

In situ and Instantaneous Determination of Primary Production in Representative Lakes in Japan by Using a New Method

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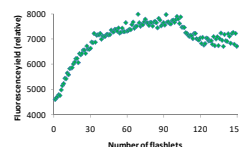
What is primary production (PP)?

PP is the organic matter produced through photosynthesis. PP plays an important role in the carbon cycle and other ecosystem functions in the inland waters and will likely be influenced by global warming.

Applied

What is Fast Repetition Rate Fluorometry (FRRF)?

FRRF is a powerful method for estimating PP in situ based on chlorophyll fluorescence in response to pulsed irradiation.



$$P^*_{O_2}(E) = E \cdot \sigma_{PSII} \cdot n_{PSII} \cdot f \cdot qP(E) \cdot \phi_e(E)$$

Advantage & Disadvantage

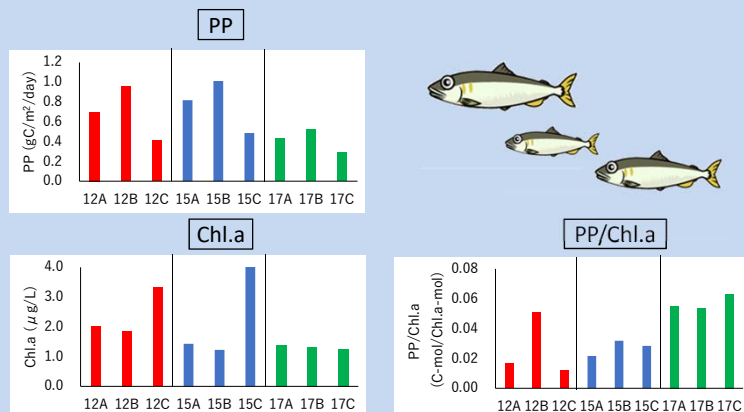
Unlike traditional methods (e.g., ¹³C and ¹⁴C methods), FRRF does not require incubation and can instantaneously estimate PP in situ. FRRF measurements do not use radioisotopes.

FRRF detects weak chlorophyll fluorescence; consequently, it is difficult to estimate PP in the surface layer of lakes under strong sunlight conditions.

Overcoming the disadvantage

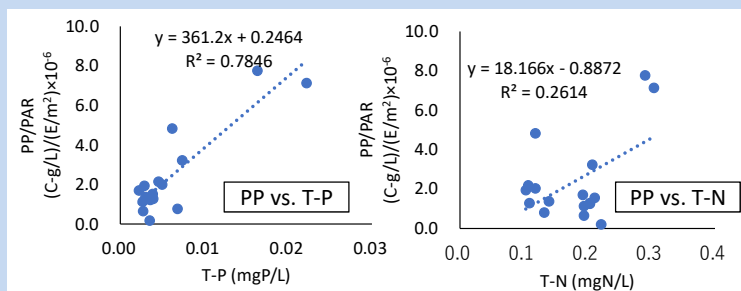
The wavelength of chlorophyll fluorescence detection is around 680 nm. To measure PP in the surface layer by FRRF, over the sensor we installed a short-pass filter that cut sunlight with wavelengths longer than 650 nm.

PP distribution in Lake Biwa in May 2018



- ✓ PP was higher at the middle stations (12B, 15B, 17B), and was lower near the lakeside.
- ✓ PP was higher at the southern stations (12A-C) than at those in the north (17A-17C).
- ✓ PP/Chl a was, conversely, higher to the north.

The relationship between PP and water quality

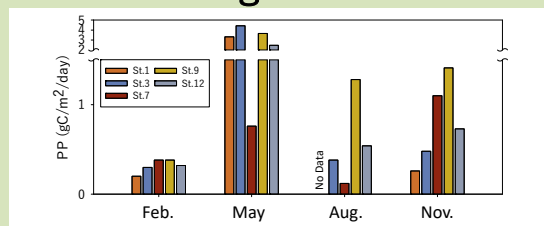


- ✓ PP was affected by total phosphorus (TP) rather than total nitrogen (TN).
- ✓ PP was also affected by some organic matter, which absorb ultraviolet light at 254nm, (UV254 absorbance) but not affected by the total concentration of organic matter.
- ✓ These results were generated by principal component analysis (PCA).

Conclusion

In Lake Biwa, PP was higher toward the south; conversely, PP/Chl a was higher toward the north. Those differences might be related to water quality. Correlation analysis and PCA results show that TP and UV254 affect PP. In Lake Kasumigaura, PP was mainly affected by anthropogenic activities in rural areas, especially in May.

PP distribution in Lake Kasumigaura in 2016



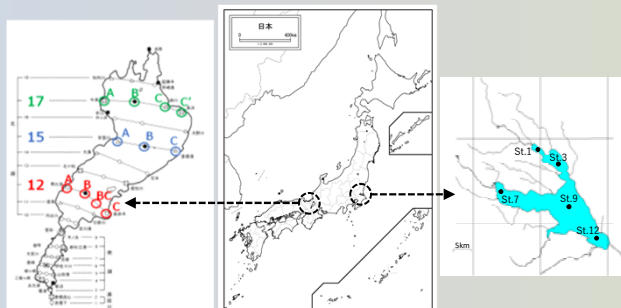
- ✓ PP was highest in May, except at Station 7.
- ✓ Stations 1 and 3 were affected by rural areas, and Station 7 was affected by an urban area
- ✓ Rice cultivation starts in May, and a large load of nutrients flowed into the lake then, potentially affecting PP at Stations 1 and 3.

Lake Biwa

- ✓ Largest lake in Japan (670 km²)
- ✓ Average depth around 41 m
- ✓ The NIES Lake Biwa Branch Office is near this lake

Survey

- The stations were 12A, 12B, 12C, 15A, 15B, 15C, 17A, 17B, and 17C.
- The survey was conducted in Mar., May, Jul., and Nov. 2018



Lake Kasumigaura

- ✓ Second largest lake in Japan (220 km²)
- ✓ Average depth around 4 m
- ✓ The main campus of NIES is near this lake.

Survey

- The stations were 1, 3, 7, 9, and 12.
- The survey was conducted monthly from 2016 to 2018.