Thames River Experimental Stream Sciences (TRESS) Centre

Project Update – April 2017

Background

Human development of landscapes is a global threat to aquatic ecosystem health. Our ability to protect these important ecosystems is hindered by limited understanding of catchment scale effects of land use on aquatic conditions. As a group though, observational field studies are limited by the impracticality of manipulating landscape conditions at large scales. Innovative approaches are thus needed to test hypotheses regarding the influence of land use patterns on aquatic ecosystem conditions, such as water quality and ecological health. This need is particularly strong in regions (e.g. Southern Ontario) where contemporary landscapes present a limited snapshot of possible landscape patterns due to widespread development (e.g. agricultural changes, urban housing, recreational golf courses). As a solution Western University has partnered with the City of London and the Upper Thames River Conservation Authority to construct a facility that houses artificial streams (also known as a "mesocosm" – see sidebar) where controlled ecosystem experiments can be completed to fill key knowledge gaps inhibiting management decisions.

TRESS Centre

The TRESS centre is an outdoor mesocosm facility constructed in 2015 with strictly controlled biological assemblages and physico-chemical conditions. Stated advantages of the stream mesocosm approach include increased experimental control and replication, elucidation of mechanism of stressor effects, and the ability to investigate effects of toxic compounds on food webs without harming natural systems because of experimental

Mesocosm

A mesocosm (*meso-* or 'medium' and *-cosm* 'world') is any outdoor experimental system that examines the natural environment under controlled conditions. In this way mesocosm studies provide a link between field surveys and highly controlled laboratory experiments.[1]

Mesocosms also tend to be medium-sized to large (e.g., aquatic mesocosm range: 1 to > 10,000 L) and contain multiple trophic levels of interacting organisms.

In contrast to laboratory experiments, mesocosm studies are normally conducted outdoors in order to incorporate natural variation (e.g., diel cycles). Mesocosm studies may be conducted in either an enclosure that is small enough that key variables can be brought under control or by field-collecting key components of the natural environment for further experimentation.

Extensive mesocosm studies have been conducted to evaluate how organisms or communities might react to environmental change, through deliberate manipulation of environmental variables, such as increased temperature, carbon dioxide or pH levels.[2]

manipulation. The TRESS Centre consists of a system of 9 artificial streams made of fabricated tanks with partial-recirculation of water flow (Figure 1). TRESS is situated at the Adelaide pollution control plant (PCP), 1159 Adelaide Street North, which provides a secure environment with ready access to a reliable supply of treated water (without contaminants such as nutrients, pesticides, sediment) through the City of London drinking water supply. The site is also closely located to the North Thames River and to the outlets of two of its tributaries, Medway Creek and Stoney Creek, which provide biological communities that can be evaluated at the TRESS Centre. Most importantly, the current location of TRESS provides a visual and informational connections between the research and examples of how that knowledge can be applied. Lastly, the location near the Thames and the Adelaide PCP provides excellent opportunities to develop educational and outreach programming in the future.

Figure 1. Schematic of the TRESS centre (left) indicating location of TRESS Centre at the Adelaide PCP. Photographs of the facility in 2015 (Top right) and of an individual stream mesocosm (bottom right).

Research Findings

To date two sets of experiments have been conducted at TRESS. In 2015, a series of experiments identifying nutrient concentrations associated with rapid effects on river ecosystems. These nutrient thresholds can serve as management targets for ensuring the continued health of

our rivers. Our study found that rapid changes in algae growth and community composition occurred in the range of 50 ug/l of biological available phosphorus (measured as soluble reactive phosphorus, or SRP) (Figure 2). This study also found indications that above 100 ug/l of SRP the community appeared saturated and no further changes occurred.

In 2016, the second experiment assessed the comparative effects of continuous discharges of SRP to stream ecosystems relative to pulse discharges. Continuous discharges mimic the release of treated municipal wastewater effluent to rivers where comparable volumes and quality of effluent is discharged over time. The pulse discharge treatment mimicked agricultural runoff events where large amounts on nutrients are released to the stream infrequently, over short periods. This study showed, that stream algae communities were equally able to utilize both sources of nutrients (Figure 3) and that the resulting changes to stream ecosystems were comparable suggesting both sources need management to protect river health.

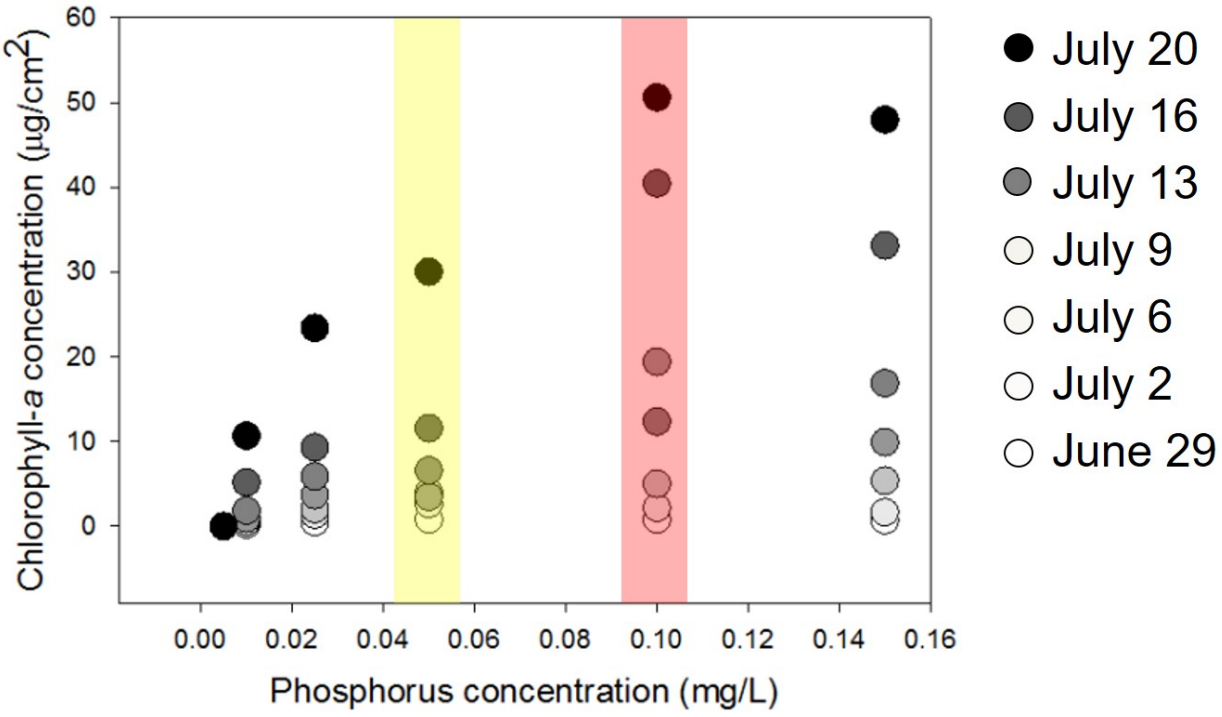
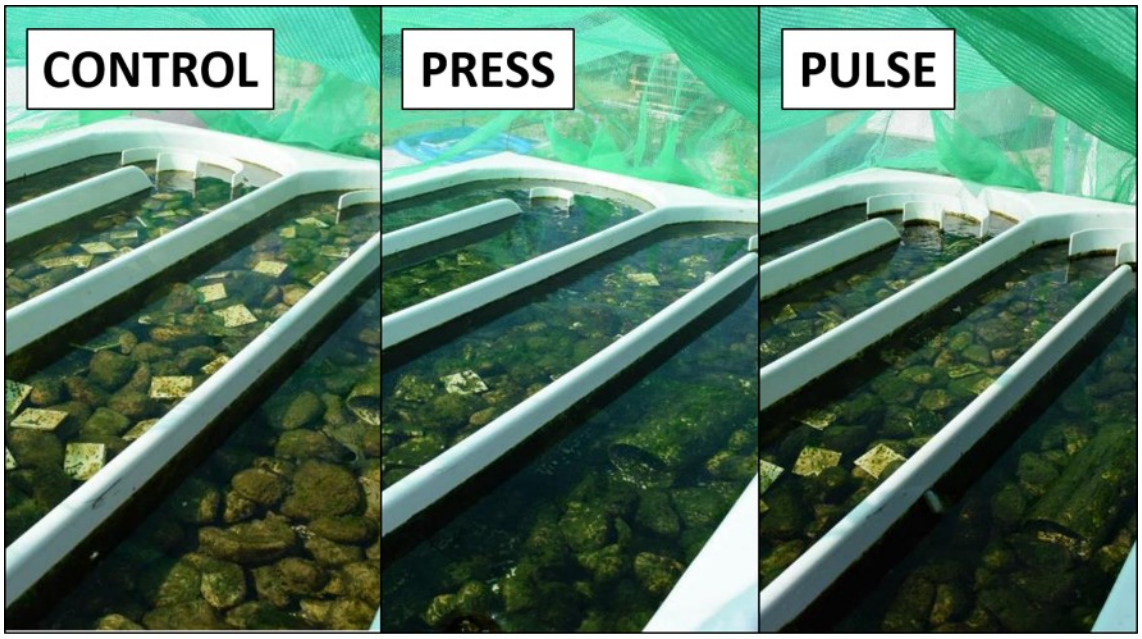


Figure 2. Algal concentration through time (dates represented by shaded circles) for six concentrations of phosphorus. Yellow bar indicates potential target for maintaining river health. Red bar indicates potential nutrient saturation point of algal community.



