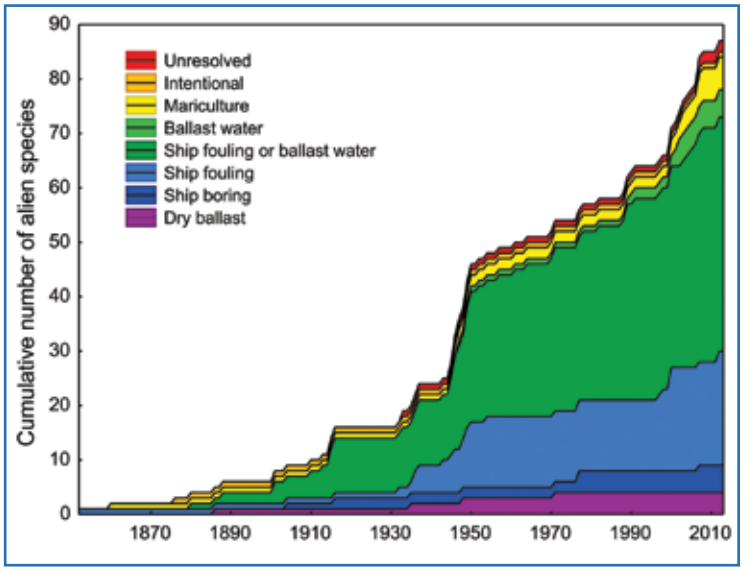
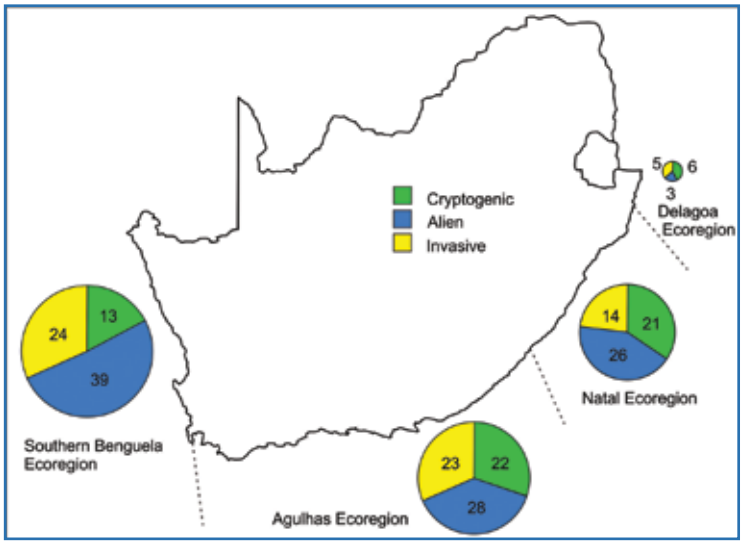
Marine invasions in South Africa: patterns and trends

Tammy Robinson looks at the way that marine organisms arrived in South Africa.

Marine organisms (mainly invertebrates and algae) have been moved around the globe, both intentionally and accidentally, since people first began navigating the seas. As such the mechanisms through which species are introduced (also called vectors) have changed as oceanic transport has developed through time. This has led to different types of species being introduced at different stages through history.



The number of marine alien species recorded in South African waters through time. Introductions are separated by the mechanism by which they are thought to have been introduced. Image: Tammy Robinson



The relative number of cryptogenic, alien and invasive species known from the four South African marine ecoregions. Note that the different size of the pies is indicative of differences in the total number of these species known from the different ecoregions. Image: Tammy Robinson

The early wooden-hulled vessels were home to a suite of specialised wood-boring species like shipworms and small crustaceans known as gribbles. These species not only damaged the ships themselves but also rapidly infested the wooden piers and pilings in the harbours that the ships visited. Because they caused damage and cost harbours and ship owners lots of money, these wood-borers were among the first alien species to be noticed by people. Of the 87 marine alien species known from South African shores today, five are thought to have been introduced in this way. It's interesting to note that we don't always know exactly when species were introduced and so scientists report the dates when alien species are first recognised. This is why the number of alien boring species known from our shores went from four to five in 2008 when a tiny protist (*Mirofolliculina limnoriae*) was recorded for the first time by Professor Charles Griffiths of the University of Cape Town and the Centre for Invasion Biology, despite all boring species most likely having arrived more than 100 years ago.

To adjust buoyancy and increase stability, early wooden ships often took on dry ballast. This solid material was usually taken from areas near harbours and consisted of coastal sand and rocks that were loaded into vessels at ports of departure. Intertidal animals were often attached to the ballast rocks, while coastal plants, seeds and insects were also accidentally loaded during the ballasting process. Many of these species survived in the damp ballast holds, only to be dumped onto new shorelines once the ships arrived at their destinations. The relatively low number of alien species introduced to South African waters by ship boring and solid ballast is indicative of the relatively few ships that called in our ports in early times when compared with the large number of modern vessels that use our harbours today.

