Objectives:
To establish ecological observation methods on coastal benthic vegetations to estimate their abundance and clarify the biodiversity in tropic waters.

Development of underwater observation methods for coastal vegetation
Objectives: To establish ecological observation methods on coastal benthic vegetations (seagrasses & macroalgae) to estimate their abundance and clarify the biodiversity in temperate and tropic waters.
<table>
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<td>Mapping</td>
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<td>Abundance</td>
<td>Abundance estimation</td>
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<tr>
<td>Community structure</td>
<td>Vegetation analysis</td>
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</tbody>
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Observation methods

- Satellite
- Aerial
- Balloon, Kite
- UW Video, Hydroacoustics
- Dive (Line transect+Quadrat)
Coastal benthic vegetation

Seagrasses
Shallow & Flat sandy bottom

Seaweeds, Macroalgae
Rocky shore
Observation methods

Remote sensing

Satellite

Aerial

Seagrasses

Seaweeds
Observation methods

Hydroacoustics

- Echosounder
- Multibeam sonar
- Sidescan sonar
Underwater Video system using with GPS, echosounder in Otsuchi bay (2003~)

1995

2003

Location

Depth

Video

This study

Quadrats

Traditional
Otsuchi bay: 1995 case
(Hayashizaki et al. 2004 & 2006)

- Small number of quadrat placements
- Summer (June) and Autumn (Sept) observation
- Development of statistical method to estimate abundance
Abundance estimation using Generalized Additive Model (GAM)

✓ Build models to relate abundance and environmental factors

\[ g(y) = \mu = a_0 + \sum_i a_i \cdot x_i + \sum_j f_j(x_j) + \varepsilon \]

Factors:
positions in the bay, water depth

✓ Select the best model by AIC
✓ Graphical presentation & interpretation
✓ Numerical prediction
Distribution of large brown algae abundance in summer

GAMs analysis result

Sargassum (perennial)

Lanimaria & Undaria (annual or biennial)
Characteristics of macroalgal vegetation in Otsuchi bay deduced from GAMs & video analysis

- Canopy-forming large brown algae were luxurious in summer, but die off in autumn.

- In 1995, large brown algae were dominant, especially *Sargassum*, perennials were luxurious.

- In 2003 large brown algae were weaker than before, and the biomass of small macroalgae became significant in autumn.
Low cost digital equipments

GPS

Echo sounder

DV w/underwater video
Otsuchi bay experiment

Main transect (50m)

Sub transect (~40m)

Can get video image with 3D positional information
Observations by underwater video

Sargassum yezoense

Nanamodori (Aug. 18, 2003)
Water depth: -3.4m

Minamikage (Dec. 5, 2003)
Water depth: -4.7m

Lanimaria japonica

Minamikage (Aug. 25, 2003)
Water depth: -4.0m

Minamikage (Dec. 5, 2003)
Water depth: -4.8m
Abundance estimation

Video observation

Distance from shore (m)

Water depth (m)

Matsushima

$\sum$(%cover x weight/m$^2$) over species & video quadrat

Expand to transect line = weight/m$_{shore \ line}$

Laminaria japonica

Small algae

Minimum destructive quadrat samples by SCUBA
Estimated macroalgal biomass in 2003 using underwater video

1. Algal biomass in winter can exceed biomass in summer with luxuriant small macroalgae.
2. Comparable to 4 kg/m$^2$ of macroalgal biomass in St. Margaret Bay, Nova Scotia, Canada (Mann, 1972)
3. Weaker Sargassums than those in 1995

<table>
<thead>
<tr>
<th>Date</th>
<th>Stn.</th>
<th>Laminaria &amp; Undaria</th>
<th>Sargassum</th>
<th>Small Macroalgae</th>
<th>Total wt(kg) per m$^1$ shore line</th>
<th>Biomass (kg/m$^2$)</th>
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</thead>
<tbody>
<tr>
<td>Aug. 2003</td>
<td>Nanamodori</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td></td>
<td>Minamikage</td>
<td>77.76</td>
<td>6.69</td>
<td>7.28</td>
<td>91.73</td>
<td>1.83</td>
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<td>9.32</td>
<td>2.34</td>
<td>44.43</td>
<td>56.09</td>
<td>1.12</td>
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<td>Hiraiso</td>
<td>3.81</td>
<td>0.00</td>
<td>31.15</td>
<td>34.96</td>
<td>0.70</td>
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<tr>
<td>Dec. 2003</td>
<td>Nanamodori</td>
<td>0.00</td>
<td>9.36</td>
<td>62.49</td>
<td>71.85</td>
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<td>Minamikage</td>
<td>189.53</td>
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</tbody>
</table>
Tropic study: Seagrass bed observation
Song Lo, Nha Trang, Vietnam, 27 Sept. 2005
- JSPS coastal oceanography -

- Limited satellite image archives
- Line transect + quadrat
- Floating GPS+underwater video+echo sounder
Seagrass bed observation in Vietnam

Larger coverage
Near sensing method

Speed up
Detection & Mapping

Biomass estimation
Quantification by echosounder

Komatsu et al, 1999

Manta tow
• Man-powered
• Low cost
• Bathymetry

GPS
Echosounder
Underwater video
Styrofoam-box

Reflection
Wind

Too shallow
Less maneuverable

Line transect as ground truth
Seagrass bed observation in Vietnam

Line transect + quadrat: Saito-Atobe method
- 50m (line A) + 50m (line B)

Species composition by Saito-Atobe method

<table>
<thead>
<tr>
<th>Name of Species</th>
<th>%cover</th>
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<tbody>
<tr>
<td>Thalassia hemprichii</td>
<td>490.5</td>
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<tr>
<td>Enhalus acoroides</td>
<td>348.0</td>
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<tr>
<td>Caulerpa sertulariodes</td>
<td>237.0</td>
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<tr>
<td>Caulerpa sp</td>
<td>107.2</td>
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<tr>
<td>Hypnea sp</td>
<td>6.2</td>
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</table>
Future plan

Hierarchical monitoring of vegetation
Habitat mapping

& Numerical prediction of benthic vegetation
Conclusion

• Under water video system can provide large amount of information as visual images on benthic vegetations & their environment.

• Archived video images could act like herbaria for ecological study of seaweeds and seagrasses.

• Possibility of abundance estimation of benthic vegetation
Thank you for your attention