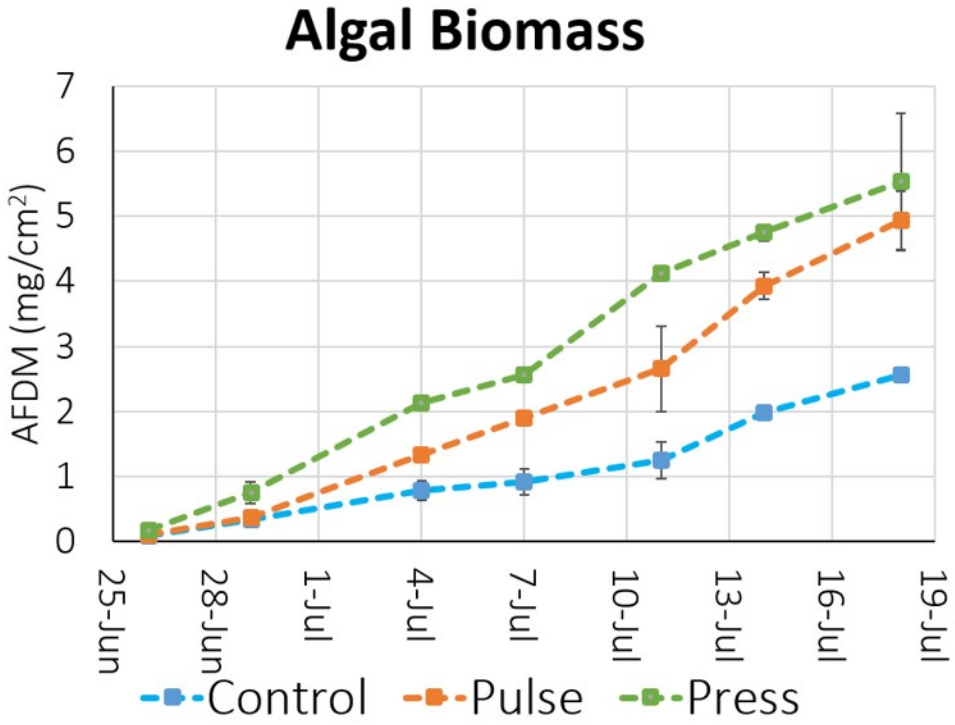


Figure 3. Comparison of algal growth from an experiment testing effects of pulse and press additions of nutrients relative to a low nutrient control. Photos (top) show relative coverage of algae by treatment. Graph (bottom) indicates algal biomass over the course of the experiment. Pulse additions occurred on July 1 and July 12.

Future of TRESS

The next phase of TRESS has three primary objectives:

1. To enhance the facility infrastructure and equipment through construction in order to enable delivery of education and outreach activities and to allow expansion of the research program at TRESS. The expansion will result in the facility containing 24 streams and associated support equipment (Figure 4). The facility expansion is modularly designed to allow phases of construction base on funding availability. The first planned phase of enhancement will focus on expansion to 12 streams from the current nine, and the construction of a stable decking that will allow the facility to host outreach activities. Upgrades through construction will allow the launch of collaboratively organized outreach programs run by Western and UTRCA staff through either existing UTRCA and City of London programs or new programs as appropriate.

