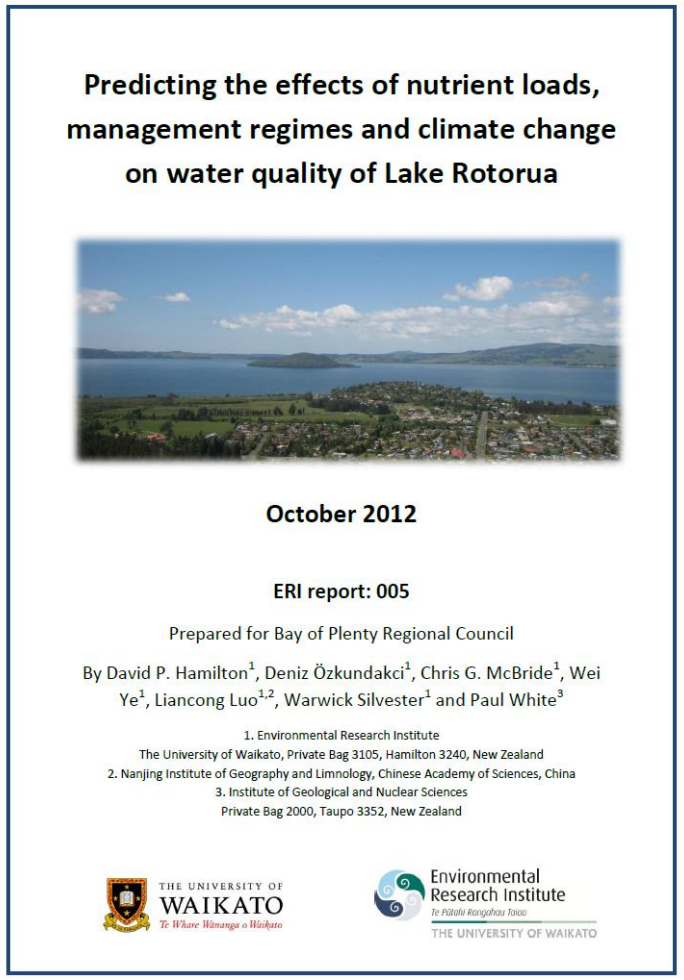
PC10 Module 5: “Review and re-run the lake model”

Chris McBride, Mat Allan, David Hamilton

Background: previous Lake Rotorua modelling



Predicting the effects of nutrient loads, management regimes and climate change on water quality of Lake Rotorua

October 2012

ERI report: 005

Prepared for Bay of Plenty Regional Council

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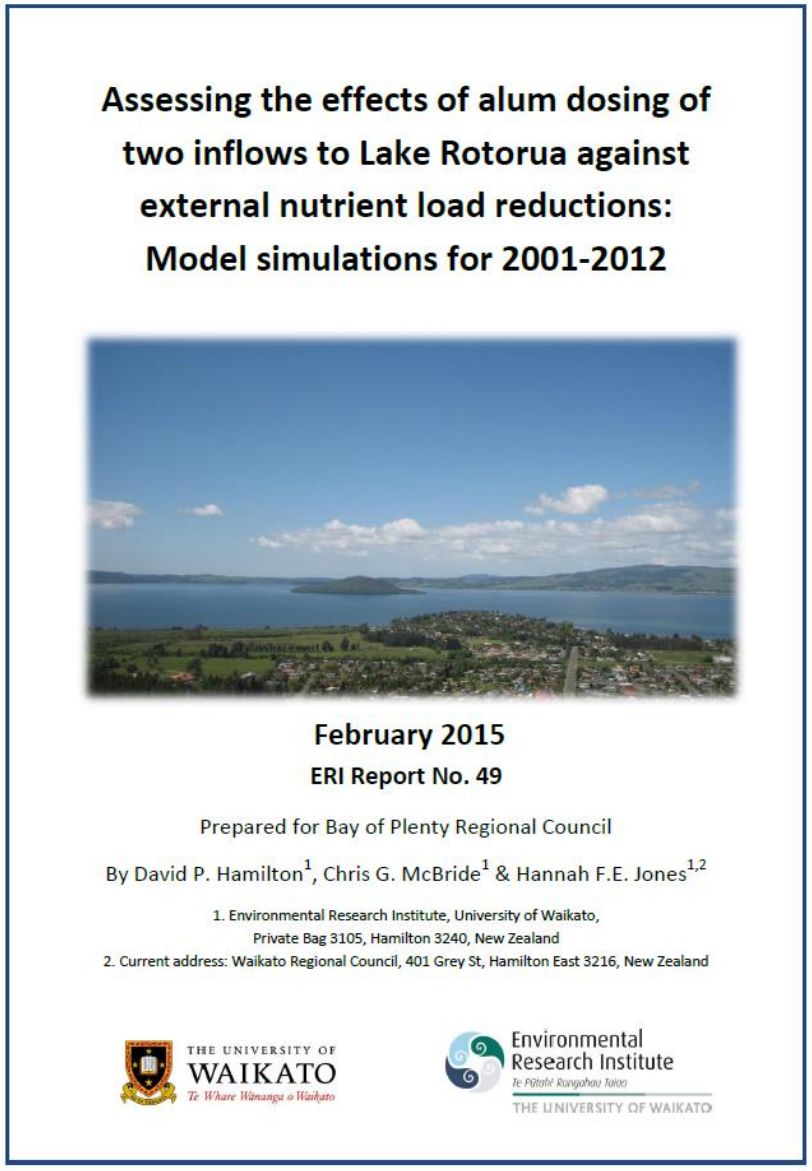
2012

