



COVERAGE EXTENT AND DAY-NIGHT ASYMMETRY DETERMINE THE EFFECTS OF FLOATING PHOTOVOLTAICS ON THERMAL STABILITY OF LAKES: A MESOCOSM EXPERIMENT

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Floating Photovoltaics (FPVs) are a rapidly emerging renewable energy technology, consisting of photovoltaic panels installed on water surfaces. While FPVs can limit the competing pressure on land and often outperform land-based arrays in efficiency, the understanding of their environmental impacts remains limited. By physically blocking direct solar radiation and modifying wind conditions at the water surface, these installations can alter the energy balance of aquatic systems. Beyond reducing average lake temperatures, the influence of FPVs on thermal variability remains understudied, despite its potential to reshape lake ecosystem dynamics. Such alterations are predicted to depend on the extent of FPV coverage and on local variability of solar radiation incidence. This study investigates the individual and interactive effects of FPV coverage (0%, 25%, 45%, and 65%) on daytime (DT) and nighttime (NT) water thermal variability using a mesocosm experiment. Temperature data was collected over four months (May to September 2023) at 30-minute intervals. We found that FPV coverage had significant individual and interactive effects with the time of day on thermal dynamics. FPV coverage decreased variability, with effects more pronounced during the DT. At 25%, 45%, and 65% coverage, DT thermal stabilization increased by approximately 15%, 25%, and 55%, respectively, compared to 8%, 15%, and 40% during NT. For instance, the 65% coverage level disproportionately reduced variability, suggesting a non-linear relationship between coverage extent and water thermal dynamics. The results show that FPVs reduce thermal fluctuations, most notably during the DT and at higher coverage levels. Consequently, these shifts can decouple lakes from natural heating cycles, potentially impairing



ecological functioning under extensive coverage. Thus, identifying critical thresholds where renewable energy expansion will not compromise the metabolic and structural stability of freshwater ecosystems is fundamental.

Keywords: *FPV; thermal variability; renewable energy*