Let’s make the Sea of Amagasaki blue!
-Restoring Water Quality of Amagasaki Port-

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Group Activities
Osaka Bay and Amagasaki Port

Two straits

weak currents

Osaka Bay

Seto Inland Sea

Amagasaki City

Sea water came in 1950

Amagasaki lock gate

Below sea level

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Why do we need high seawalls?
Typhoon Muroto in 1934
The highest stage: 5.10m

Mean high water: 2.10m

Typhoon Jane in 1950
The highest stage: 4.30m
Amagasaki Lock Gate protects our city.
Problems

- The canal is separated from the sea.
- The water inside is stagnant.
- Nutrient salts are trapped inside.
- Dissolved Oxygen (DO) is low.
- Red tides and blue tides occur often.
Red tide
Blue tide
Blue tide
(the bottom of the sea)
Improvement of the Water Quality of Amagasaki Port

Local Activity

A Model for Other Enclosed Coastal Seas Around the World

Global Impact
◆ Investigation points
Comparison of DO

- Low DO water disappeared by winter.

Legend:
(1) Less than 3mg/L.
(2) 3 or more and less than 5.
(3) 5 or more.

October 22, 2010
December 13, 2010
Comparison of Transparency and Water Color

The investigation date: October 22, 2010

Investigation points

Depth[m]

1 2 3 4 5 6 7 8

Offshore

1 2 3 4 5 6 7 8

Olive Green Blue
Low DO water rises to surface in fall, and sea life dies.

**Variation in DO Levels**

- 0  - 3 or more and less than 5.
- 3 or more and less than 7.
- 7 or more.

- Less than 3mg/L.

Depth [m] 0 1 2 3 4

Date 7/28 8/25 8/28 9/11 10/22 11/14 12/13 1/14
Blue tides can occur in the canal by temperature change and sea surface wind.
To Improve the Water Quality

We took advantage of cleaning effects of bivalves.
We used these materials...

- Artificial lawn
- Carpet
- Wire netting
- Bamboo blind
- Duckboard
Results...

Left: the 1st day
Upper right: 20 days later
Lower right: 35 days later

<table>
<thead>
<tr>
<th>Materials</th>
<th>Stuck Mass [kg/m^2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artificial lawn</td>
<td>12</td>
</tr>
<tr>
<td>Duckboard</td>
<td>2.1</td>
</tr>
<tr>
<td>(Including acorn barnacles)</td>
<td></td>
</tr>
<tr>
<td>Carpet</td>
<td>0.78</td>
</tr>
<tr>
<td>Wire netting</td>
<td>0.42</td>
</tr>
<tr>
<td>Bamboo blind</td>
<td>Decayed and sunk</td>
</tr>
</tbody>
</table>
Results...

Bivalves stuck most successfully to the artificial lawn.

We concluded that the intricate structure of the artificial lawn was most suitable for the bivalves to live securely and grow well.

Stuck bivalves → [Small Brown Mussel] Scientific name: *Xenostrobus securis*  [Black-Striped Mussel] Scientific name: *Mytilopsis sallei*
Comparison of Water Purification Ability

150g sample of each bivalve species was put in a separate container of 2L of canal water. (923 black-striped mussels/ 19 manila clams)

Then, we compared the water cleaning ability by the decrease of chlorophyll in the water.
Comparison of Water Purification Ability

▲ Black-striped mussel
   Upper: 0min. Bottom: 60min.

▲ Manila clam
   Upper: 0min. Bottom: 60min.
Comparison of Water Purification Ability

- With samples of equal mass, black-striped mussels absorbed more chlorophyll than manila clams.
- It might be hard for manila clams to function properly in canal water.
From the results, we suggest the following plan.

**Spring**
Sink artificial lawns with bivalves attached.

**Summer**
Bivalves take in the organic matter.

**Fall**
Check water DO level.

**Winter**
DO increases.

If DO is high, we can keep growing bivalves.

If DO is low, we need to recover the bivalve-covered materials.

Use as fertilizer.
Bivalves Become Fertilizer

We crushed black-striped mussels and mixed them with soil. Eventually, they were decomposed by bacteria and became fertilizers. Then, we observed growth of turnip leaves which were grown by the bivalve fertilizers.

- Both Bivalve fertilizers grew turnip leaves successfully.
- Therefore, bivalve make good fertilizer.
Life is not sustainable throughout a year.

High concentration nutrient salts:
- red tide, blue tide

Black-striped mussels can absorb nutrient salts and become good fertilizer.

There is a cycle to improve water quality throughout the year.