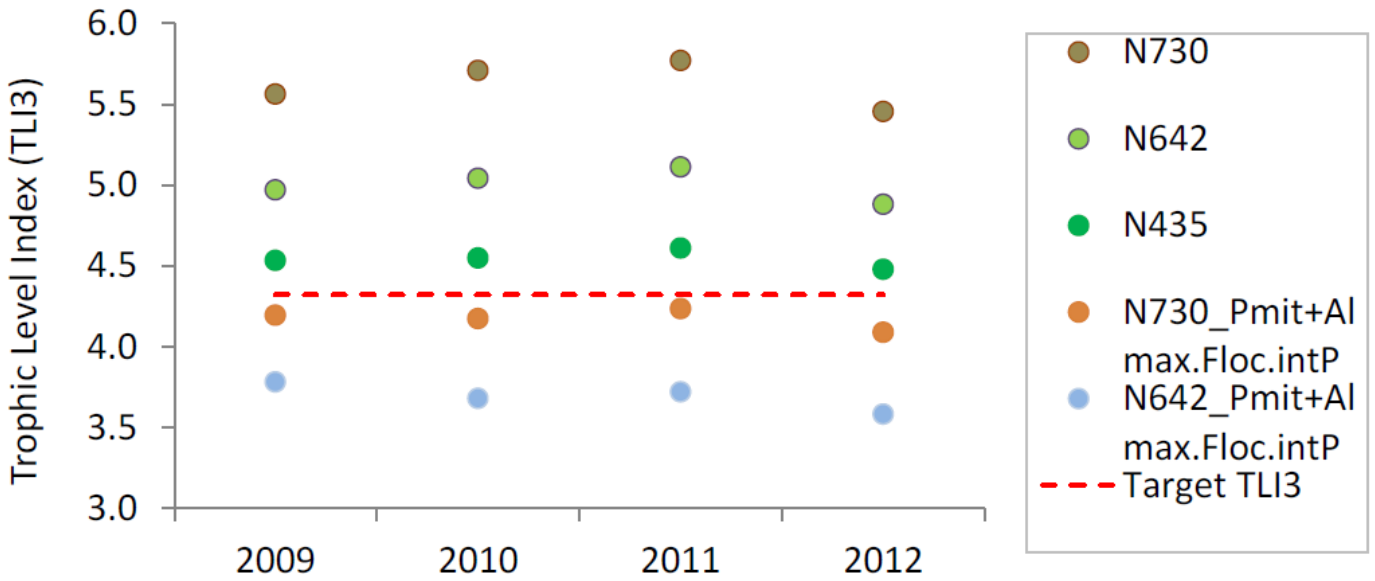
- Focused on nutrient loading and climate change
- N loading and scenarios from early version of ROTAN
- P inputs linearly interpolated from monthly measurements (i.e., minimal stormflow particulates)
- P scenarios proportional reduction based on CLUES simulations
- Baseline period 2001 – 2009
- Effects of alum were not considered

