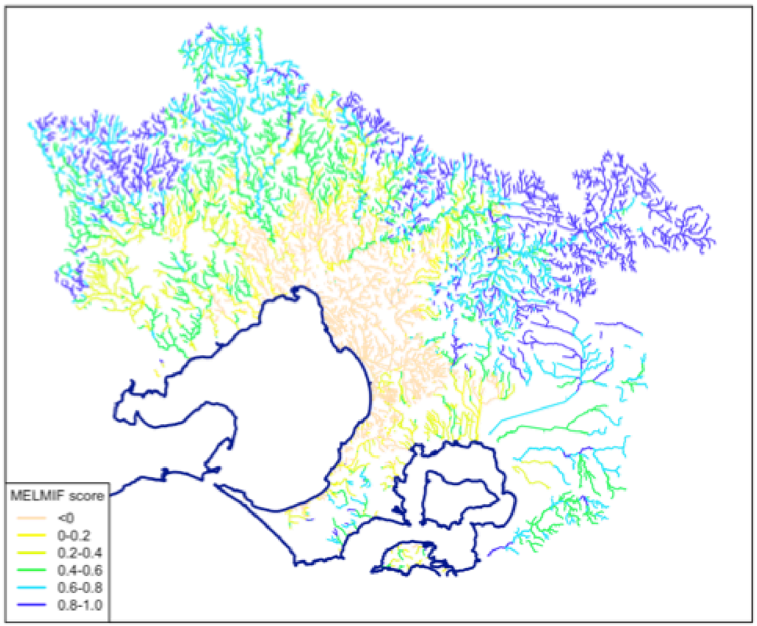
Ensuring scientific validity (the bugs story)

Predicting stream macroinvertebrate assemblage composition as a function of land use, physiography and climate:

a guide for strategic planning for river and water management in the Melbourne Water management region.

Christopher J. Walsh and J. Angus Webb
(Chapter 2 by Christopher J Walsh, J Angus Webb, and Alistair Danger)



Report 13-1

Melbourne Waterway Protection and Restoration Science-Practice Partnership
Department of Resource Management and Geography
The University of Melbourne

Journal paper 1:
Walsh and Webb (2014) Spatial weighting of land use and temporal weighting of antecedent discharge improves prediction of stream condition. *Landscape Ecology*

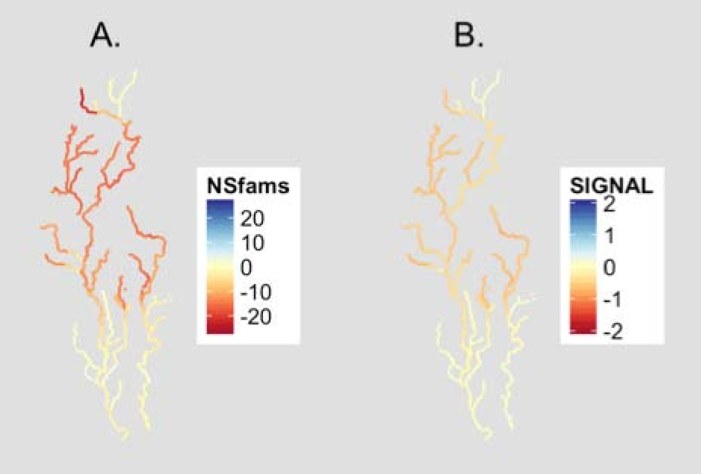
Leading to at least 3 other papers –
Distribution models of stream macroinvertebrate families predict interactive effects of urban stormwater drainage and forest loss
Can family level macroinvertebrate data adequately portray biodiversity loss in stream ecosystems?
Development of a new stream condition index from family distribution models.

Communicating what it all means to users

Possible ecological futures for Merri and Darebin creeks

Christopher J Walsh[1], Nick Bond[2], and Tim D Fletcher[1]

Melbourne Waterway Science-Practice Partnership
[1]*Department of Resource Management and Geography, The University of Melbourne*
[2]*Australian Rivers Institute, Griffith University*



A need for more accessible and targeted communication tools –
Fact sheets
Catchment-specific reports

Web-based tools –
To allow managers to

a) Determine what taxa should be in a reach
b) What taxa could be there under different scenarios
c) Use new biological data to assess the model predictions – could other factors be at play?

Use the predictions in a systematic way to prioritize management investment (1.3)

The next stages

Use outputs from 1.1 (& 1.4) to develop improved predictor variables

Develop improved models for macroinvertebrate families and fish species

Work with collaborators to develop similar models for other species (platypus, frogs)

All with the aim of producing a suite of predictions that can be used in systematic planning tools for managing multiple values.

Project 1.3. Spatial prioritization of waterway management for biodiversity outcomes

