Alien species are moving across oceans faster, accelerated by climate change

June 8 2022, by Nicole Martin

The brown mussel has retracted its range in South Africa due to decreasing seawater temperatures. Credit: Olga Ernst/ Wikimedia Commons

Oceans and coastlines have been subjected to human use for centuries. But the effects of human activity on the oceans are now more extensive,

with the resulting changes happening more rapidly than ever before.

It is hard to find a spot in the ocean that has not been invaded by an alien species. Shipping is a big contributor to this process as over 90% of the world's trade occurs via shipping.

The marine environment is changing too: ocean temperatures, salinity, chemistry, sea levels, ice content and weather patterns are all being altered as a result of climate change. These changes in oceanic environments are bound to affect biological invasions.

In a recent paper, we explored the implications of climate change along the entire invasion process. We found that climate change is likely to lead to more marine invasions because it will shift which species are moved, how they are moved and where they are moved to.

On top of this, climate change will alter where alien and native species have the greatest chance of survival and spread. Climate change essentially makes marine invasions less predictable. The patterns and processes that have underpinned invasions in the past can't be transferred to future invasions.

And that is expected to bring a consequent decline in the ecosystem services that people currently enjoy from the ocean.

The main drivers

Shipping is the main pathway for marine species invasions. Climate change will affect shipping through altered weather patterns, sea conditions, melting ice and more frequent extreme climatic events. Some of the current shipping routes will become unviable in terms of safety or cost. This will change transportation routes, destinations and transit times. It will ultimately have an impact on how, when, and where alien

species are transported and introduced by ships.

For example, the melting of the Arctic icecap will enable about 5% of the world's trade to use new shipping routes across the north pole. These new shipping routes will increase the connectivity between Europe and Asia and subsequently decrease transit times by up to 40%.

The implications of this for alien species are two-fold: firstly, there will be a greater mixture of European and Asian marine species; and secondly, shortened transit times will likely increase the survival of the organisms being transported.

Shifting global trade, industries and tourism are also expected to affect traffic volumes and thereby the volume of alien species that are unintentionally transported and introduced. For example, with increased traffic through the Arctic there will be fewer ships moving on other routes. This will shift the volume of alien species that are transported and introduced to different regions.

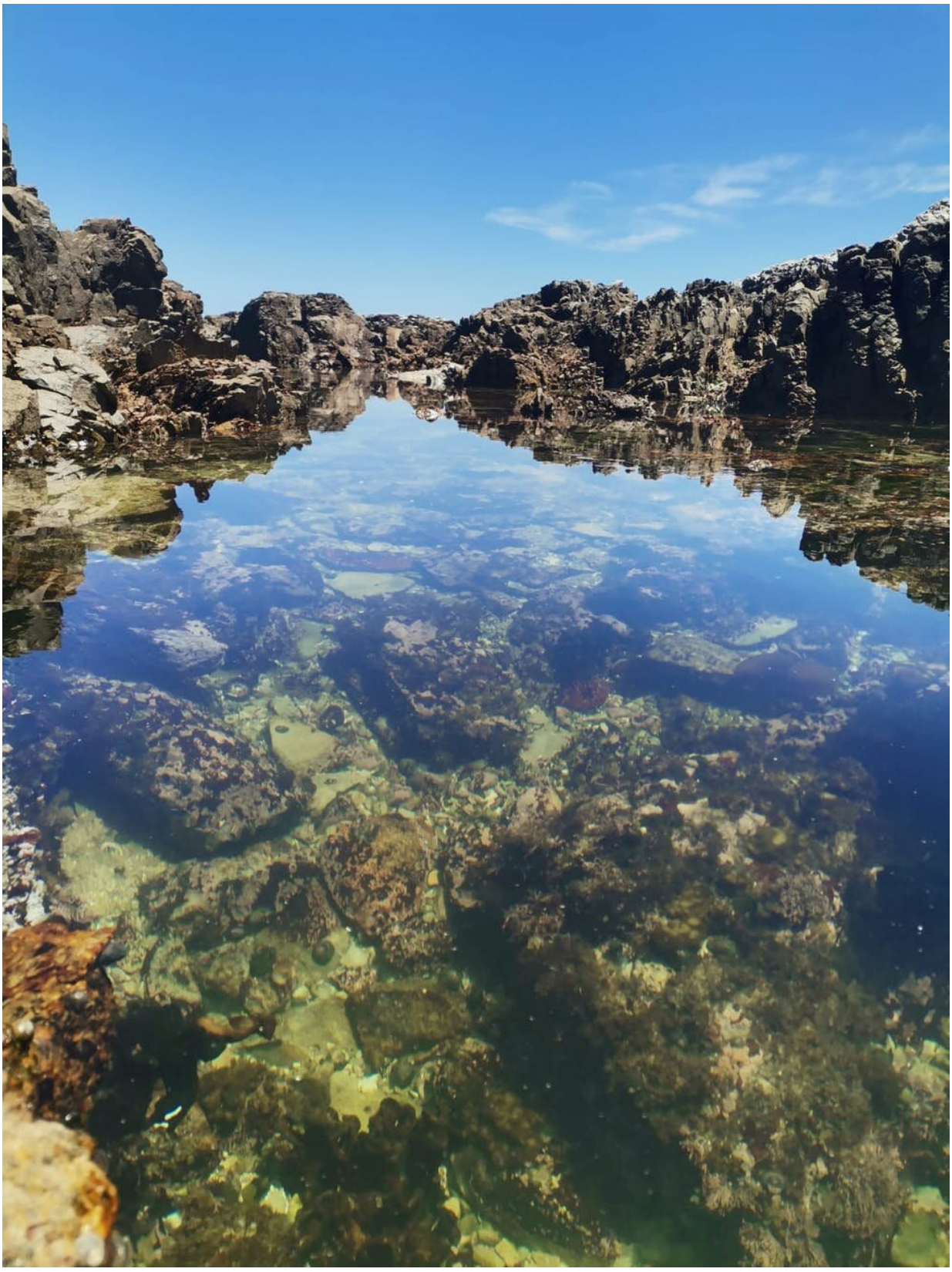
It's hard to know exactly how this will pan out in Africa as research into the implications of climate change for African shipping routes and the consequential effects on the volumes of alien species transported and introduced to African ports is lacking.