Background: previous Lake Rotorua modelling

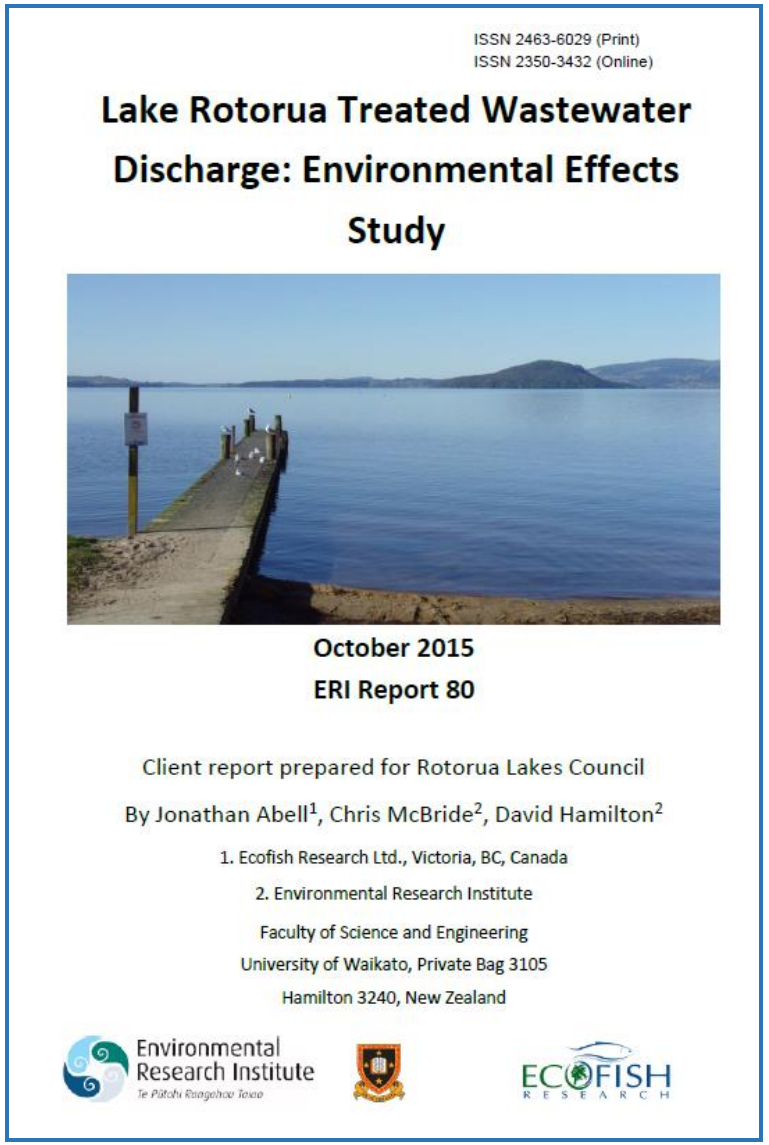


Early-2015

- Focused on nutrient loading and alum effects
- N loading and scenarios from later version of ROTAN
- P inputs linearly interpolated from monthly measurements (i.e., minimal stormflow particulates)
- P scenarios assumed proportional reduction of P and N
- Calibration period 2001 – 2007, scenario period 2007 – 2012
- Limited number of scenarios



Background: previous Lake Rotorua modelling



Late-2015

- Further improvement of stream inputs
- N and P loading from measurements, w/ high-flow concentration modelling (i.e. includes stormflow particulates)
- Scenarios focused on effects of additional load from wastewater

PC10 modelling ‘re-run’

Terms of Reference for the 2017 Plan Change 10 Science Review

Updated version 2.2

Review and re-run of the lake model, including its ability to replicate recent years data. Four scenarios have been selected to assist in a better understanding of the N and P reduction options. These scenarios are being re-run with UoW.

Note 13: Decouple the ‘review’ of the lake model from the ‘rerun’ aspects of this point (Action)

PC10 modelling ‘re-run’

Terms of Reference for the 2017 Plan Change 10 Science Review

Updated version 2.2

Review and re-run of the lake model, including its ability to replicate recent years data. Four scenarios have been selected to assist in a better understanding of the N and P reduction options. These scenarios are being re-run with UoW.

Review:

The ability of the lake model to ‘replicate recent years data’ (i.e., the ‘alum era’) was the focus of Hamilton et al. (2015).

PC10 modelling ‘re-run’

Terms of Reference for the 2017 Plan Change 10 Science Review

Updated version 2.2

Review and re-run of the lake model, including its ability to replicate recent years data. Four scenarios have been selected to assist in a better understanding of the N and P reduction options. These scenarios are being re-run with UoW.

