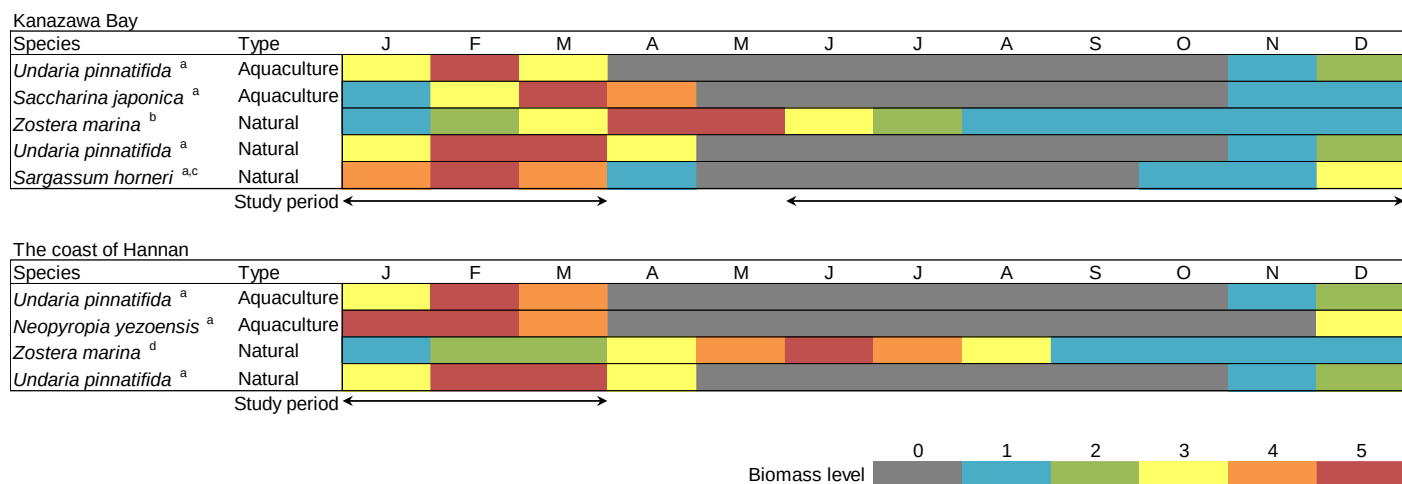




**Fig. S1** Seasonal changes in the biomass level in each macrophyte habitat in Kanazawa Bay and off the coast of Hannan. Biomass levels were classified into six levels based on the information. The biomass level "0" indicates that there is almost no biomass, and the maximum annual biomass is assumed to be "5", which was divided uniformly into each level.

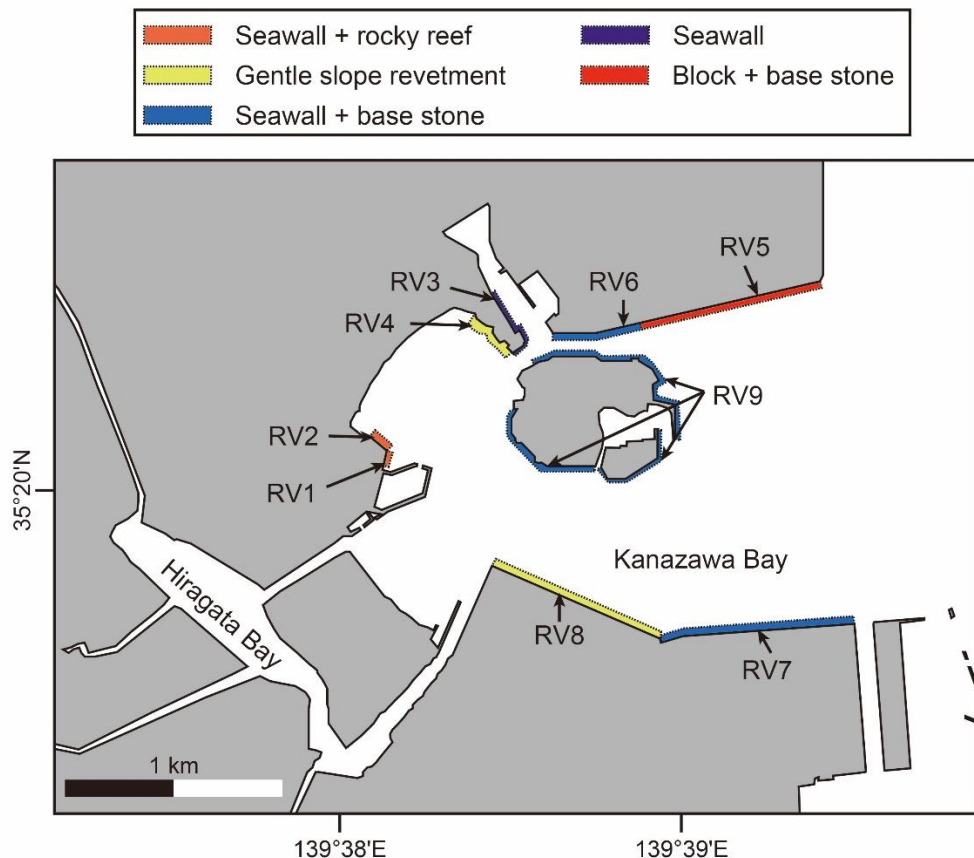
<sup>a</sup> Watanabe et al., unpublished data; <sup>b</sup> Aioi, 1980; <sup>c</sup> Terawaki, 1986; <sup>d</sup> Fujiwara et al., 2009.

