



Removing *E.coli* with Mushrooms: Mycofiltration at a Stream in Lake Erie State Park, New York



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Background



Lake Erie State Park

Lake Erie State Park is located in Chautauqua County, New York and is a popular destination in the spring due to its scenic views. However, in the summer, high levels of *Escherichia coli* (*E. coli*) detected in beach surface waters have led to frequent beach closures. Certain strains of *E. coli* are linked to adverse health effects such as gastrointestinal illness, and the presence of *E. coli* is used as an indicator of other, potentially more harmful microorganisms. *E. coli* has negative impacts on recreation and health, and so management is key.

New York State Park's Environmental Management Bureau (EMB) received Great Lakes Restoration Initiative (GLRI) funding to conduct sanitary survey and remediation work at State Parks beaches. Bacterial sampling of a stream near the Lake Erie State Park beach revealed high levels of *E. coli*, sometimes exceeding the NYS Department of Health (DOH) standard of 235 colony forming units (cfu) per 100mL by several orders of magnitude. To meet remediation objectives, EMB researched innovative techniques to treat streams containing high levels of *E. coli*.

Mycelium as a promising solution

Mycelium are the vegetative structures of fungi (mushroom roots), able to hold soils together, absorb nutrients and, in certain species, consume harmful bacteria. EMB identified Fungi Perfecti as a creator of an innovative, low-cost bacteria removal system called **mycofiltration** – using mycelium to treat contaminated stormwater runoff. In 2013, the company studied various fungi for treating urban runoff and found that *Stropharia rugoso-annulata* (“garden giant”) mycelium can survive harsh environmental stresses and remove large amounts of *E. coli* from flowing water. This fungus species is seen throughout North America and is regarded as common in the Northeast.

Fungi Perfecti provided EMB with six customized, experimental “mycototes” filled with mycelium-infused Alder wood chips for testing the effectiveness of this new system in removing *E. coli* from an actual stream. The lids were specially designed to accommodate flow and debris characteristics of our target creek. The original plan was to have two layers of three mycototes lining the cross-section of a weir, side-by-side for maximum filtration.

6 mycotote systems: \$5,210 + \$3,300 shipping
Consultation/design services: \$7,000
Total cost: \$15,510; Est. continuation cost: \$2,000/year



S. rugoso-annulata
(image from Wikipedia.org)



Mycelium-infused wood chips



Mycotote: inside (top) outside (bottom)

Installation & Data Collection

June 6th, 2014 – Four of the six mycototes were installed at a cement weir on an unnamed tributary, located in the center of the Park and classified by NYS Department of Env. Conservation as a Class C stream (secondary recreation & fish survival). The weir had a “waterfall” with an initial 5.5 foot drop, a sump, and then a 1.5 foot drop. The original tote design did not account for the narrower channel width near the bottom of the first drop, and so rocks were arranged to ensure filtration. June 9th – rubber was placed to seal any cracks and ensure full filtration through the mycotote lids (See rocks and black rubber in bottom center photo). July 12th – Two final mycototes were installed. Water flowing over the weir was filtered through the totes and released downstream.