Re-run:

~~*Note 14: The rerun of the scenarios through the model would be put on hold until the phytoplankton experiment data is available.*~~

“At a meeting on 13 October 2017 (with Chris McBride, David Hamilton, Paul Scholes, Andy Bruere and Simon Park), it was agreed that:
- the lake model scenarios would be expanded from the above approach
- a ‘5 x 5’ matrix of nitrogen and phosphorus loading scenarios would be used, with some scenarios including alum.” (TOR, Appendix IV)

PC10 modelling module: work plan

Core deliverables:

- Update the DYRESM-CAEDYM lake model to incorporate aspects of the Hamilton et al. (2015) and Abell et al. (2015) versions, as well as Tempero et al. (2015).
- Scenario ‘matrix’

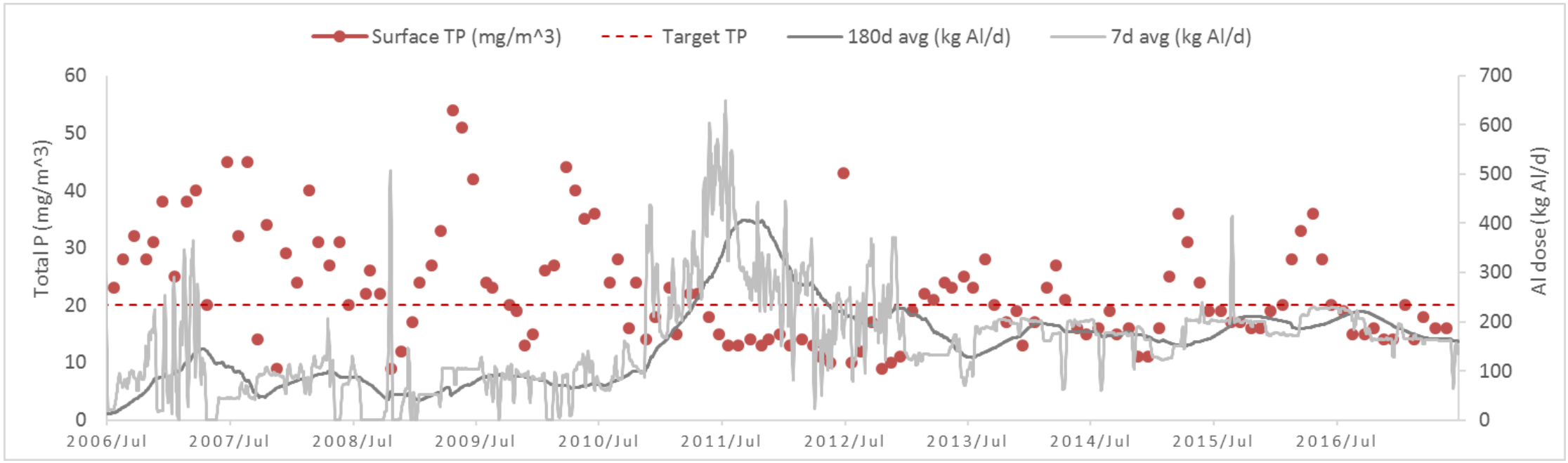
Additional deliverables:

- Sensitivity analysis of baseline model (to increase confidence in model performance).
- Development of similar model using GOTM-FABM-PCLake
- Extension of modelling framework to cover the entire ‘management period’ (1960 to present).

Core deliverables

Model re-run

- Model inputs based on observed concentrations (rather than ROTAN and scenarios).
- Simulation period: 2001 – 2017. Calibration/validation period: 2001 – 2007 (as for Hamilton et al. 2015; to avoid the confounding influence of alum dosing on model calibration).
- Incorporate and refine model using new knowledge from Tempero et al. (2015), Abell et al. (2015)
- Scenarios will represent long-term sustainable management, i.e., without alum. *Why? Because CAEDYM cannot (presently) account dynamically for alum dosing rate.*



Core deliverables

‘Scenario matrix’

- Presently refining the 2015 versions of the DYRESM-CAEDYM modelling.
- Scenarios to be run within 3 weeks.
- Draft report available mid-June.

M = minimum load
L = lower load
P = Present load (2001 – 2007)
I = Increased load
X = Maximum load

TN load in t y^{-1}

TP \ TN	435	550	655	700	750
39 (27)	M.M	L.M	P.M	I.M	X.M
45 (31)	M.L	L.L	P.L	I.L	X.L
51 (35)	M.P	LP	P.P	I.P	X.P
53 (37)	M.I	L.I	P.I	I.I	X.I
55 (38)	M.X	L.X	P.X	I.X	X.X

TP load in t y^{-1} (brackets = load without stormflow particulates)

‘Extra’ deliverables

Extend model time-frame to the entire management period (1960 to present)