## Appendix S1. Habitat area and biomass of natural macroalgae and seagrass beds

The habitat area and biomass of macroalgae inhabiting artificial revetments were investigated in February 2019 in Kanazawa Bay. A transect line was set up for each of the nine revetments with different cross-sectional structures, from the shore to the end of the structure (Fig. S2). Four to eleven quadrats ( $1\text{ m} \times 1\text{ m}$ ) were located at equal intervals along each transect line to measure the coverage of the dominant macroalgae, *Sargassum* spp. and *Undaria pinnatifida*. Biomass (dry weight: DW) per unit area was estimated by multiplying the average biomass at the quadrat of 100% macroalgae cover by each coverage. The total area of each surface was estimated by measuring the lengths of the vertical and bottom surfaces of each revetment.

The total surface areas of the vertical and bottom surfaces of the revetments were estimated to be  $19,642\text{ m}^2$  and  $86,062\text{ m}^2$ , respectively (Table S1). The mean biomass of macroalgae inhabiting the vertical and bottom surfaces of the revetments were  $\sim 179\text{ g-DW m}^{-2}$  and  $\sim 3484\text{ g-DW m}^{-2}$ , respectively (Table S1). The total macroalgae biomass associated with the revetments in Kanazawa Bay was estimated to be about 25 tons dry weight.

Seagrass biomass per unit area in Kanazawa Bay was measured by using quadrats in June 2019 and February 2021. The mean above- and below-ground biomasses of seagrass were  $33\text{--}343\text{ g-DW m}^{-2}$  and  $116\text{--}162\text{ g-DW m}^{-2}$ , respectively. We used the habitat area of seagrass in Kanazawa Bay estimated in previous studies (about  $110,000\text{ m}^2$ ; Kuwae et al., 2022; Tanaka et al., 2017) to estimate the total biomass of seagrass in the bay as 21–50 tons dry weight.



