

USING HYDRODYNAMICS TO IMPROVE SEA STAR FISHERIES IN COASTAL REGIONS

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INTRODUCTION

Sea stars (starfish) predate on various shellfish such as mussels and clams, and can have a negative impact on the blue-mussel production and aquaculture. This has encouraged the harvesting of sea stars to protect blue mussels and clams from predation, but they are also targeted commercially, as a valuable protein source used e.g. in animal feed. Towed fishing gears can be used to harvest sea stars in coastal regions, however, little is known scientifically about the hydrodynamics around these gears.

EXPERIMENTAL AND NUMERICAL STUDY

To better understand the hydrodynamics around towed fishing gears, an experimental investigation has been carried out in a current flume within the DTU Civil and Mechanical Engineering Hydraulics Laboratory. In these experiments flow velocities have been measured with Laser Doppler Velocimetry around a model of the ground gear of a standard fishing gear. The experimental data is used to validate a computational fluid dynamics (CFD) model in OpenFOAM using the $k-\omega$ turbulence model developed in Wilcox (2006). Instantaneous flow velocities are obtained in the flume from which the turbulent fluctuations are determined through Reynolds decomposition. The three dimensional CFD model provides promising results where both the turbulent kinetic energy and velocity fields are well predicted, Figure 1. The energy spectra of the velocity fluctuations are likewise determined along the length of the ground gear. The CFD model will be used with the intent of improving catch efficiency and selectivity of the sea star fisheries.

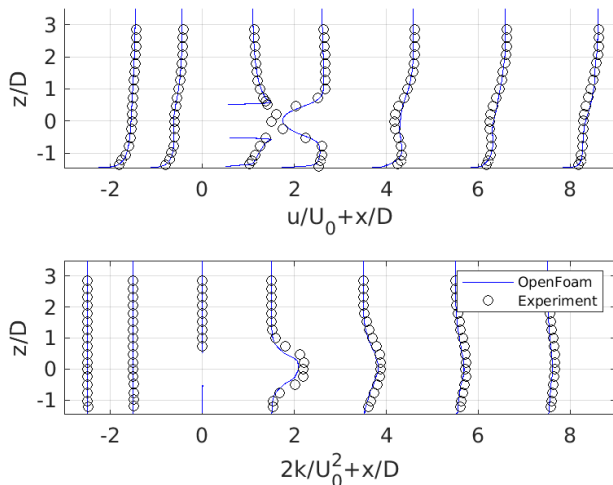


Figure 1 - Horizontal velocity and turbulent kinetic energy around ground gear. The seven vertical profiles (from left to right) have $x/D = -2.5, -1.5, 0, 1.5, 3.5, 5.5, 7.5$, respectively.

PARTICLE PATH MODEL

With knowledge about density and settling velocity of sea stars the results from the CFD model has been combined with a particle path model to provide an initial estimate of how the hydrodynamics around the groundgear affect the sea star dynamics. The flow around the groundgear can cause the sea star to be ejected from the sea bed into the water column. The ejection and path of the sea star is found to depend on when in the vortex shedding the groundgear gets close to the sea star. The paths are determined over an entire vortex shedding frequency to find the probability of the sea star location downstream of the groundgear (Figure 2).

If the overall movement of the sea star is known, the netting on the fishing gear can be positioned accordingly to increase the efficiency of the gear and reduce damaging contact with the sea bed.

The influence on the sea star movement from different parameters such as the size of the ground gear and the gap between the ground gear and the seabed are investigated in the CFD model. Especially the gap ratio is seen to have a considerable effect on the ejection of the sea star into the water column.

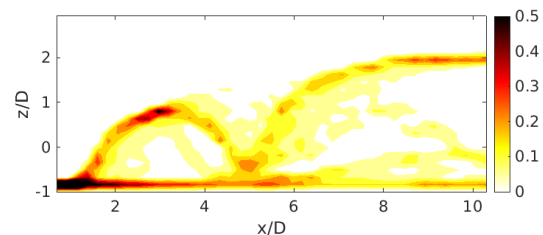


Figure 2 - Computed probability of sea star location based on the particle paths downstream of groundgear.

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