

Fiscal 2005 Study on Verification of Seaweed Bed Development in Omaezaki Port

[Abstract]

The Basic Plan for Seaweed Bed Development in Omaezaki Port intends to develop seaweed beds by using an environmentally-friendly breakwater; zoospores are supplied from retarding areas where seaweed is grown, so that new seaweed beds are developed around the breakwater.

In the sequential studies since fiscal 2000, mother plants were transplanted on a large scale to retarding areas, a measure to prevent feeding damage was taken, and monitoring surveys have been conducted. As a result, the presence of new seaweed plants outside the retarding areas and the effectiveness of slit caissons as a supply source of zoospores were confirmed.

The succeeding monitoring surveys conducted in fiscal 2005 revealed the presence of a mixed community of mother plants transplanted in fiscal 2003, second-generation plants germinated in fiscal 2004, and third-generation plants germinated in fiscal 2005 as well as small-scale seaweed beds within the retarding areas.

1. Study items

The study items are listed in Table 1.

2. Study method

Table 1 Locations and items of field study

Study item		Location	Description
Field study	Fixed-point survey	Inside of retarding area 1 of No. 38 and retarding area 3 of Nos. 40 through 42 and 48	The growth and density of sea trumpet, feeding damage, plant and animal species, coverage, and deposition of floating mud are observed within a square (1 m x 1 m) at four locations.
	Traverse-line survey	Front of retarding area 1 of No. 38 and retarding area 3 of Nos. 40 through 42 and 48	The growth and density of sea trumpet, feeding damage, plant and animal species, coverage, and deposition of floating mud are observed within consecutive squares (4 m x 4 m) that cover the caisson front wall, foot protection block, and armor stone areas.
	Complementary survey	Retarding areas and front of Nos. 38 through 48	Locations of sea trumpet growth, approximate population, seaweed lengths, and feeding damage are observed.
	Survey on swarming fish and shellfish	Front of retarding area 3 of No. 41 and C construction area	Species and population of fish and shellfish that appear in the retarding area and its frontal area are observed.
	Light quantity measurement	Retarding area 3 of Nos. 40 through 42 and retarding area 2 of No. 48	Light quantity in the retarding areas is measured by using a quantum counter to investigate whether light quantity is affected by the feeding damage prevention.
	Removal of sea urchins	Retarding areas of Nos. 38, 40 through 42, and 48 (excluding retarding area 3 of No. 41)	Sea urchins are removed to protect sea trumpet from feeding damage.
	Survey on feeding damage prevention	Slits of Nos. 38, 40 through 42, and 48	The feeding damage prevention is checked for damage and degradation. Minor damage is repaired underwater. The protection net is removed if a large amount of organisms adhere to the net.

Note 1. The numbers preceded by "No." indicate slit caisson numbers.

Note 2. Retarding area 3 is the third retarding area from the left when viewing from the front of a slit caisson.

3. Study results

(1) Fixed-point survey

The results of the fixed-point survey are shown in Figure 3-1, and the growth of sea trumpet in a retarding area is shown progressively in Photo 3-1.

The second-generation juveniles germinated in fiscal 2004 grew steadily in the retarding areas. In 2005, germination of third-generation plants was observed. Therefore, there was a mixed community of first- to third-generation plants including mother plants. The population of sea trumpet excluding mother plants decreased probably because of natural depletion and destructive waves associated with typhoons. In fact, newly germinated juveniles were not found in the February 2006 survey.

Average seaweed and stem lengths remained almost unchanged from June to December 2005, and significant growth was observed in the February 2006 survey. It is inferred that the seaweed grew during the June to December period but shoot tip injury occurred at the same time.

Little feeding damage caused by *Siganus fuscescens* was found, which confirms the effectiveness of the feeding damage prevention.

<1> Number of plants per chamber <2> Average seaweed length <3> Average stem length