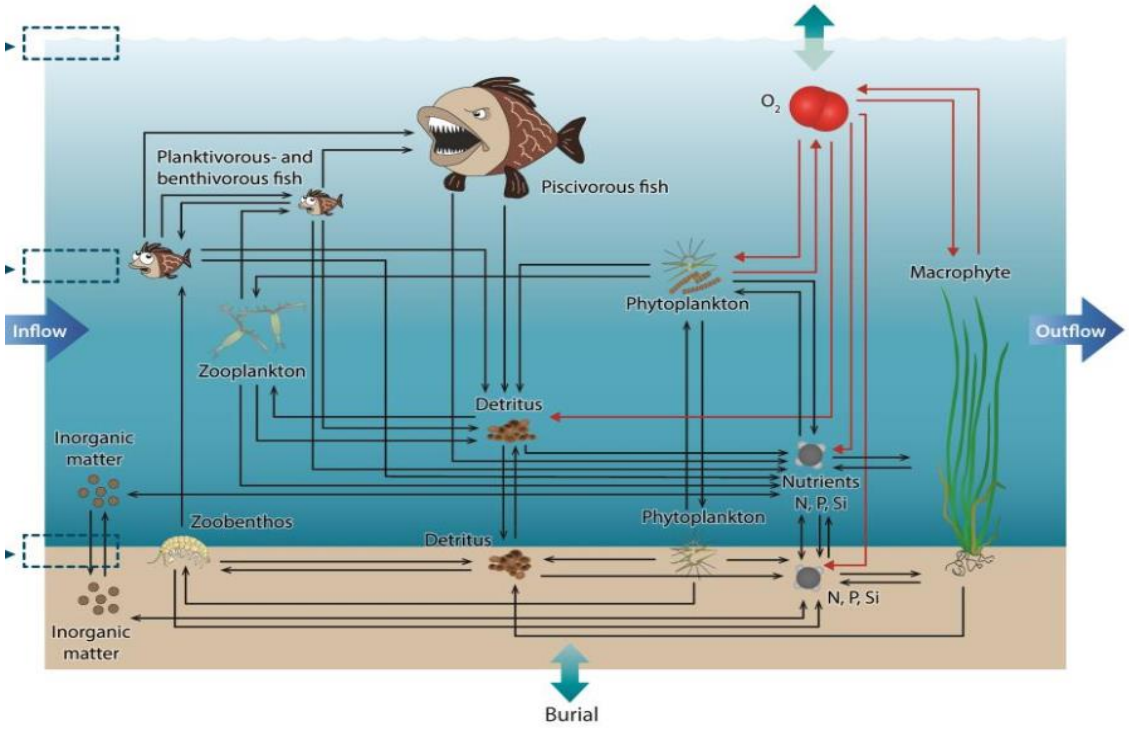
- Requires synthesis of all monitoring data in the catchment and lake to provide data with which to drive and calibrate the model over the long-term.
- Need to represent long-term processes and feedback mechanisms.
- ‘Multi-model’ approach: DYRESM-CAEDYM & GOTM-FABM-PCLake

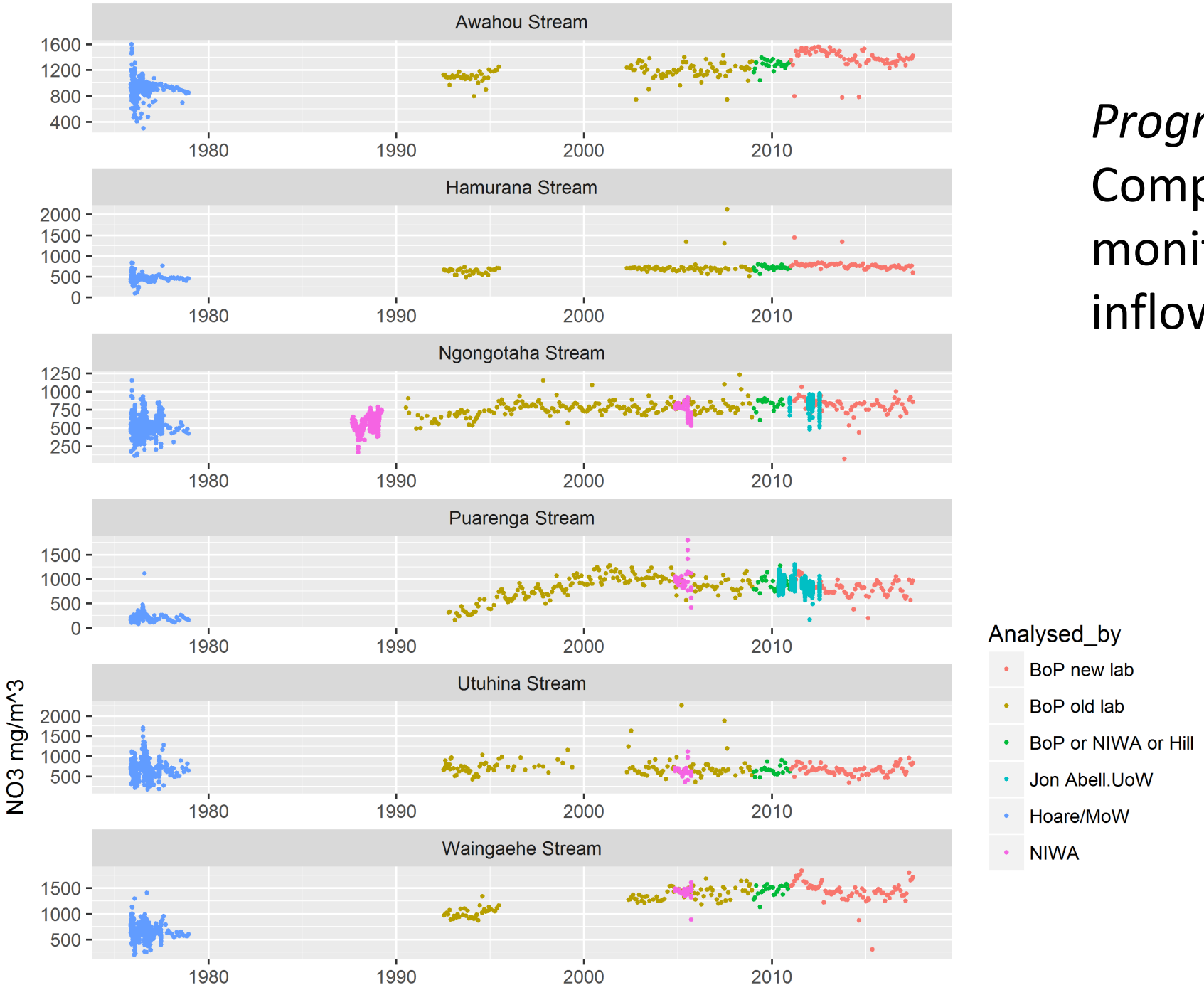
Why GOTM-PCLake?

PCLake includes a simplified sediment model which links internal nutrient cycling/feedbacks ('internal loading') to nutrient loading from the catchment and sedimentation/burial processes in the lake.

This makes PCLake much more suitable for simulations over the entire management timeframe for Rotorua, and reduces the number of assumptions required for previous CAEDYM simulations.

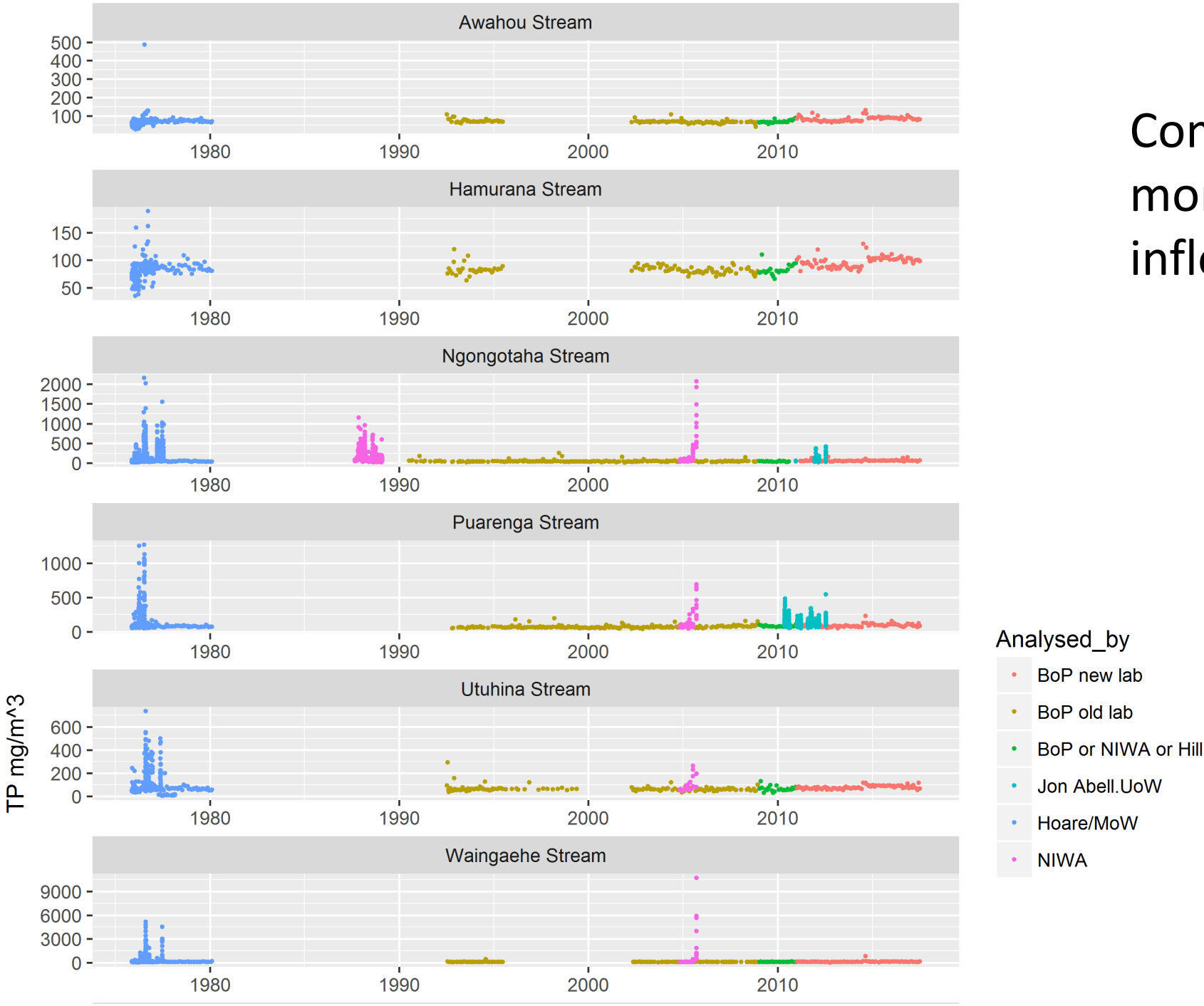
PCLake also includes more functional representation of macrophytes and higher biology.





