A comparative study of distribution pattern of two endangered benthic animals on artificial and natural tidal flats

Takashi Kawai & Naotomo Ota
Anan National College of Technology, Japan
“Recover 40% loss”

- 40% area of tidal flat was lost in Japan
- Artificial construction is practical way
- Dredged material is increasingly regarded as a potential resource

“What factor is crucial for habitat creation?”
Ohgata Port tidal flat

East of Shikoku

Japan

Tokyo
Course of land reclamation

(1) 1986 reclamation plan was formulated

(2) 1991 start of project embankment construction

(3) 1990-1994 sheet-pile breakwaters located navigation dredging was disposed

(4) 1998-2000 mountain soils was disposed over the 2/3 of dredging materials
Unintentionally created tidal flat formed by dredged & terrestrial materials with abundant endangered organisms!

Coarse mountain soils

50 m

Reclaimed in 2008

Fiddler crab
_Uca arcuata_

15 endangered benthic animals were found

Mud snail
_Cerithidea rhizophorarum_

Dredged fine materials

Reed marsh

50 ha

Formerly plan

Coarse mountain soils
Dredged fine materials

Coarse mountain soils

Coarse mountain soils
Fiddler crab *Uca arcuata* and mud snail *Cerithidea rhizophorarum* are most abundant species.

Objective 1: density comparison created vs. natural habitat

Method 1: quantitative sampling in 1 created and 2 natural habitats
Ohgata created vs. Natural tidal flats

(1) Ohgata created

(2) Nakagawa

(3) Katsuuragawa
ecological processes at the early stage may be variable.
**density comparison in snail**

- **(1) Ohgata**
- **(2) Nakagawa**
- **(3) Katsuuragawa**

**Dredged fine materials**

**Coarse mountain soils**

**Muddy (dredged materials or mud)**

**Sandy (mountain soils or sand)**

**a) Adults**

Aug-2009

- similar level

**b) Juveniles**

sandy preference

- Aug-2009

Number/0.25m² (±SE)

- (1) Ohgata created
- (2) Nakagawa natural
- (3) Katsuuragawa natural
Objective 1: density comparison created vs. natural habitat

Result 1: 
a) Density in the created habitat was comparable with natural one.
b) Distribution pattern/mechanism was different between the two species.
Objective 2:
2-1. habitat preference
2-2. recruiting processes to a newly created habitats of the two species

Method 2:
Sediment manipulation experiment
Setting of Experiment (from April 2007)

- Dredged fine materials
- Coarse mountain soils

particle proportion

Coarse mountain soils
Dredged fine materials

- Cray
- Silt
- Sand
- Gravel

Dig & backfill

Dredged materials

0.5 m in depth
2m 3m 2m

16m

50cm

2m

DFM
Recruitment/immigration of crab

- Reached a ceiling within 4 months
- Rapid increase only on dredged fine materials

**Graph Details:**
- **X-axis:** Time (Apr-2007 to Oct-2010)
- **Y-axis:** Number/m² (±SE)
- **Legend:**
  - Dredged fine materials
  - Coarse mountain soils
- **Statistical Test:** MANOVA: treatment x time, p<0.001
**Experiment (1-4 years) vs. Aged (> 13 years)**

**Density comparison**

- A. Experimental area (1-4 years aged)
- B. Edge (>13 years aged)
- C. Inner (>13 years aged)

**Lower than the inner: Why?**

Experiment (1-4 years) = Edge (>13 years)
Experiment (1-4 years) vs. Aged (>13 years)

Body size aspect

A. Experimental area (1-4 years aged)

B. Edge (>13 years aged)

C. Inner (>13 years aged)

Experiment (1-4 years) = Edge (>13 years) skewed to large individuals

wanderers without burrows

Sep-2009

A. Experimental area

B. Edge (>13 years aged)

C. Inner (>13 years aged)

Many recruits and settlers with burrows in the inner

Experiment successfully simulated the edge part.
For the maintenance of population, the inner part is more important.
Recruitment/immigration of snail

Gradual increase on the both sediments
Coarse mountain soils > Dredged fine materials

MANOVA:
treatment x time, p<0.001
Experiment (3 years) vs. Aged (>13 years)

Density comparison

A. Dredged fine materials (>13 years aged)
B. Dredged fine materials (Experiment)
C. Coarse mountain soils (Experiment)
D. Coarse mountain soils (>13 years aged)

Experiment (3 years) = Aged (>13 years)
**Experiment (3 years) vs. Aged (>13 years)**

**Body size aspect**

- **A. Dredged fine materials (>13 years aged)**
- **B. Dredged fine materials (Experiment)**
- **C. Coarse mountain soils (Experiment)**
- **D. Coarse mountain soils (>13 years aged)**

### a) Adults

<table>
<thead>
<tr>
<th>Number/0.25 m² (±SE)</th>
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<td>Aug-2009</td>
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### b) Juveniles

- Preference of juvenile is strong.

### Comparable density of both generation occurred
Experiment (3 years) vs. Aged (>13 years)

Food resource (Chlorophyll a)

Amount of food may be important at the juvenile stage

![Diagram showing food resource comparison between Experiment (3 years) and Aged (>13 years) for different types of soils.](image)

- A. Dredged fine materials (>13 years aged)
- B. Dredged fine materials (Experiment)
- C. Coarse mountain soils (Experiment)
- D. Coarse mountain soils (>13 years aged)

The graph illustrates that:

- A. Dredged fine materials (Aged) have a lower amount of food resource (Chlorophyll a) compared to the other samples.
- B. Dredged fine materials (Experiment) have a moderate amount of food resource (Chlorophyll a).
- C. Coarse mountain soils (Experiment) have a slightly higher amount of food resource (Chlorophyll a) than B.
- D. Coarse mountain soils (Aged) have the highest amount of food resource (Chlorophyll a) among all samples.

The bar chart indicates that there is a statistically significant difference in food resource (Chlorophyll a) between the Aged and Experiment samples, with the Aged samples showing higher values.

**Conclusion:**

- Higher in Coarse mountain soils
- Amount of food may be important at the juvenile stage
**Objective 2:**

2-1. habitat preference

2-2. recruiting processes to a newly created habitats of the two species

**Result 2:**

**Crabs:**
- Strongly preferred fine sediment
- Only large crabs quickly immigrated

**Snails:**
- Juveniles preferred sandy sediment
- Slowly recruited, but steady
For successful habitat creation

- Importance of detailed ecological processes of each target species
  - Importance of micro habitat
    - Inner habitat for the fiddler crab
  - Habitat preference
    - Creation of multiple habitats would promote coexistence of species