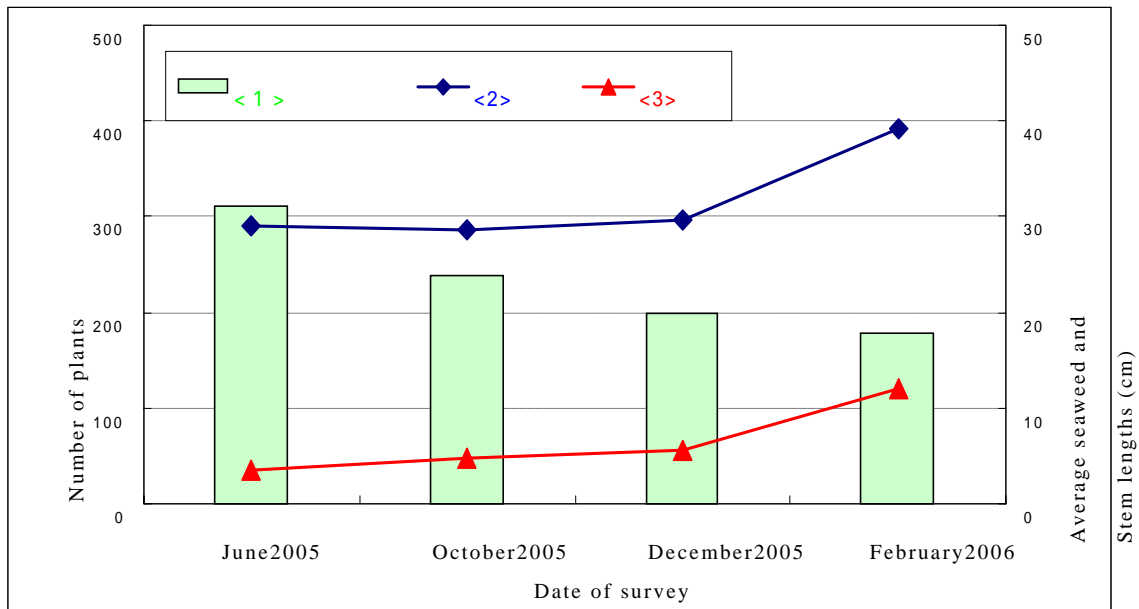


Figure 3-1 Population, average seaweed length, and average stem length of sea trumpet in fixed-point survey

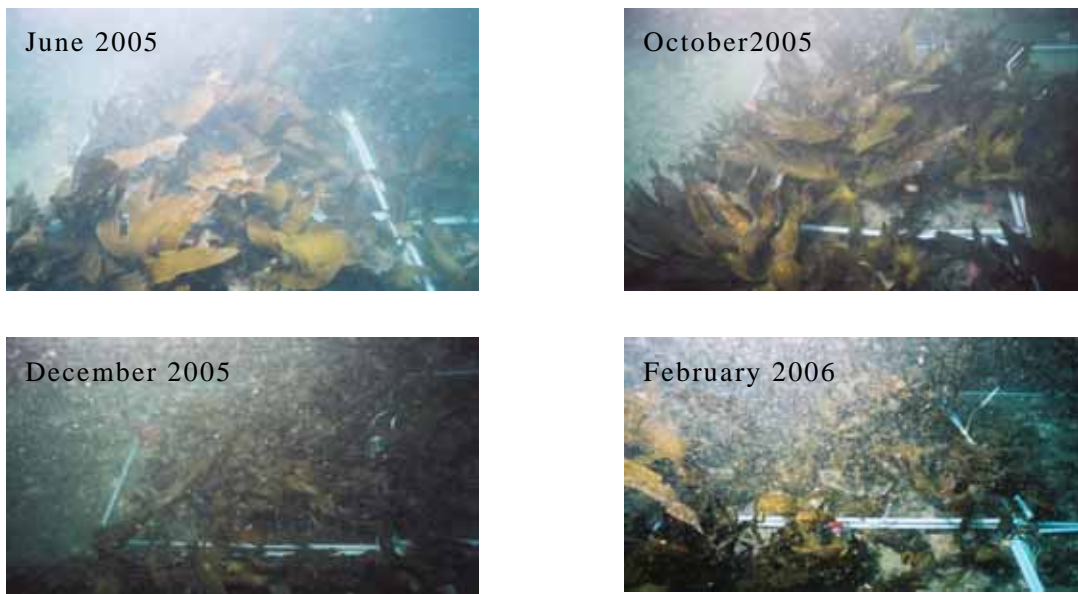


Photo 3-1 Growth of sea trumpet in retarding area 3 of No. 41 caisson

(2) Traverse-line survey

The results of the traverse-line survey are shown in Figure 3-2, and the growth of sea trumpet in the frontal area of a caisson is shown progressively in Photo 3-2.

The second-generation juveniles germinated in 2004 disappeared by December 2004. Then, germination of third-generation plants was observed in 2005, and seaweed beds developed widely in front of the caissons mainly around the foot protection blocks. The population of sea trumpet decreased from June to December 2005, presumably because of feeding damage, natural depletion, and waves. New plants emerged and the population increased in the February 2006 survey. The same pattern of seasonal variation (a decrease in population from summer to fall and an increase from winter to spring) was also observed in fiscal 2004.