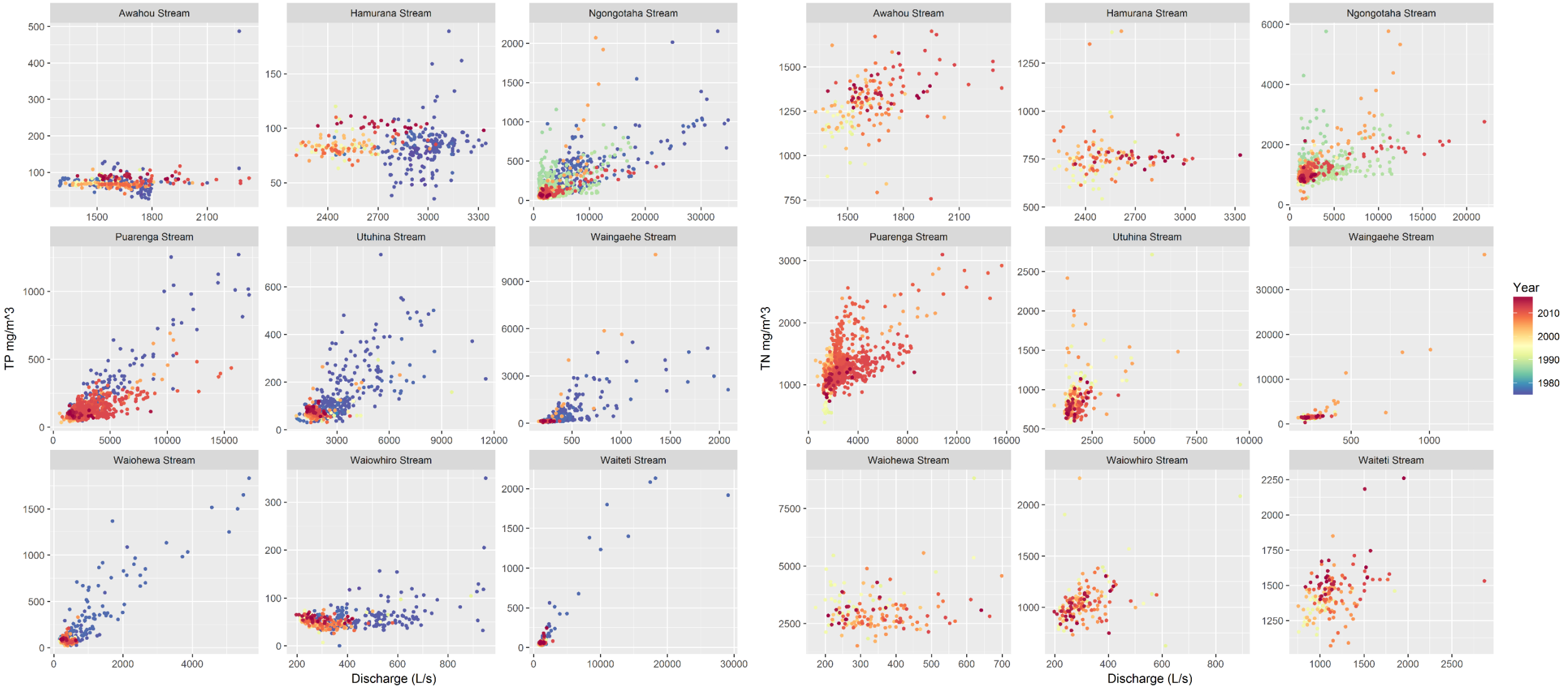
Progress:

Compiled long-term monitoring record for inflows (multiple sources)

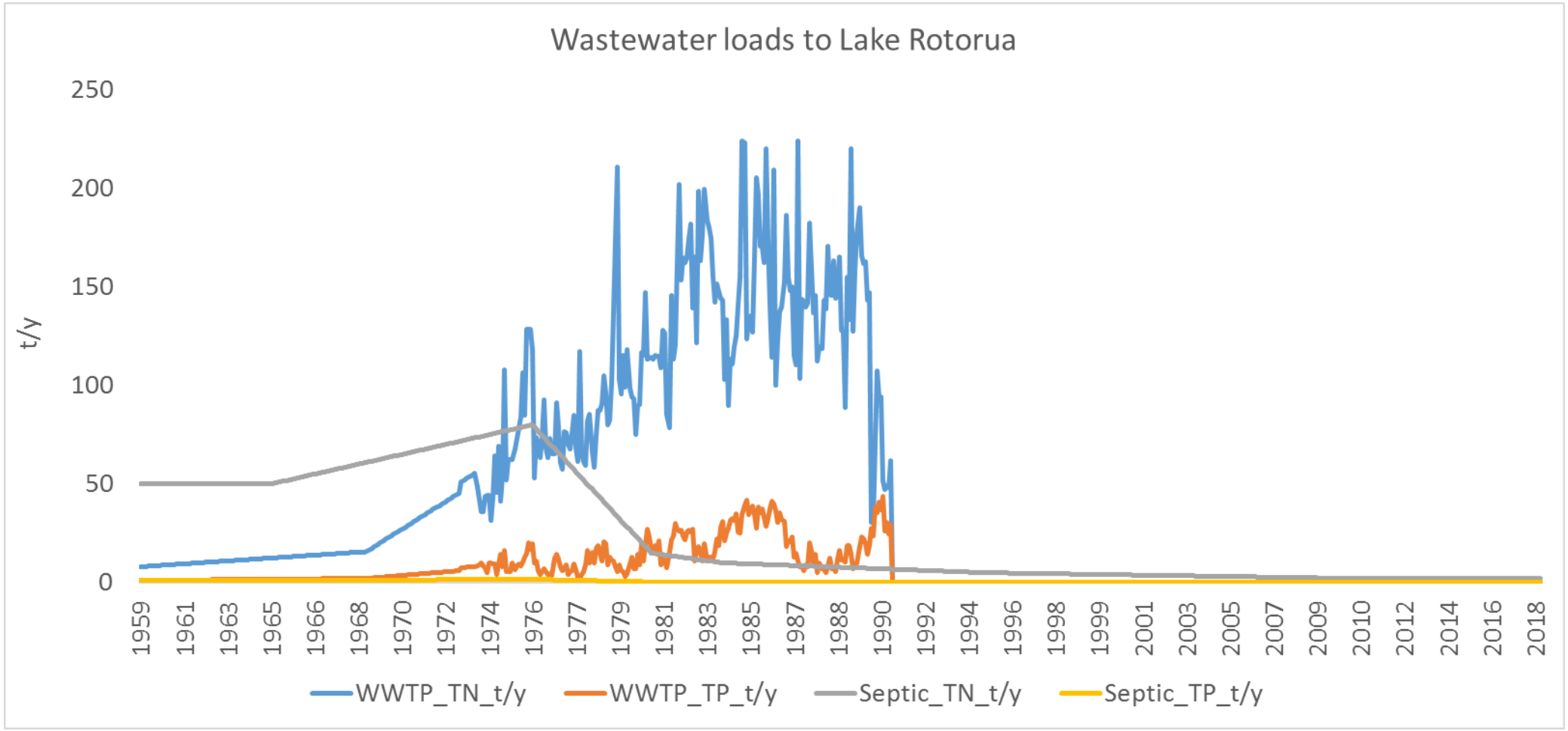


Compiled long-term monitoring record for inflows (multiple sources)

Discharge-flow relationships, through time



Compiled and estimated long-term wastewater inputs (excluding LTS)



Compiled long-term lake monitoring record (multiple sources)