Project Leader: Nick Bond
Project coordinator: Graham Rooney

MU Project team: Chris Walsh, Myles Coker
MW Project team: TBC

Project aims

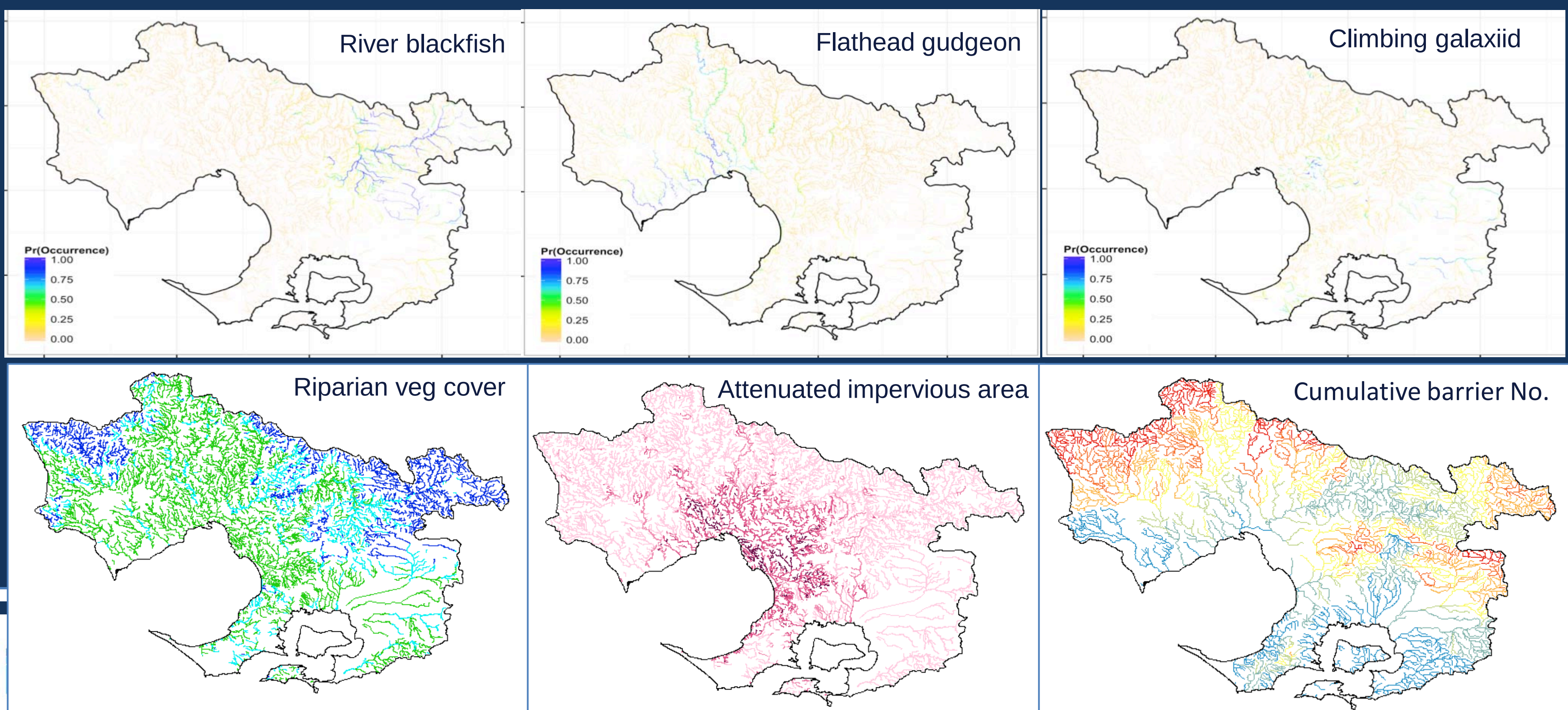
- Develop spatial planning tools to inform investment priorities for waterway protection and restoration

- Evaluate and build on existing *priority waterway* layers
- Incorporate outcomes into current strategy revision

- Draw on techniques/tools originally developed for systematic conservation planning

The challenge

- Multiple non-contiguous values, multiple management options, and spatial interactions among assets in terms of the values they can support



How do we set priorities?

- Simple rule based approaches
  - E.g. protect the best, no net loss etc.
- Scoring systems (e.g. WHIPS)
  - Score areas based on threats/values etc.
  - Incorporate high ranked areas
- Systematic approaches
  - Identify ‘sets’ of areas that achieve a target or maximise return on investment

Key principles of systematic approaches

– Complementarity – priority areas should be selected as a complementary set, where each area complements all the others.

– Efficiency – set of priority areas should achieve the intended goals or maximise outcomes for the least cost.

– CAR(E) – comprehensive/adequate/representative (efficient)

Systematic planning tools

- Several software tools available to perform systematic conservation planning
- Zonation – ranking of landscape features
- Marxan –target-based feature selection

- Constantly evolving to address perceived limitations in algorithm driven approaches
  - Connectivity, uncertainty, irreplaceability, flexible cost functions, multiple feature classes (e.g. species/communities), interactive modes etc.

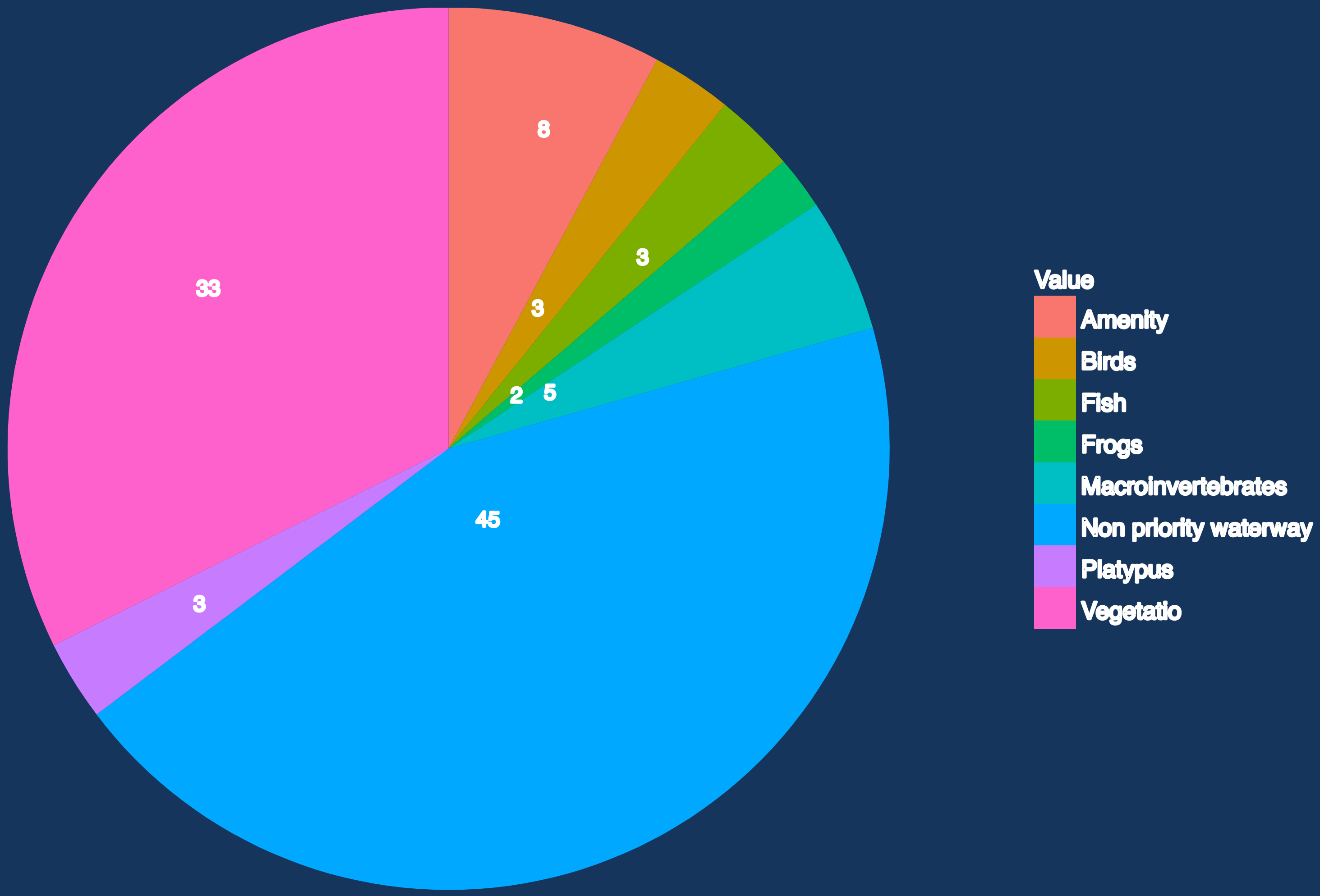
Basic data requirements for river networks

