Development and Validation of a Hydrodynamic Model of Macroalgae Longlines

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ABSTRACT

Successful design and operation of a macroalgae farm demands accurate models for analyzing the system behavior in waves and currents. In this study, we performed a series of tank tests of a physical model of a 1-m section of a kelp longline with 3-m long kelp fronds. Normal and tangential drag coefficients, as well as added mass coefficients, were derived from tow tank and forced oscillation testing of the physical model. These coefficients were used to build a Finite Element hydrodynamic model [2] of macroalgae longlines using a modified Morison formulation [1].

Structural properties of the physical kelp model were also incorporated. Results from the numerical model showed good agreement with the experimental results. A multi-variate sensitivity study was applied to understand the effects of the hydrodynamic and structural parameters on the resultant forces. Finally, the RMS error between numerical and experimental results was quantified for a series of simplifying assumptions applied in the numerical model. These assumptions included neglecting the hydrodynamic coefficients' dependence on tow speeds and Keulegan–Carpenter number and incrementally decreasing the resolution of the finite element model. Thus, the minimum required model complexity was established. The result is a validated numerical representation of macroalgae longline that can be used by engineers to analyze and design macroalgae farms.

REFERENCES

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