**Fig. S2** Distribution and structure types of revetments in Kanazawa Bay

**Table S1** Length and surface area of revetments and the biomass of macroalgae inhabiting the revetments.

| Revetment<br>ID | Revetment | Vertical surface   |                         | Bottom hard structure |                         | Total   | Structure type         |
|-----------------|-----------|--------------------|-------------------------|-----------------------|-------------------------|---------|------------------------|
|                 | length    | Total surface area | Macroalgae biomass      | Total surface area    | Macroalgae biomass      | biomass |                        |
|                 | (m)       | (m <sup>2</sup> )  | (g-DW m <sup>-2</sup> ) | (m <sup>2</sup> )     | (g-DW m <sup>-2</sup> ) | (kg-DW) |                        |
| RV1             | 69        | 69                 | 168                     | 207                   | 341                     | 82      | Seawall + rocky reef   |
| RV2             | 93        | 93                 | 0                       | 1581                  | 3484                    | 5508    | Seawall + rocky reef   |
| RV3             | 352       | 1056               | 56                      | —                     | —                       | 59      | Seawall                |
| RV4             | 280       | —                  | —                       | 3640                  | 715                     | 2603    | Gentle slope revetment |
| RV5             | 852       | 4260               | 28                      | 32,376                | 0                       | 119     | Block + base stone     |
| RV6             | 385       | 1887               | 0                       | 15,785                | 25                      | 395     | Seawall + base stone   |
| RV7             | 1,055     | 4853               | 0                       | 11,605                | 79                      | 917     | Seawall + base stone   |
| RV8             | 820       | —                  | —                       | 10,660                | 398                     | 4243    | Gentle slope revetment |
| RV9             | 1856      | 7424               | 179                     | 10,208                | 944                     | 10,965  | Seawall + base stone   |
| Total           | 5762      | 19,642             |                         | 86,062                |                         | 24,891  |                        |

**Table. S2** Time periods and datasets used for generalized linear models.

| Time period      | Site         | Dataset                                                   |
|------------------|--------------|-----------------------------------------------------------|
| Annual           | Kanazawa Bay | October 2017–September 2018                               |
| February–March   | Kanazawa Bay | February–March 2018 and February–March 2019               |
| June–July        | Kanazawa Bay | June–July 2018                                            |
| August–September | Kanazawa Bay | August–September 2018                                     |
| October–November | Kanazawa Bay | October–November 2017 and October–November 2018           |
| December–January | Kanazawa Bay | December 2017–January 2018 and December 2018–January 2019 |
| January–March    | Hannan coast | January 2020, February 2021, and March 2021               |

**Table. S3** Biomass-based gross community production (GCP), community respiration (CR), net community production (NCP), community calcification (CC), dissolved organic carbon (DOC) release, biomass, and area of macroalgae farms growing *Undaria pinnatifida* and *Saccharina japonica* in 2021. For carbon metabolism variables, means  $\pm$  standard deviations are shown.

| Site/Species          | Date        | GCP                                            | CR       | NCP      | CC                                               | DOC release | Biomass                  | Area             |
|-----------------------|-------------|------------------------------------------------|----------|----------|--------------------------------------------------|-------------|--------------------------|------------------|
|                       |             | ( $\mu\text{mol-C g-DW}^{-1} \text{ h}^{-1}$ ) |          |          | ( $\mu\text{mol-C g-DW}^{-1} \text{ day}^{-1}$ ) |             | ( $\text{g-DW m}^{-2}$ ) | ( $\text{m}^2$ ) |
| Kanazawa Bay          |             |                                                |          |          |                                                  |             |                          |                  |
| <i>U. pinnatifida</i> | 9 February  | 69.8±23.5                                      | 7.8±1.6  | 561±256  | 17.7±4.2                                         | 173±21      | 471                      | 19,950           |
|                       | 22 February | 55.7±10.6                                      | 12.4±3.1 | 325±140  | 45.7±11.3                                        | 205±7       | 401                      | 19,950           |
| <i>S. japonica</i>    | 9 February  | 80.5±6.2                                       | 1.9±0.3  | 819±67   | −19.1±3.5                                        | 61.7±17.2   | 20                       | 4050             |
|                       | 15 March    | 131±44                                         | 19.0±3.6 | 1100±535 | 12.5±7.5                                         | 128±78      | 67                       | 4050             |
| Hannan coast          |             |                                                |          |          |                                                  |             |                          |                  |
| <i>U. pinnatifida</i> | 28 January  | 41.4±2.9                                       | 5.3±1.4  | 305±45   | 24.5±6.4                                         | 143±15      | 392                      | 42,128           |
|                       | 24 February | 53.7±1.7                                       | 6.9±0.5  | 393±22   | −34.4±2.7                                        | 108±8       | 528                      | 42,128           |
| <i>N. yezoensis</i>   | 28 January  | 77.7±19.8                                      | 10.9±1.1 | 616±225  | 68.9±11.0                                        | 244±27      | 567                      | 18,825           |
|                       | 24 February | 109±4                                          | 15.8±3.5 | 847±94   | 25.7±5.4                                         | 286±6       | 511                      | 18,825           |

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