- spatially complete raster layers on the features of interest (e.g. species presence/absence, probability of occurrence, other attribute layers)

- Planning unit layer (typically identifying individual sub-catchments)

- Connectivity tables (defines catchment hierarchy
- Cost layers (penalty functions)
- Additional weightings (e.g. conservation status)

Progress so far… reviewing existing priorities



Progress so far… reviewing existing priorities

Looking ahead

- Collating relevant data layers
  - ~140 layers for invertebrates, ~40 layers for fish
  - Connectivity penalty functions
- Preliminary results will support workshops and more meaningful engagement/integration with MW programs
- Interaction with SAMPs team
- Broaden scope to incorporate additional values

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Theme 3
Catchment-scale interventions

3.1: Scaling up the hydrological consequences of site-scale stormwater control measures

3.2: Monitoring of stream response to catchment-scale interventions

3.3: Long-term performance and willingness to maintain distributed stormwater control measures

Project 3.1: Scaling up the hydrological consequences of site-scale stormwater control measures

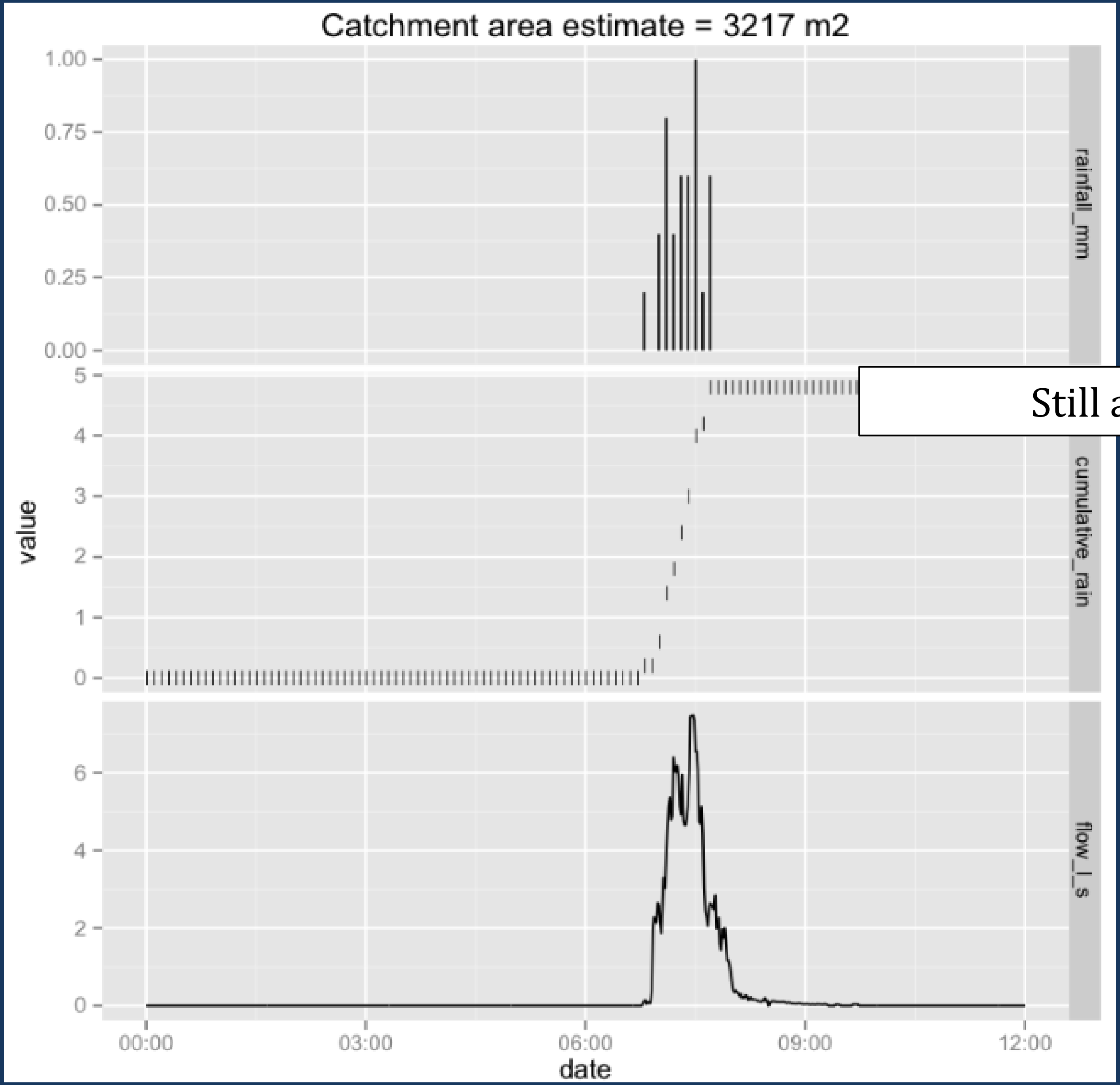
Matt Burns, Tim Fletcher, Hugh Duncan, Mike Sammonds, Jasper Kunapo, Justin Lewis and Marion Urrutiaguer

This project will examine the hydrological consequences of small scale stormwater measures at different scales…

It will provide guidance on the optimal scales and arrangements of measures to achieve waterway health outcomes

Heath Avenue, Mt Evelyn

What are the "streetscape-scale" hydrological implications of distributed rainwater tanks?