The seaweed length of sea trumpet decreased from June to December 2005. It is inferred that, during this period, the seaweed grew but the population decreased because of dropouts, so that the average seaweed length decreased. During the period from December 2005 to February 2006, the average length was suppressed by the addition of small juveniles.

<1>Number of plants per chamber <2>Average seaweed length <3>Average stem length

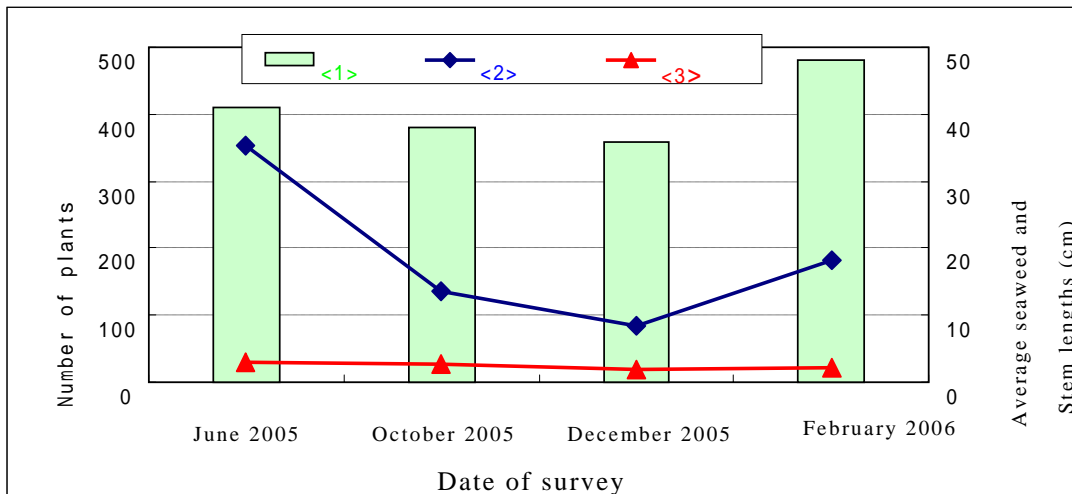


Figure 3-2 Population, average seaweed length, and average stem length of sea trumpet in traverse-line survey



Photo 3-2 Growth of sea trumpet plants in front of retarding area 3 of No.41 caisson

As shown in Figure 3-3, the population of sea trumpet plants and the area of seaweed beds decreased significantly by December 2005 and then increased. The same trend of population decrease from summer to fall and increase from winter to spring was observed in fiscal 2004, although disappearance of seaweed beds due to feeding damage was observed in December 2005.

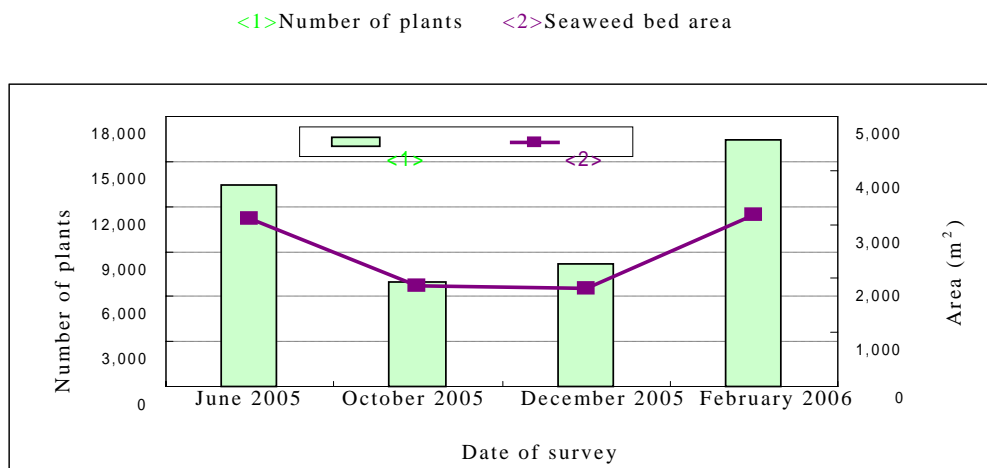


Figure 3-3 Approximate population of sea trumpet plants and area of seaweed beds in complementary survey

(4) Survey on swarming fish and shellfish

Prionurus scalprum and *Siganus fuscescens* were observed in the C construction area in June 2005 and in many areas in October 2005.

