A decision support model to promote sustainable biofouling management in the Baltic Sea

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Introduction

The International Maritime Organization (IMO) notices biofouling, the accumulation of organisms on ships' underwater surfaces, as one of the key concerns of shipping. Biofouling management of ships is crucial to control the friction caused by the growths as it increases the ships' fuel consumption leading to higher fuel costs and air emissions. Further, biofouling creates a threat to marine ecosystem as it may contain harmful alien species. However, biofouling management causes both ecological risks and economic costs. The special environmental characteristics of the Baltic Sea create extra challenges and management methods suitable in other marine areas cannot be directly transcribed to the Baltic Sea. Consequently, when searching sustainable ship biofouling management strategies for the Baltic Sea, numerous aspects must be considered in parallel. Therefore, tools supporting comprehensive, case-specific, and multi-dimensional understanding are essential.

[max 150 words]

Materials and methods

We collected data and knowledge by 1) interviewing shipping and in-water cleaning companies, 2) conducting literature reviews, as well as 3) performing on-board emission monitoring and recording voyage data on ships. To integrate the heterogeneous data and better understand the multi-dimensional biofouling management problem, we applied a Bayesian Network and constructed a decision support model to compare biofouling management strategies in the Baltic Sea, given the characteristics and operating profile of a ship, case-specifically considering the comprehensive environmental impact and the economic costs of the alternative management strategies.

The Bayesian model can be used to analyze ship- and route-specifically, how the different combinations of alternative hull coating types and in-water cleaning methods, together with the treatment frequency, affect the costs, the CO_2 emissions and risk levels due to biocidal release and potential alien species introductions.

[max 150 words]

Results

We created a set of scenarios to further analyze the multidimensional management problem and to test and demonstrate the model. Based on the results, the most sustainable biofouling management method is always case-dependent. Biocidal-free fouling-release coatings seem to be a reasonable alternative in ice-free areas such as in the southern Baltic Sea. More studies on their ecological impacts are needed, though. However, the softness of the fouling-release coating prevents its use in ice conditions and thus a biocidal-free, hard coating with regular cleaning and a debris capture system seems to be a promising option both economically and ecologically in the northern Baltic Sea. On the other hand, for some ship types, such as tankers, a regular cleaning is very expensive and in these exceptional cases the use of a biocidal coating may be justifiable.

[max 150 words]

Implications on sustainable maritime operation

The results of our study indicate that by careful consideration of the biofouling management strategy, both money and environment can be saved. The model supports sustainable biofouling management by aiding to see the system holistically, both in terms of the different impacts to be considered while choosing the management strategy, and the magnitude of the effects on a yearly basis. In addition, based on the interviews made, the shipping companies seem to be willing to make ecologically better choices in their operation as long as they are economically sensible. However, they experience to lacking knowledge about the sustainability of different management options. Decision support models like this can increase their understanding and knowledge and thus support the implication of sustainable methods and strategies. Finally, in addition to efficient and sustainable management decisions, models allowing a holistic assessment can support the future enactment of international legislation.

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