**Effect of Lake Shinji periphyton upon phosphorus sorption by concrete**

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**Background, hypotheses, and questions:**
Periphyton (attached algae and bacteria) removes phosphorus from water (Craggs 2001, Dodds 2003)
Concrete materials sorb phosphorus from water (Sato et al. 2004, Park and Tai 2004, Takio et al. 2007)
Periphyton may have a preference for recycled concrete material (RCM) type
Periphyton-covered RCM may differ in phosphorus sorption behavior
RCM may be engineered to optimize most favorable periphyton condition (Future Research)

1) What is the phosphorus affinity of RCM?
2) What is the effect of RCM upon periphyton growth in Lake Shinji?
3) What is periphyton effect upon phosphorus sorption by RCM?
4) Is phosphorus sorbed to RCM available to periphyton?

### RCM test cylinder (50mm x 50 mm)

<table>
<thead>
<tr>
<th>Material</th>
<th>Size (mm)</th>
<th>Density (g cm⁻³)</th>
<th>Portland (%)</th>
<th>Aggregate (%)</th>
<th>Unit Weight (kg m⁻³)</th>
<th>Max P Sorption (mg g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass RCM</td>
<td>3-8</td>
<td>1.32</td>
<td>23</td>
<td>77</td>
<td>1186</td>
<td>2.88</td>
</tr>
<tr>
<td>Kimachi RCM</td>
<td>3-8</td>
<td>1.68</td>
<td>19</td>
<td>81</td>
<td>1432</td>
<td>2.34</td>
</tr>
<tr>
<td>Concrete RCM</td>
<td>7-15</td>
<td>1.67</td>
<td>16</td>
<td>84</td>
<td>1440</td>
<td>2.14</td>
</tr>
</tbody>
</table>

Lake Shinji conditions at research site near Izumo (35° 27' 04.38" N 132° 57' 36.32" E)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather</td>
<td>Visual</td>
<td>Rain</td>
<td>Clear</td>
<td>Cloudy</td>
<td>Rain</td>
<td>Cloudy</td>
<td>Sunny</td>
</tr>
<tr>
<td>Depth (m)</td>
<td></td>
<td>0.56</td>
<td>0.51</td>
<td><strong>1.15</strong></td>
<td>0.53</td>
<td>0.46</td>
<td>0.47</td>
</tr>
<tr>
<td>pH</td>
<td>(n/a)</td>
<td>6.42</td>
<td>7.00</td>
<td>7.35</td>
<td>7.55</td>
<td>7.80</td>
<td>7.64</td>
</tr>
<tr>
<td>Conductivity</td>
<td>(sec m⁻¹)</td>
<td>0.38</td>
<td>1.10</td>
<td>0.83</td>
<td>0.12</td>
<td>0.20</td>
<td>0.24</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>35</td>
<td>4</td>
<td>80</td>
<td>37</td>
<td>45</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Dissolved O₂</td>
<td>mg L⁻¹</td>
<td>9.3</td>
<td>6.7</td>
<td>6.8</td>
<td>6.7</td>
<td>7.6</td>
<td>6.2</td>
</tr>
<tr>
<td>Temperature</td>
<td>(°C)</td>
<td>24.5</td>
<td>25.8</td>
<td>26.0</td>
<td>24.5</td>
<td>24.9</td>
<td>29.3</td>
</tr>
<tr>
<td>Salinity (%)</td>
<td></td>
<td>0.2</td>
<td>0.6</td>
<td>0.5</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Dissolved Solids</td>
<td>(g L⁻¹)</td>
<td>2.5</td>
<td>7.0</td>
<td>5.3</td>
<td>0.8</td>
<td>1.3</td>
<td>1.6</td>
</tr>
</tbody>
</table>

1) [Graph showing sorption vs. concentration]
2) [Graph showing sorption vs. time]
Phosphorus Uptake (mg PO₄ g AFDM⁻¹) vs Time (minutes)

- LIVE - Kamachi Stone
- LIVE - Recycled Concrete
- LIVE - Foamed Glass
- DEAD - Kamichi Rock
- DEAD - Recycled Concrete
- DEAD - Foamed Glass

Phosphorus in solution (mg) vs Time (hours)

- Kamachi Rock with Periphyton
- Recycled Concrete with Periphyton
- Foamed Glass with Periphyton
- Kamachi Rock only
- Recycled Concrete only
- Foamed Glass only

Mean Chlorophyll a (mg m⁻²)

- Rock
- Concrete
- Glass

SRP load added to RCM (mg L⁻¹)

- 0
- 25
- 50
- 75
- 100

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Summary:
1) RCM exhibited different P sorption capacities based on composition
2) Lake Shinji periphyton rapidly colonized all RCM with no preference
3) Periphyton biofilms negatively affected dissolved P sorption by RCM
4) Increasing amounts of P sorbed to RCM exhibited both null (rock, concrete) and positive (foamed glass) effects upon periphyton biomass accumulation

References: