

Ecological Roulette: Invasion of Exotic Species in Enclosed Coastal Seas

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One of the most pervasive phenomena globally impacting enclosed coastal seas in the 1990s is the invasion of non-native marine and estuarine organisms. Ecologists refer to introduced species as *biological invasions*; ichthyologists use the term *exotic species*; botanists use the term *alien species*; the U.S. federal government uses the phrase *nonindigenous species*; many other words, with different shades of meaning, are used as well. All refer to the same basic phenomenon: the establishment of a species in a community, transported by human agency, where it did not occur in historical time. Natural biological invasions include range expansions (almost always along predictable biogeographic corridors) but these are rare in coastal ecosystems compared to the ubiquitous nature of human-mediated introductions. Human-mediated invasions do not 'simply speed up' natural processes -- the majority of recognized invasions represent species that have transcended natural barriers.

At the end of the 20th century, ballast water (not bilge water) may be the single most important means for the rapid transoceanic and interoceanic dispersal of neritic (coastal) marine organisms around the world. Recent studies in Canada, the United States, Australia, Germany, and elsewhere have documented the occurrence of 100s of species of living marine animals (holoplankton, meroplankton, tychoplankton, benthic organisms, and demersal species) and plants (phytoplankton, macroalgae, and seagrasses) in ballast water. In turn, the recent appearance of the carnivorous American comb jelly *Mnemiopsis leidyi* in the Black and Azov Seas, the carnivorous Japanese seastar *Asteria amurensis* in Australia, the omnivorous Japanese shore crab *Hemigrapsus sanguineus* on the Atlantic North American coast, the carnivorous New Zealand seaslug *Philine auriformis* in San Francisco Bay, and scores of other invasions in the past several years are linked to ballast water release. Current estimates are that at any one moment several thousand species are in motion on ballast water conveyor belts around the world.