(Step 1) Cement supports in weir



Chips inside mycototes



(Step 2) Totes lifted onto weir

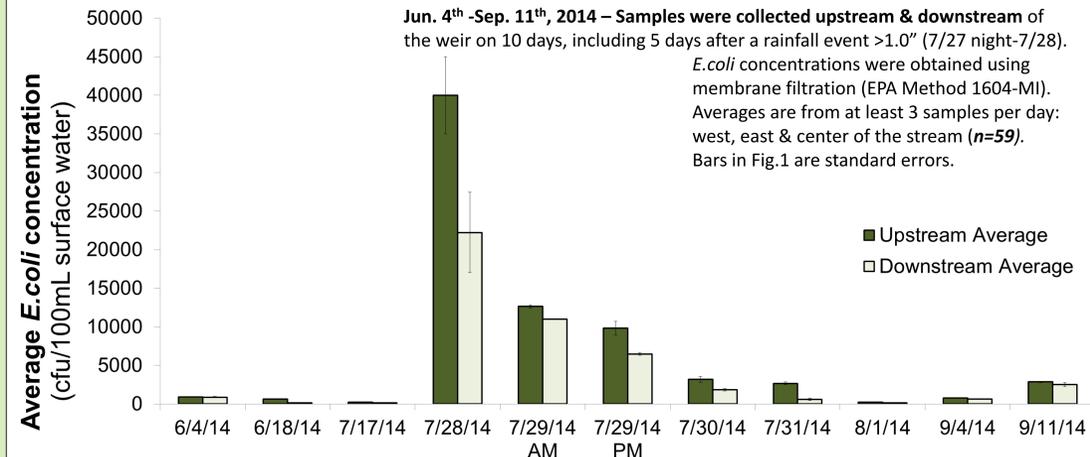


(Step 3) Arranged on cement



Two layers of three mycototes (each 4'x4'x2.3') in weir:
View from upstream (left, with rubber and rocks) & downstream (right)

Figure 1: *E. coli* sampling



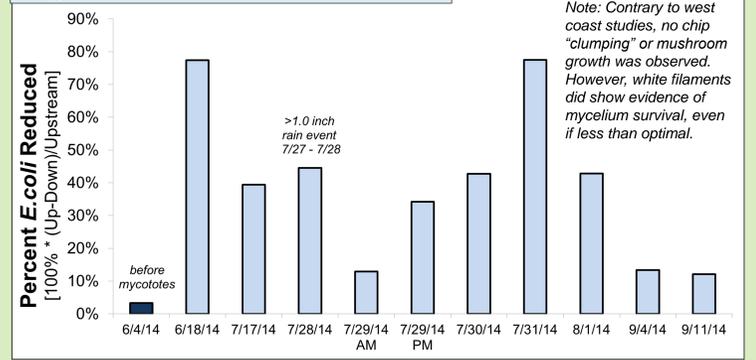
Preliminary Findings

Table 1: *E. coli* summary

Location from mycotote station	<i>E. coli</i> (cfu/100mL) Jun. 18-Sep. 11, 2014		
	Min.	Max.	Median
Upstream	200	45,000	2,750
Downstream	100	27,000	800

Although the stream still exceeded DOH 235 cfu/100mL criteria (Fig.1, Tab.1), mycototes effectively reduced upstream *E. coli* levels 12 -78% each day of sampling (Fig.2), with a seasonal average reduction of 40% ± 7.5% (vs. 3% reduction before totes installed, due to natural variability).

Figure 2: *E. coli* reduction at weir



Considerations & Lessons Learned

The mycototes successfully reduced *E. coli* levels in our study stream. DOH levels might be met by fine-tuning the design & set-up stage. More studies may improve the system and help assess benefits at beach areas. Overall, mycofiltration shows promise in treating high levels of *E. coli* in streams. Considerations for implementation below:

- Design & set-up**
 - “Measure twice, cut once” (Size down if cross-section angles-in)
 - Local myco-chips (Perhaps shipping hindered mushroom growth)
 - Heavy equipment to lift extremely heavy mycototes
 - Must place near water drop with minimal sediment
 - Special lids to deflect high flow and storm debris
- Maintenance**
 - Clear debris and clean totes regularly
 - Change mycelium chips annually (Consider woodchip source, inoculation process, removing & composting “old” material)
- Research & education**
 - Study long-term use and impacts on water/ecological quality
 - Prevent visitor consumption



Considerations: lifting heavy mycototes



Considerations: place totes at water drop, clear debris/sediment

Site Location

Lake Erie State Park,
Chautauqua County, NY

(OPRHP Allegany Region)



About the Park

Lake Erie State Park is located in the Village of Brocton, New York. The high bluffs around the lake provide beautiful sunset views, and the offshore waters are an important habitat for a variety of fish. Many visitors enjoy camping and watching migratory birds. Also, the park is a great place to spot our national bird, the bald eagle.

<http://nysparks.com/parks/129/nature-up-close.aspx>

About Fungi Perfecti

Fungi Perfecti, LLC is a mushroom cultivation company based in Washington State. Their mycofiltration work was featured on TED Talks (Paul Stamets 2008). Testing and development of their mycofiltration systems was funded by an EPA Small Business Innovative Research grant. <http://www.fungi.com/>



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Further Information

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