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Numerical Modeling of Structural Response of IMTA System to Environmental Loading of the Gulf of Mexico

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ABSTRACT

Multitrophic aquaculture systems combine species from different trophic levels to promote nutrient recycling and reduce environmental impact while increasing productivity. In this paper, we examine a sustainable Integrated Multi-Trophic Aquaculture (IMTA) system designed by the University of New Hampshire for deployment in the Gulf of Mexico. Building on previous successful experiences (Chambers et al., 2024), this system is tailored for the cultivation of 4,000 red drum (*Sciaenops ocellatus*) as the fed species, integrated with eastern oysters (*Crassostrea virginica*) and graceful red seaweed (*Gracilaria tikvahiae*).

The floating structure includes two fish containment sections, as shown in Fig. 1. The frame is constructed of high-density polyethylene (HDPE), and floatation is achieved with expanded polystyrene (EPS) billets. Mooring attachment loads are estimated using Hydro-FE, a dynamic fluid-structure interaction software integrated with the Hexagon Marc solver (Knysh et al., 2021). Input parameters consider both regular service and extreme hurricane conditions. The structural model is validated by comparing results from SolidWorks finite element analysis and Marc simulations for a reduced-order model. The simulation results are used to evaluate system stresses, determine appropriate safety factor values, and estimate the structure's design life.

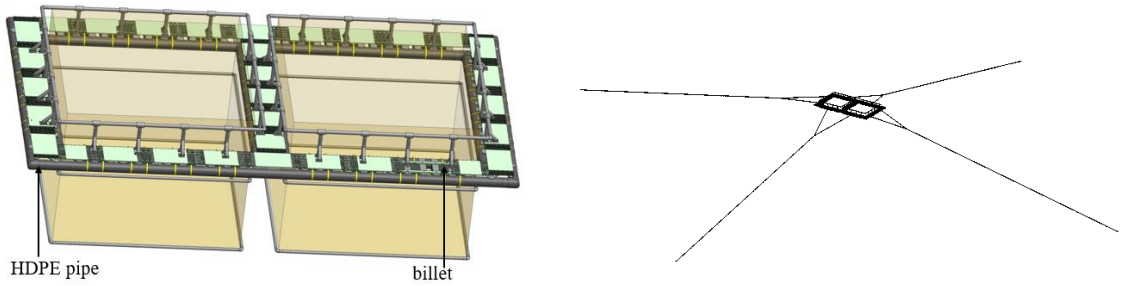

Figure 1: Schematics of (a) IMTA cage and (b) mooring system considered for the Gulf of Mexico.

References

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