Modelling stressors on the eelgrass recovery process in two Danish estuaries - DTU Orbit (08/11/2017)

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Eelgrass (Zostera marina L.) depth limit is used as an environmental indicator in Danish coastal waters in the Water Framework Directive (WFD) to evaluate coastal waters and their ecological condition. Even after decades of reduced nutrient loadings the reestablishment of eelgrass has not yet succeeded. The mechanisms hindering/delaying eelgrass recovery were recently identified: 1) lack of sediment anchoring capacity, 2) resuspension created by drifting ephemeral macroalgae, 3) seedling uprooting created by current and wave forces, 4) ballistic stress from attached macroalgae and 5) burial of seeds and seedlings by lugworms. These processes were quantified and introduced to an ecological MIKE 3D model. The developed model was calibrated and validated on two Danish estuaries, Odense Fjord and Roskilde Fjord. Analyses of the simulations were performed on area distribution maps. The parameterized stressors impact has been investigated over a three-year period.The results indicate accumulated effects from multiple stressors weakening the capability of eelgrass to recolonize. Combining all stressors in the model decreased the total area covered by eelgrass 83.72% in Odense Fjord and 80.30% in Roskilde Fjord compared to simulation without stressors. Eelgrass peak biomass declined in both fjords from 33.4 to 4.55 ton C km-2 in Odense Fjord and from 24.42 to 5.58 ton C km-2 in Roskilde Fjord. Combining lugworm burial of seeds and seedlings with resuspension from macroalgae and wave forcing had the second strongest negative impact on eelgrass growth, area reduction of 78.31% and 73.14% in Odense and Roskilde Fjord was seen. Ballistic stress from attached macroalgae also reduced growth drastically. Light conditions, sediment organic content along with shear stress at the sediment surface impact the ability of eelgrass to cope with above mentioned stressors. The spatial resolution of the model setup made it possible to generate maps where eelgrass is exposed to lowest stress, revealing areas for potential eelgrass recovery. The developed eelgrass model is now used as a national tool to predict areas where eelgrass restoration effort may be initiated.

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