Still analyzing data…

Wicks Reserve, The Basin

What are the “precinct” scale hydrological implications of large systems?

Geomorphic implications of “releasing” trapped sediment

3.2: Monitoring of stream response to catchment-scale interventions

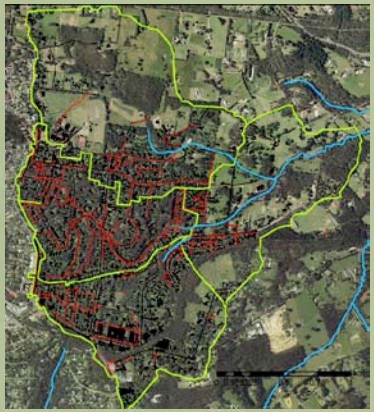
(AKA the Little Stringybark Creek and Dobsons Creek projects)

Current core team:
Chris Walsh,Tim Fletcher, Darren Bos, Sam Imberger, Genevieve Hehir, Mike Sammonds, Peter Poelsma, Rob James, Matthew Burns, Jeremie Bonneau

MW coordinator: Marion Urrutiaguer

Other team members: Helen Brown, Rhiannon Birch, Belinda Hatt, Toby Prosser, Sharyn Rossrakesh, Perrine Hamel, Julia White, Jemima Milkens, Helena Woollums, Jamie Tainton, Tommy Plachinski, Vjeko Matic, Beth Wallis, Marit Larson, Sophie Hestin and the people of Mt Evelyn

Objectives for and beyond the catchments

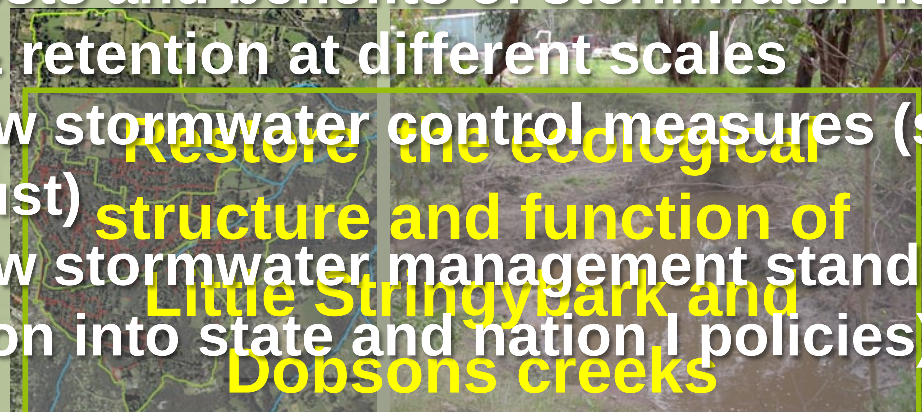


Little Stringybark Creek

Objectives for <u>and</u> beyond the catchments

Increase the adoption and effectiveness of new approaches to stormwater, urban water and stream management

1. **Alternative community engagement and incentive tools**
2. **Evaluate costs and benefits of stormwater harvesting, treatment & retention at different scales**
3. **Develop new stormwater control measures (simple, cheap, robust)**
4. **Develop new stormwater management standards (for incorporation into state and nation l policies)**



Little Stringybark Creek

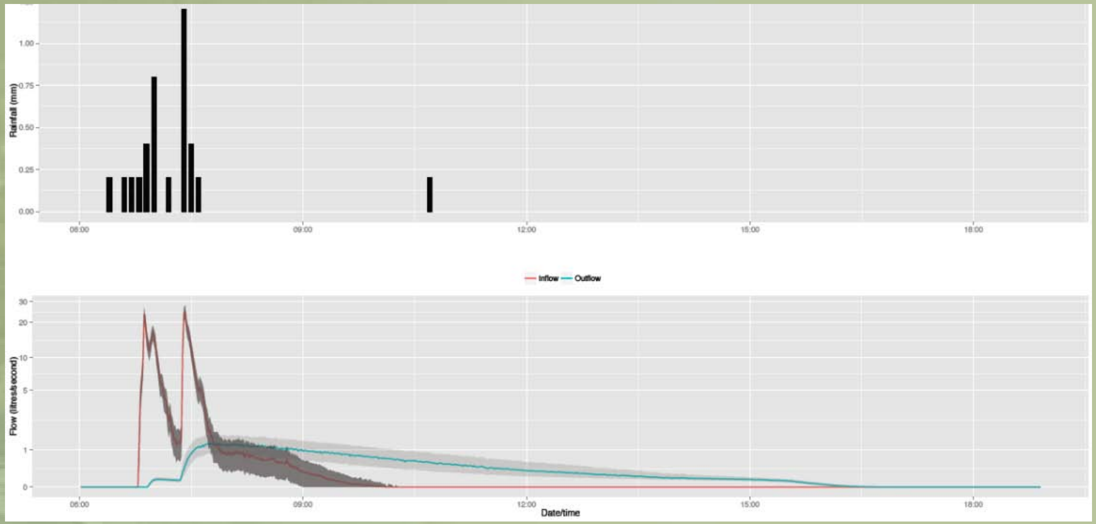
LSC Implementation works (2008-2014)

Monitoring at different scales

	Site (system)	Precinct (paired streets)	Tributary (sub-catchment)	Stream (whole catchment)
				
Hydrology	Infiltration Runoff retention	Continuous flow (event & low-flow)	Continuous flow (event & low-flow)	Continuous flow (event & low-flow)
Water quality	Inflow & outflow concentrations & loads	Event loads & concentrations (SS, P, N, metals)	Monthly routine + storm event: Temp, EC, DO, pH, N, P, SS	Monthly routine + storm event: Temp, EC, DO, pH, N, P, SS
Ecology	-	-	Macroinvertebrate, fish, algal & diatom assemblages, algal biomass Leaf breakdown	Macroinvertebrate, fish, Chl *a*, algal & diatom assemblages Leaf breakdown
Other	Costs Operation & maintenance data	-	-	-

