Identification of wakame (Undaria pinnatifida) living in the seawater based on the spectral reflectance measurements for satellite remote sensing

*Asako Kitai[1], Wataru Taneya[1], Natsumi Inoue[2], Kaihe Yamazaki[3], Deepak H V[2], Hiroshi Kawamata[1,4], Nobuyasu Naruse[1,4,5], Yukihiro Takahashi[1,6]

1. Global Science Campus, Hokkaido University, 2. Graduate School of Life Science, Hokkaido University, 3. Graduate School of Environmental Science, Hokkaido University, 4. Institute for the Advancement of Higher Education, Hokkaido University, 5. Shiga University of Medical Science, 6. Faculty of Science, Hokkaido University

Wakame (Undaria pinnatifida) is nominated on 100 of the World’s Worst Invasive Alien Species. This seaweed invasion causes serious problems on local biological diversity and human activities. In New Zealand the lobster farms were forced to close due to the invasion. In order to accurately identify the wakame areas, field survey and remote sensing have been performed so far. Field survey has limited the monitoring area. Satellite remote sensing is expected to map the proliferating areas of wakame. Previous remote sensing researchers reported, 1) a method to estimate the marine forest from the ocean temperature and the current, and 2) a monitoring using some indices of satellite images of various bands.

However, the former method is difficult to specify the marine forest due to an indirect estimation. The latter can also be unable to distinguish the marine forest unless the extinction coefficient (wavelength dependence of light attenuation by seawater) in the local sea area is known. Moreover, the previous researches have problems that the influence of seawater to the reflectance of seaweed is not sufficiently taken into consideration due to their analysis based on the spectra measured outside seawater. There is also a problem that only wakame areas cannot be distinguished from other marine forest.

In this research, to solve the above problems, we aim to establish a remote sensing sensitive to identification of wakame area by directly measuring the spectral reflectance of wakame inside seawater.

With the cooperation of Enoshima Aquarium, we measured the water depth dependence of wakame spectra (in the range of 380-1050 nm) inside seawater as follows. The halogen lamp light was irradiated from outside of the aquarium. A white board as a reference set on each depth (10 - 90 cm) in seawater and the spectral reflectance of wakame at the depth were measured using a homemade spectrometer. Our observation showed the intensity of light becomes undetectable below 580 nm and over 900 nm at over 30 cm depth. We found remote sensing using some bands in the wavelength range of 580 - 900 nm is indispensable. In addition, based on the water depth dependence of the reflectance for the white board, the spectrum of wakame at a large depth was deduced from the spectrum measured at 30 cm depth. Consequently, we can sufficiently detect the characteristic spectra of wakame even at water depth of over 90 cm. Considering the seasonal changes of marine forest, we can perform a remote sensing to distinguish the wakame area from other marine forest.

The authors thank Enoshima Aquarium for the support of experiments. This work was supported by Hokkaido Uniersity Super Scienist Program (SSP) of Global Science Campus (GSC), Japan Science and Technology Agency (JST)

Keywords: wakame (undaria pinnatifida), reflection spectra under water, remote sensing