(5) Light quantity measurement

June 2005 (fair day): about 136 $\mu\text{E}/\text{m}^2/\text{s}$ with feeding damage prevention; about 208 $\mu\text{E}/\text{m}^2/\text{s}$ without prevention (average for Nos. 40 to 42)

October 2005 (cloudy day): about 5 $\mu\text{E}/\text{m}^2/\text{s}$ with feeding damage prevention; about 35 $\mu\text{E}/\text{m}^2/\text{s}$ without prevention (average for Nos. 40 to 42)

December 2005 (fair day): about 9 $\mu\text{E}/\text{m}^2/\text{s}$ with feeding damage prevention; about 11 $\mu\text{E}/\text{m}^2/\text{s}$ without prevention (average for Nos. 40 to 42)

February 2006 (fair day): about 9 $\mu\text{E}/\text{m}^2/\text{s}$ with feeding damage prevention; about 11 $\mu\text{E}/\text{m}^2/\text{s}$ without prevention (average for Nos. 40 to 42)

Light quantity in the retarding areas was reduced when the feeding damage prevention was used.

(6) Removal of sea urchins

A total of 339 individuals of *Sea urchins* (such as *Temnopleurus toreumaticus*, *Anthocidaris crassispinga*, *Pseudocentrotus depressus*, and *Diadema setosum*) were removed during the four surveys in fiscal 2005.

(7) Survey on feeding damage prevention

A total of 240 feeding damage prevention nets were damaged. The damage started from the upper slit area and then gradually extended to the middle slit area.

It is considered that the protection nets were damaged because of their friction with barnacles adhered to the attachment frames and impact with drifting objects. Most of the sever damage observed was probably caused by high waves that produced forces exceeding the breaking strength of the nets.

(8) Summary of progression (fiscal 2003 to 2005)

The development of sea trumpet plants in the retarding areas with time since fiscal 2003 is summarized in Figure 3-4.

The above study results indicate the effectiveness of the method adopted in the western part of Omaezaki Port to develop seaweed beds by using an environmentally-friendly breakwater. In this method, retarding areas are created in slit caissons as a supply source of zoospores (mother zone) and the retarding areas are protected from attacks by herbivorous fish.