Marine farming is another area we identified as a source of major change. Many marine alien species are intentionally imported for cultivation. As climates shift, sea conditions can become less optimal for traditional cultured species. Operations will likely switch to using new species that are productive under altered environmental conditions. Or industries may shift to new locations. The oyster industry along the west coast of North America is a great example.

Ocean acidification in this area has caused such high mortalities of

Pacific oyster larvae (Crassostrea gigas) that almost all oyster mariculture in the Pacific Northwest has failed. Many farmers have now shifted their operations to Hawaii, where conditions are more favorable. While this is good for oyster production, it has increased the invasion risk faced by Hawaii.

At the moment, not enough information is available to see if similar situations might occur along African coastlines. However, as many African people's livelihoods depend on marine farming it is essential to improve our understanding of how ocean conditions may change in mariculture hotspots and what the implications of this for cultured species may be.



Interactions between alien and native species will be impacted. Credit: Nicole Martin

The third driver we identified was changing habitats.

To become a successful invader, an alien species needs to survive and establish a population in the new environment. Then the species needs to spread within the new region. The ability of introduced species to do these things is influenced by both the environment and interactions between alien and native species.

As climate change continues to alter ocean temperatures and chemistry (for example, ocean acidification), previously unsuitable habitats are predicted to become suitable for newly arriving, established or spreading alien species.

Alternatively, changing ocean conditions may become less optimal for some native species. For example, the native brown mussel (Perna perna) has retracted its range along the south coast of South Africa in response to decreasing seawater temperatures.

It is still very difficult to anticipate how a particular species (alien or native) may be affected by environmental change. This is because each species will respond based on its ability to tolerate new conditions or adapt to them.

The effects of environmental change will spill over to the interactions between alien and native species. This is problematic because sometimes native species outcompete and predate on alien species, preventing them from becoming invasive. Alternatively, the lack of predation and competition by native species can help alien species establish and spread.

For example, the invasions of the Mediterranean mussel (Mytilus galloprovincialis), the Bisexual mussel (Semimytilus patagonicus) and the Common Acorn Barnacle (Balanus glandula) in South Africa are all unhindered due to predators such as the Girdled Dogwhelk (Trochia cingulata) exerting weak predation pressure against them.

Knowledge gaps

There are still serious knowledge gaps that prevent a better understanding of how climate change will affect biological invasions. These gaps are evident, for example, in:

- Taxonomy—cryptic invasions often go unrecognized when an alien species is misidentified as a native species.
- Natural history—life-history traits of alien species are seldom quantified.
- Ecology—species ranges are often not georeferenced or routinely monitored.
- Invasion biology—sometimes we don't know if a species is native or alien.
- Physiological tolerances of native and alien species.
- Basic environmental data in many regions.

These uncertainties make it increasingly difficult for managers, conservationists and policymakers to anticipate and thus prevent invasions.

Our ability to effectively manage invasive species will depend on how proactive and adaptive our prevention, eradication, containment and mitigation measures are. These need to take into account how climate change affects the movement of alien species, fitness at the species level, and understanding how changing climate impacts interactions among groups of species.

Provided by The Conversation