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## Four arguments why so many alien species settle into estuaries, with special reference to the German river Elbe

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**Abstract** In one of the largest European rivers, the Elbe, from its source in the Czech Republic to the German North Sea, 31 alien macrozoobenthic species have been recorded in total. Most of these species have been introduced by shipping activities. With a total number of 21 species, many of the established aliens occur—partly exclusively—in the brackish area of the Elbe estuary. In order to explain this observed settlement characteristic, four main arguments come into consideration: (1) estuaries with intensive international shipping have a higher potential infection rate than other aquatic zones; (2) brackish water species have, due to specific physiological characteristics, a better chance of being transported alive than euhaline or freshwater species and they also probably have a higher perennation and establishment potential after release; (3) brackish waters have the greatest natural ‘indigenous species minimum’, so that more alien species can potentially establish; and (4) salt-tolerant limnetic alien species introduced into inland water reached the coast at first in the estuaries. It seems that the combination of brackish water with its unsaturated ecological niches and intensive international ship traffic has the highest potential infection rate for aquatic systems with alien macrozoobenthic species. And, estuaries are subjected to a two-sided invasion pressure by alien species, via the ocean (mainly shipping) and via inland waters (mainly shipping canal construction). The identification of such patterns is an important prerequisite for the development of a forward-looking alien monitoring and management strategy.

**Keywords** Introduced species Macrozoobenthos Elbe estuary Establishment Management

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