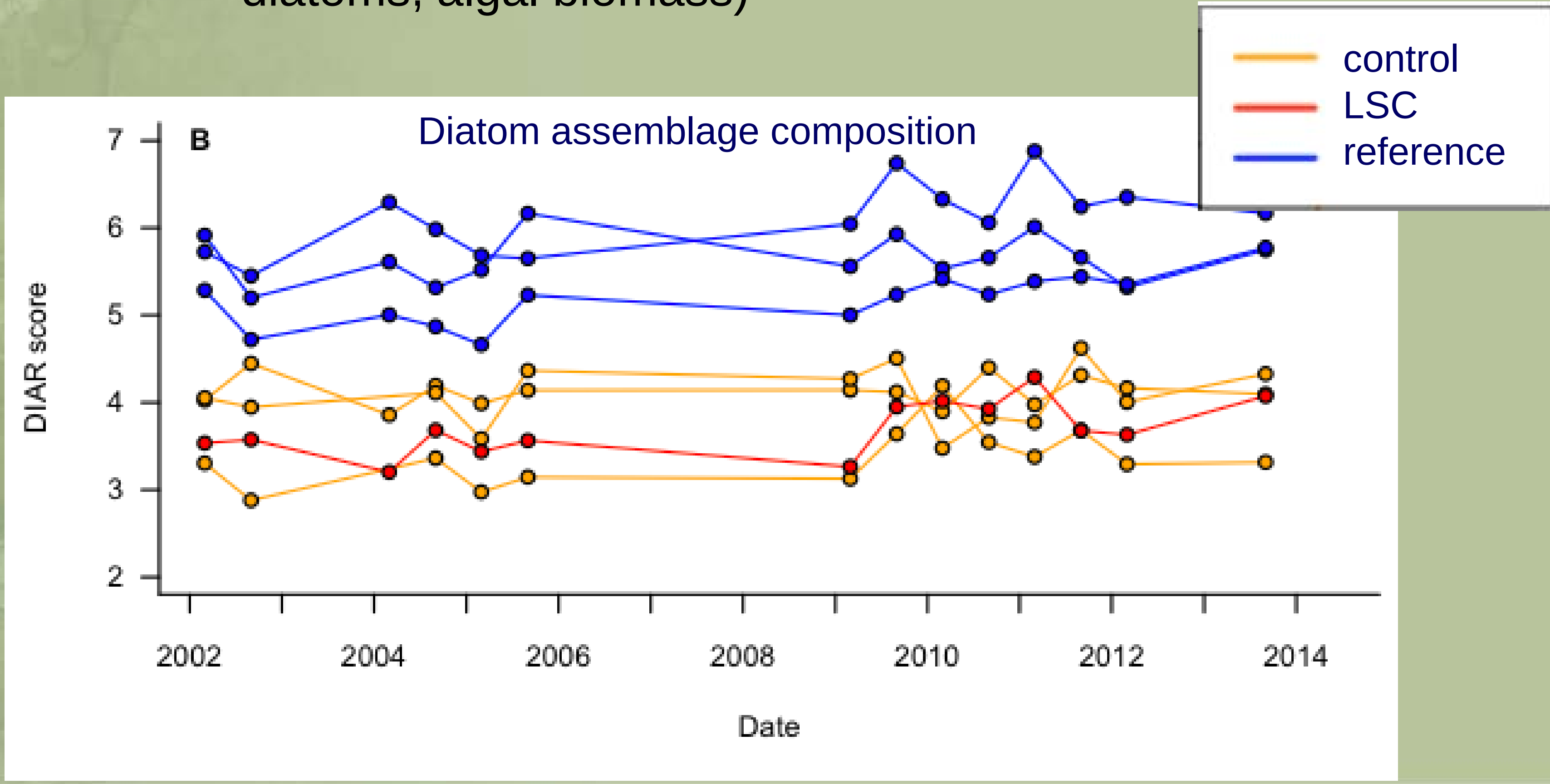
What have we found so far ?

Hydrology: Good data at <u>system-scale</u>. *Analysis of <u>catchment scale</u> still in progress….*



What have we found so far ?

Ecology: no tangible response so far (macroinvertebrates, diatoms, algal biomass)