As wooden vessels travelled slowly they were ideal habitats for a wide variety of fouling organisms. Fouling biota are species that normally live permanently attached to rocks (i.e. they are sessile) but are able to attach other hard substrata like the bottoms of ships. Typical fouling species include mussels, barnacles and tubeworms. Modern steel ships continue to carry fouling species, but as they are generally larger, travel more rapidly, and are painted with anti-fouling paint designed specifically to discourage fouling organisms, the numbers and types of fouling species have changed through time. It's notable that the number of species introduced to South Africa through fouling increased rapidly after the 1930s and then again after the early 2000s. While the first increase probably reflects increased shipping traffic the second probably reflects the banning of toxic anti-fouling paints. These paints were good at preventing fouling but proved to be so toxic that they were banned though an international convention. While this was good for preventing poisoning of coastal waters, it has meant that more fouling

species are now being spread across the world's oceans.

Dry ballast was first replaced by water ballast in the late 1800s and was completely phased out by the 1950s. The conversion to ballast water saw a decline in dry ballast introductions but spurred a new wave of invasions. Also, ballast water is usually loaded in shallow port areas with lots of sediment. This results in sediment layers building up on the floor of the ballast tanks that can support a group of sand-burrowing species, such as clams and worms that would not previously have been translocated. Although many sessile alien organisms are thought to have arrived through ship fouling, it is often difficult to distinguish this vector from that of ballast water because sessile species can also be introduced as free swimming larvae. This pattern is reflected in most alien species known from South Africa being thought to have arrived by one of these two vectors.

Besides introducing alien species through different shipping-associated vectors, people sometimes intentionally introduce organisms. Most often such species are introduced for mariculture purposes, i.e. they are taken into a new region so that they can be farmed. Examples of mariculture species in South Africa include mussels, oysters and abalone. While some alien mariculture species remain confined to farms, in some cases they can escape and spread into surrounding natural habitats. Sometimes mariculture species can bring along 'hitchhikers'. These associated organisms can then spread from farms and go on to negatively impact the receiving environment. To date two species originally introduced for mariculture (i.e. the oyster *Crassostrea gigas* and the common carp *Cyprinus carpio*) have become invasive, while four associated species have established in our waters. This should warn us about the risks associated with culturing alien species.

Interesting patterns emerge when the numbers of cryptogenic (i.e. those species that can't definitively be called alien or indigenous because we don't know enough about where they naturally occur), invasive alien marine species are considered across the four marine ecoregions of our coast. It's notable that the highest number of invasive alien species are known from our cold west coast and decrease with an eastward movement. The reason for this pattern is unclear, but it could be the combined effect of the very long shipping history of the Southern Benguela ecoregion (i.e. west coast), the fact that mariculture is focused on this coast, and a higher sampling effort in this well-studied region. The relatively low number of cryptogenic species on the west coast might also reflect that this area has been very well studied by marine biologists. Here researchers have a good knowledge of indigenous species, enabling them to better distinguish between indigenous and alien organisms and so reducing the number of species designated as cryptogenic. The very low number of marine invasive alien species in the Delagoa ecoregion (the area just south of the Mozambique boarder) is thought to be due to the lack of any harbours and the small size of this ecoregion, but it must be acknowledged that this region is less well studied than the rest of the coast.

While the last 20 years has seen much progress in the field, marine invasion biology is in its infancy in South Africa. It is clear that there is much work that needs to be done and this offers exciting opportunities to future researchers. **Q**

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Unexpected outcomes from the invasion of the Mediterranean mussel *Mytilus galloprovincialis*

In the late 1970s a new species of mussel was noticed on the rocky shores of Saldanha Bay. Genetic studies confirmed that it was the alien mussel *Mytilus galloprovincialis* that originates from the Mediterranean Sea. As with many species, the vector of introduction is uncertain but is thought to be hull fouling or ballast water. This mussel rapidly spread along the coast, inducing changes as it went. Before this invasion rocky shores were open habitat, typified by the presence of large grazing *Scutellastra granularis* limpets. However, as the mussel spread it out-competed the limpets on most shores and coated the rocks in thick mussel beds. This change from bare rocks with limpets to complex mussel beds totally altered rocky communities, a clear negative impact associated with this invasion. At first glance we would expect the limpet populations to be threatened by this process, but the opposite happened. In fact, many more limpets are now present on these shores but they are much, much smaller, with each limpet living on its own small mussel. Another unexpected consequence of this invasion involves the African black oystercatcher *Haematopus moquini*. This endemic coastal bird was listed as endangered by the IUCN prior to the mussel invasion. However, the increase in mussels meant an increased food supply for these birds, enabling them to increase their population size to a point that they have been removed from the endangered species list. This example demonstrates that while invasions can have detrimental impacts on natural systems, they can sometimes have unexpected consequences too.

The invasive mussel Mytilus galloprovincialis *coats rocky shores from the border with Namibia to East London on the east coast.* Image: Sophia Turner