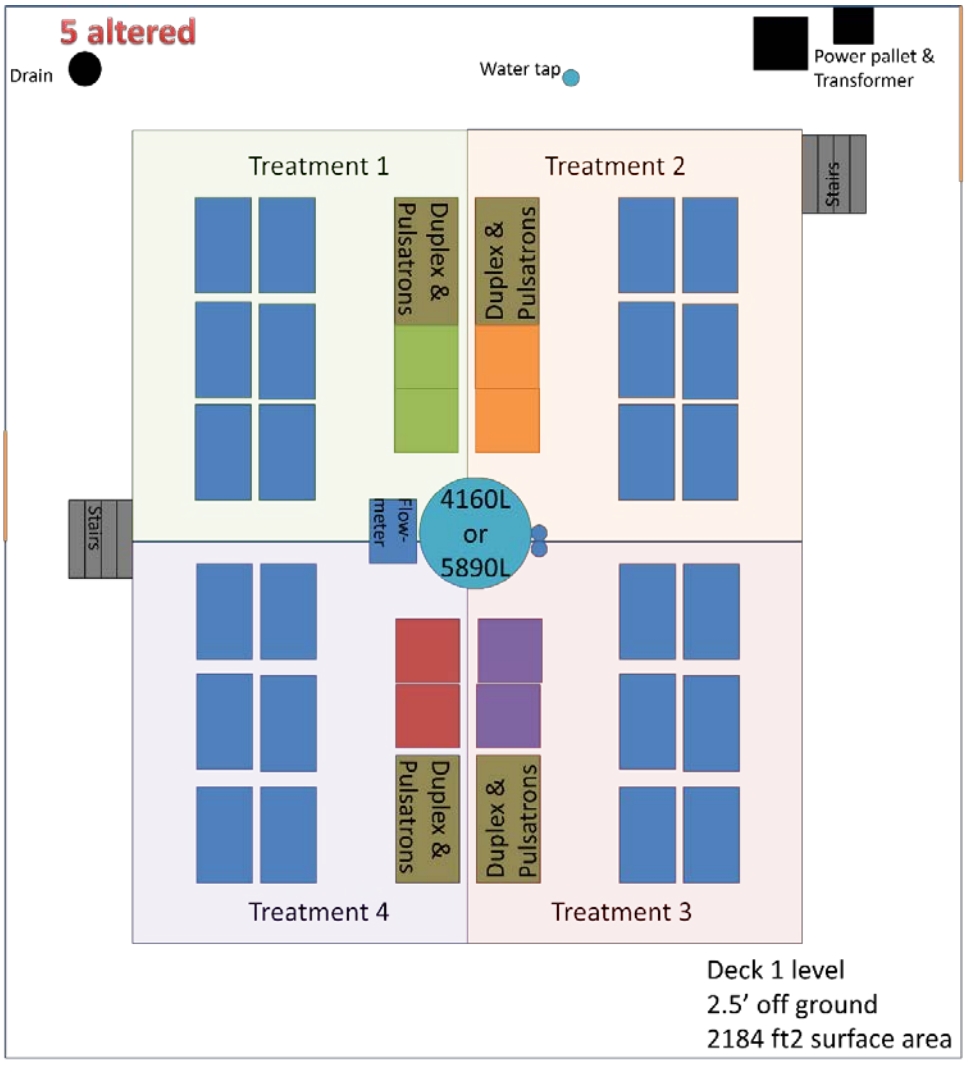


Figure 4. Schematic layout of proposed expansion of TRESS centre to 24 artificial streams. Solid decking and railing would allow for outreach activities to take place at Centre.

2. To target outreach towards the public at large with focus on school and youth groups. Participants in the outreach programs will make visual linkages between water management actions and potential river health consequences illustrated by healthy and unhealthy stream conditions in TRESS' artificial streams. StrEAMS lab HQP will lead interactive exercises introducing participants to river flora and fauna, their habitat requirements and abilities to indicate river health. Learning outcomes will include a better understanding of how people impact and are impacted by neighbourhood streams and rivers.

3. To continue research to focus on understanding nutrient affects on rivers and to identify capacity of river to assimilate nutrients without unacceptable harm to ecological function and diversity. Near term, research projects will centre on the effects of nutrient pulse concentration and duration, as well as interactive effects of additional stressors commonly associated with pulse events (e.g., sediments). In addition, to projects on nutrients the TRESS centre is planning to explore collaborative research projects with governments, industry and universities across North America. This is especially topical given the recent focus on increased Phosphorus levels into Lake Erie and the contribution from the Thames River. These projects would raise the profile of the TRESS centre while also generating revenue to cover facility operation and maintenance costs through "bench fees". All research directly associated with TRESS partners would continue to take precedence over external research.

Summary

The first 3 years of operation of the TRESS centre has achieved the intended results that were anticipated to satisfy academic research goals. It also has provided an interesting potential opportunity for the Centre to take advantage of work being undertaken through the Thames River Clear Water Revival initiative and the ongoing development of a Domestic Action Plan concerning Lake Erie and excessive nutrients (specifically Phosphorus) by the province and federal governments. These potential opportunities can only be fully investigated through successful collaborations like the one embodied in TRESS.

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