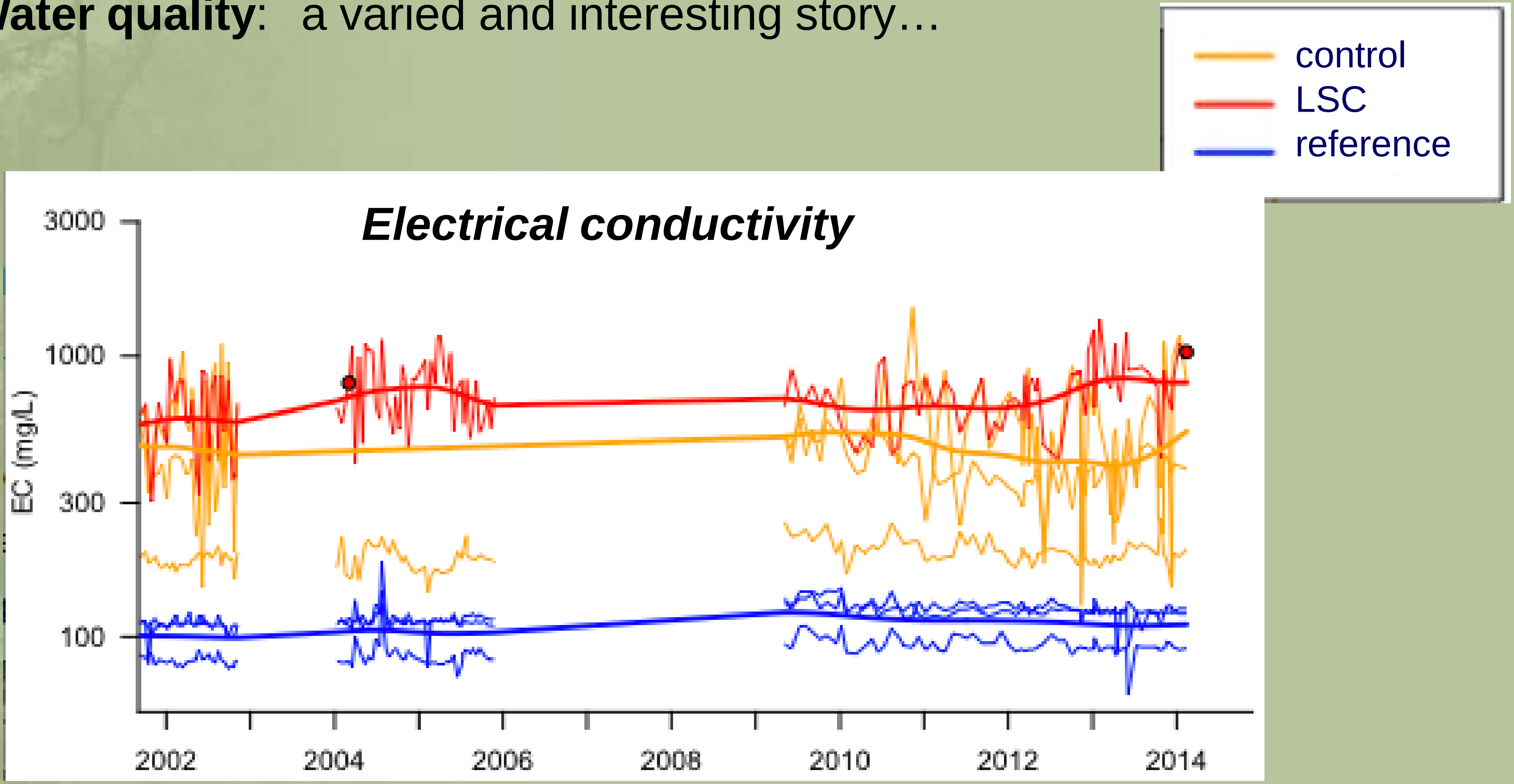


Chessman BC, Bate N, Gell PA, Newall P (2007) A diatom species index for bioassessment of Australian rivers. Mar. Freshwater Res. 58:542–557

Little Stringybark Creek

What have we found so far ?

Water quality: a varied and interesting story…



Little Stringybark Creek

What have we found so far ?

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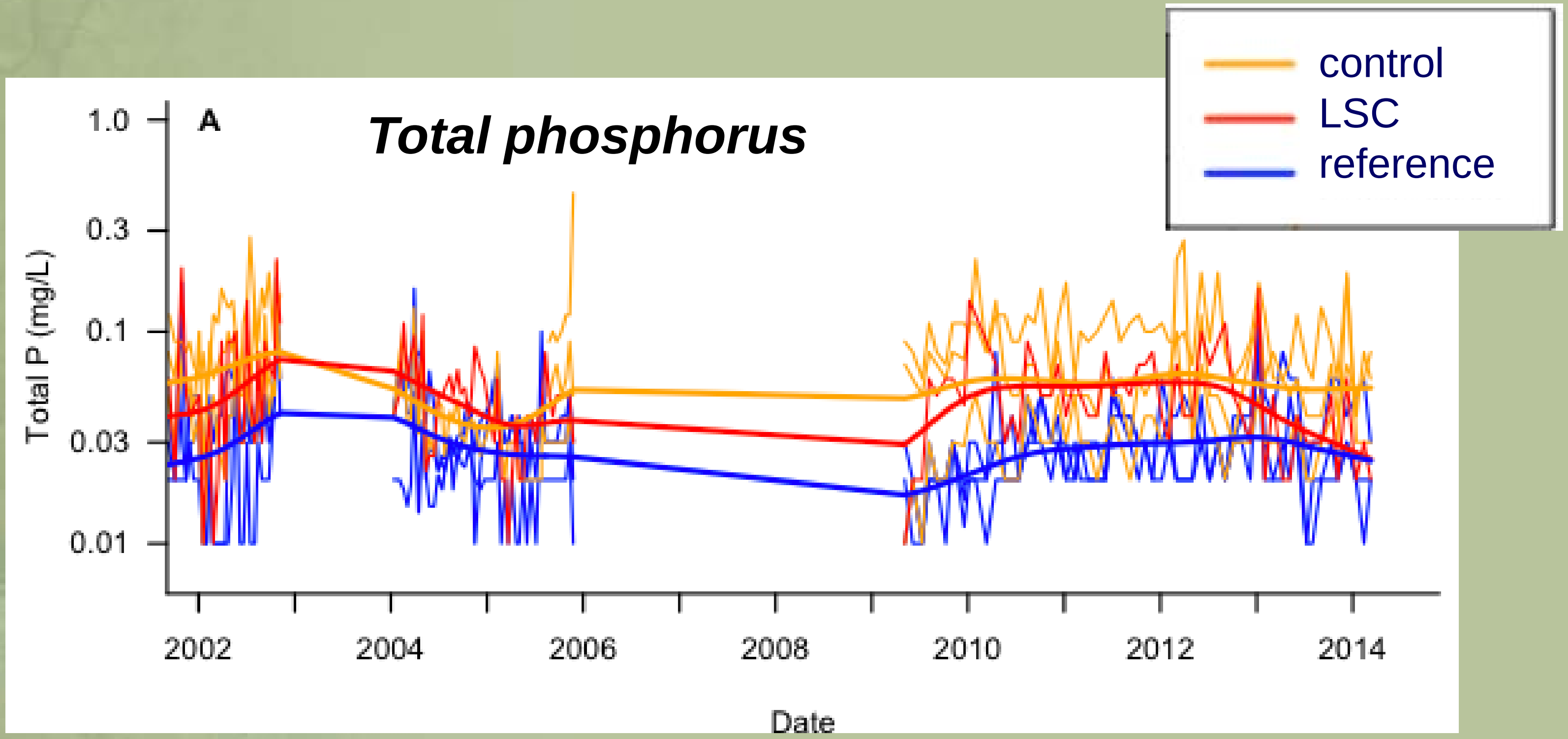
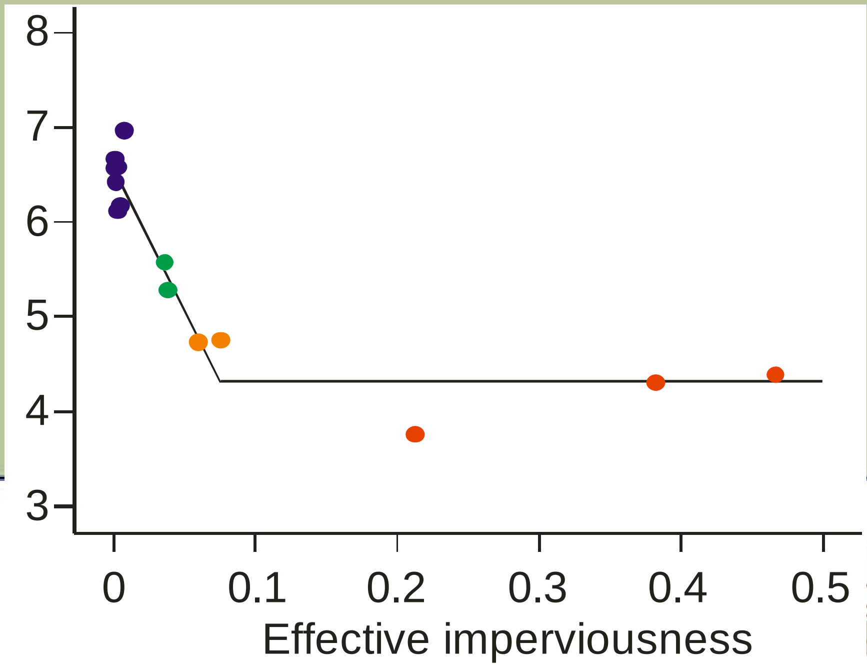