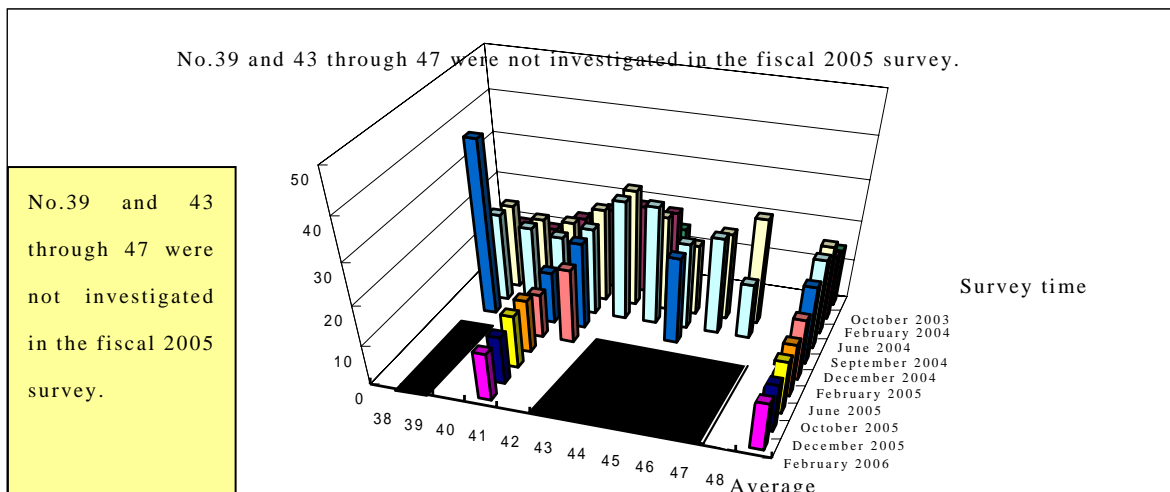
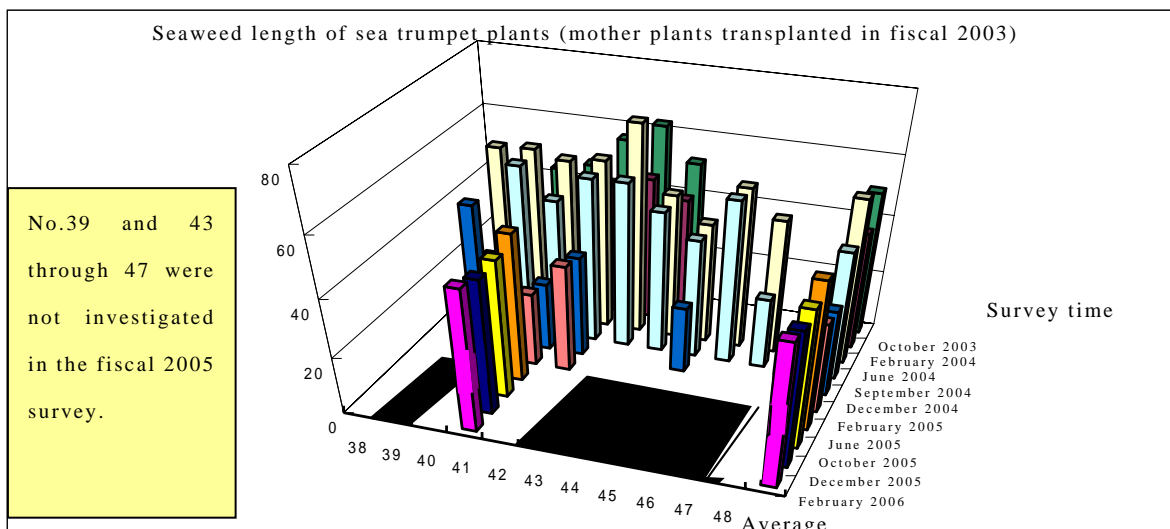
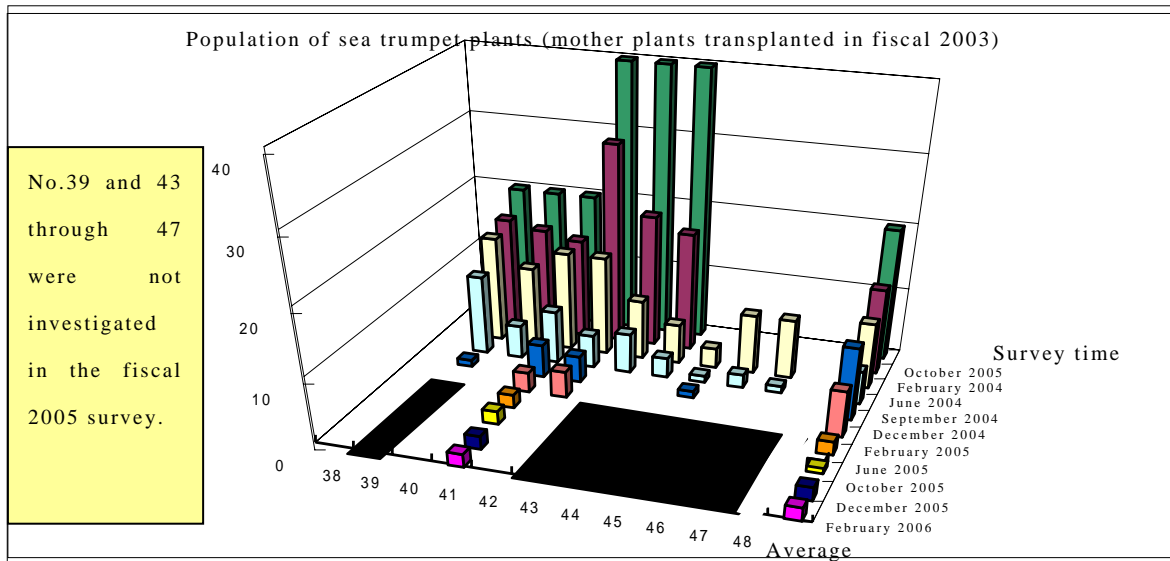


Figure 3-4 Development of sea trumpet plants (mother plants transplanted in fiscal 2003) in retarding areas with time

Note 1. The fixed-point survey was conducted in retarding area 1 of No. 38 and retarding area 3 of the other caissons.

Note 2. The results of the February 2004 and preceding surveys are from the Report of Fiscal 2003 Study on Verification of Seaweed Bed Development in Omaezaki Port.