

## **Marine bioinvasion in the global network of shipping connections**

**Bernd Blasius**

*ICBM, University Oldenburg, Germany, [blasius@icbm.de](mailto:blasius@icbm.de)*

Transportation networks play a crucial role in human mobility, the exchange of goods, and the spread of invasive species. With 90% of world trade carried by sea, the global network of merchant ships provides one of the most important modes of transportation. Shipping also constitutes the world largest transportation vector for marine bioinvasion, transferring accidentally numerous species around the world. Here we use information about the itineraries of 16,363 cargo ships during the year 2007 to construct a network of links between ports. We show that the network has several features, which set it apart from other transportation networks. In particular, most ships can be classified in three categories: bulk dry carriers, container ships and oil tankers. These three categories do not only differ in the ships' physical characteristics, but also in their mobility patterns and networks. The network of all ship movements possesses a heavy-tailed distribution for the connectivity of ports and for the loads transported on the links with systematic differences between ship types. Our analysis improves current assumptions based on gravity models of ship movements, an important step towards understanding patterns of global trade. Based on these results we develop a probabilistic model to quantify bioinvasion by global shipping. The model allows for identification of bioinvasion hot spots, high risk routes and major source regions from which bioinvasion is most likely to occur and thus enables the identification of high risk scenarios, which are necessary for the development and implementation of effective prevention and management programs.