Little Stringybark Creek

What have we learnt so far?

- Restoring the creek has been the underpinning objective of the project from the start… *are we there yet?*
- Some promising signs
  - some signs of water quality response
  - too early yet to see ecological responses
- Many important lessons
  - pick the right catchment!



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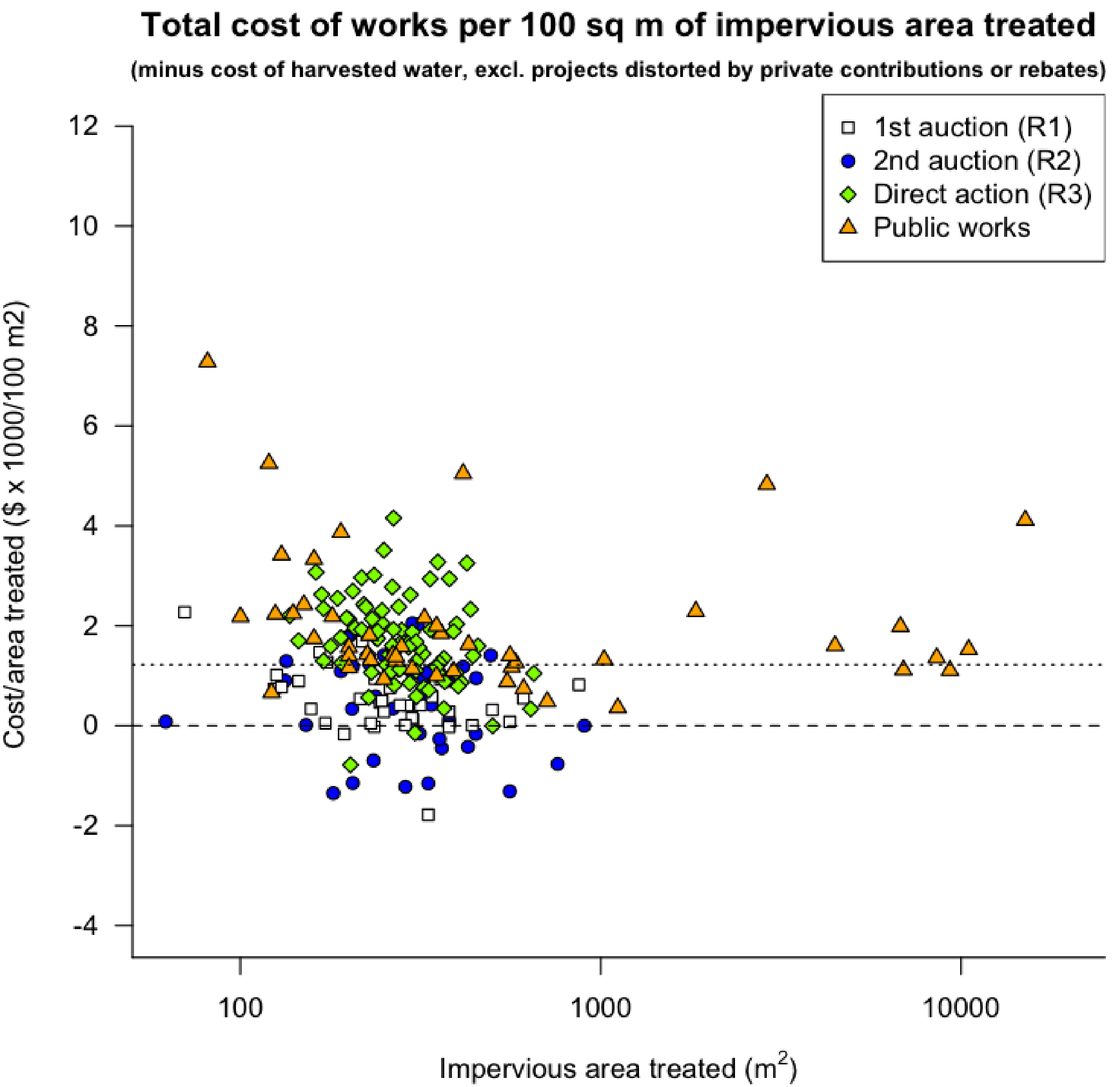
  - pick the right catchment!
  - new design standards > translation into policy
  - new insights into the economics of stormwater control measures…

Little Stringybark Creek

An absence of economies of scale



Mean cost of protecting streams from urban stormwater runoff =

$1220/ 100 m^2 of imp area

Little Stringybark Creek

Many outputs and offshoots

- Advances in ecology, hydrology, social science, economics, large-scale experimental research…

Stream experiments at the catchment scale: the challenges and rewards of collaborating with community and government to push policy boundaries

Chris

Depa

The U

Restoring a stream through retention of urban stormwater runoff: a catchment-scale experiment in a social-ecological system

Christopher J.

Department o

Overcoming barriers to community participation: experiences in building trust and changing behaviour

Darren G. Bos[1] and Helen L. Brown[2]

Australia

Building capacity in low-impact drainage management through research collaboration

Matthew J Burns[1], Elizabeth Wallis[2] and Vjekoslav Matic[3]

Yarra Ranges C

Integrating stormwater management to restore a stream: perspectives from a waterways management authority

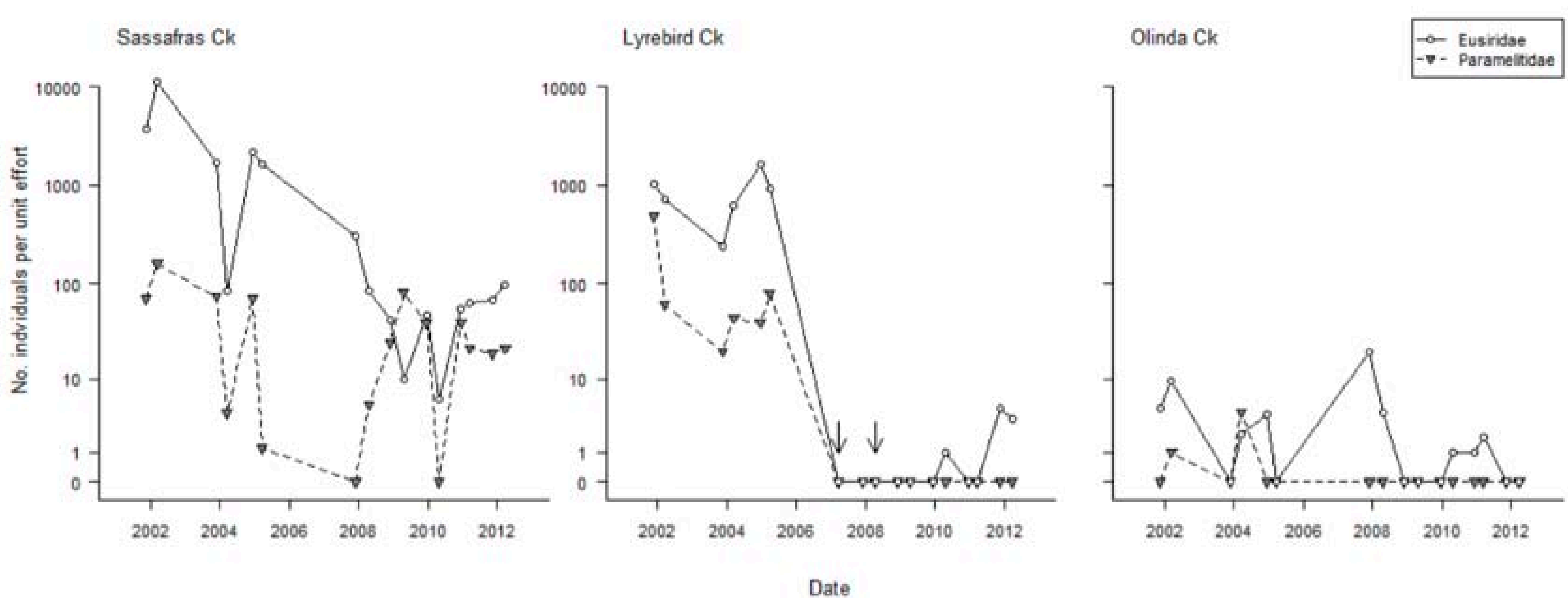
Toby Prosser[1], Peter J. Morison[2] and Rhys Coleman[3]

Melbourne Water, 900 Latrobe St, Melbourne 3000, Australia

Stringybark Creek

Many outputs and offshoots

- Advances in ecology, hydrology, social science, economics, large-scale experimental research
- Some unexpected ecological findings…



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Little Stringybark Creek

Many outputs and offshoots

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- Input into broader analyses

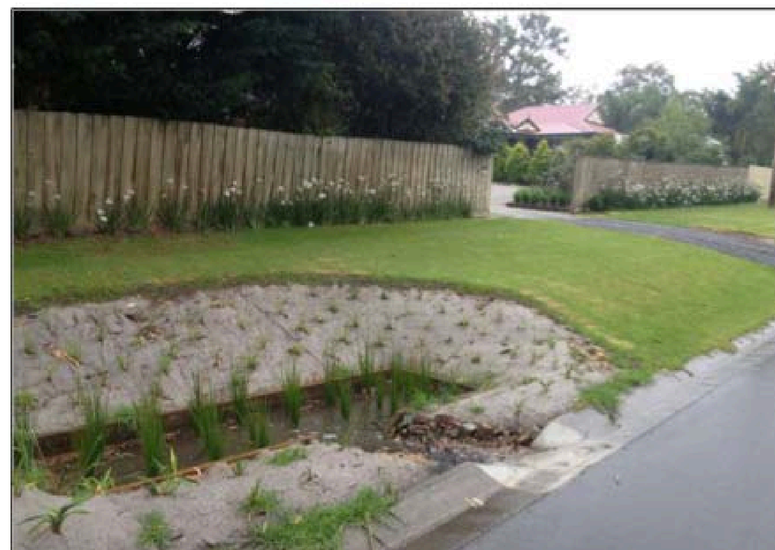
Feasibility and cost of stormwater management for stream protection at property, street and precinct scales

Christopher J Walsh[1], Rhys L Eddy[2], Tim D Fletcher[1], Matthew Potter[3]

[1] Waterway Ecosystem Research Group, Department of Resource Management and Geography, The University of Melbourne, 500 Yarra Blvd, Burnley 3010, Victoria

[2] Envirostream Solutions Pty Ltd, Level 4, 349 Collins St, Melbourne Vic 3000, Victoria

[2] Melbourne Water, 990 La Trobe St, Docklands Vic 3008, Victoria



Melbourne Waterway Research-Practice Partnership report 14-1. June 2014

Many outputs and offshoots

- Advances in ecology, hydrology, social science, economics, large-scale experimental research
- Some unexpected ecological findings
- Advancement of policy: the LSC environmental significance overlay, BPEM review
- Input into broader analyses
- Design of robust infiltration systems workshop
- And many others…

The future

- Additional investment from MW to complete treatment of stormwater in the catchment
- Two more years of ARC funding for stream monitoring
- Many potential international collaborations
- Enough time to detect ecological change?
- Plenty of work to tell the story and shout it from the rooftops

Little Stringybark Creek