

Evolution & Behaviour

Ships with hitchhiking critters connect Antarctica to the rest of the world

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ABSTRACT

Ships expose Antarctica to many kinds of human impacts, including invasive species that cannot cross the rough seas of the Southern Ocean without help. To successfully conserve iconic Antarctic species and environments we need to know where non-native species might come from, and where to look for them in Antarctica.



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Antarctica may seem like it is cut off from the rest of the world but in our modern, globalized world Antarctica is connected to all of us, everywhere, via ships. For millions of years Antarctica was unreachable for most marine animals and seaweeds who are unable to cross the strong barriers of winds and ocean currents that circle around the icy continent. Ships, however, allow not only people to access Antarctica but give other species an opportunity to hitch a ride and expand their populations to a new region. Species that arrive in new locations can cause drastic changes to ecosystems, sometimes by outcompeting native species

or eating native species that have no suitable defenses. These invasive species are not yet a problem in the oceans around Antarctica, but climate change is making it easier for new arrivals to survive.

Antarctica is our last remaining region that is free of invasive marine species and by understanding where ships come from and where they visit in Antarctica, we can make decisions to help reduce the chances of accidentally introducing non-native species.

Thankfully, modern ships are equipped with satellite transmitters. Their activity can be tracked all around

the world and data on their movements are collected by commercial providers. We used ship movement data and created a traffic network that included worldwide ports and locations around Antarctica. We investigated where ships go when they are outside Antarctica, what routes they take to get to Antarctica, and where they visit when they are in the Southern Ocean. Ship's hulls are generally only cleaned every couple of years so anything growing on the hull or in protected nooks and crannies can be accidentally transported vast distances.

Ships collect seaweeds and animals growing on their hulls, wherever they are in the world, in a process called biofouling. Common animals growing on ships include crustaceans like crabs, water fleas and barnacles, or bivalves like mussels. The more time a ship spends in one location, the more species from that location will grow on their hull. Therefore, where ships come from tells us something about where the hitchhiking species come from. Of course, ships also lose some of their biofouling critters to surrounding water and the animals and seaweeds can breed and release larvae or young offspring in new locations. Thus, to know where invasive species might be introduced to in Antarctica, we need to know where the ships visit.

Our results show that an extensive network of ship activity connects Antarctica directly to all global regions, especially to South American, South Atlantic, and European ports. Antarctic-going vessels visit these areas most frequently and spend more time there than other regions. As such, ships are more likely to introduce organisms from southern South America, northern Europe, or the north-western Pacific Ocean than from other parts of the world.

Most voyages reach Antarctica via one of the five cultural and logistical hubs of Antarctic activity, known as gateway cities – Punta Arenas (Chile) and Ushuaia (Argentina) in South America, Hobart (Australia), Christchurch (New Zealand), and Cape Town (South Africa). Antarctic gateway cities were last ports of call for over half of voyages to Antarctica during our study period. Even so, we found a total of 58 different departure ports for ships on Antarctic voyages. With such a wide range of ports and regions with direct links to Antarctica, non-native species could come from almost anywhere.

If non-native species could be introduced from anywhere, then where in Antarctica will they most likely end up? We found that ship visits are more than seven times higher to the Antarctic Peninsula and nearby islands than elsewhere around Antarctica. This part of Antarctica reaches towards the southern tip of South America and is slightly warmer than other stretches of Antarctic coastline. Here, less sea ice means ships don't have to battle to reach the shore and seafarers (including tourists) do not have to spend as many days at sea to reach their destinations. Together, higher ship traffic and a milder climate make it much more likely that invasive marine species will impact these areas before reaching other parts of Antarctica.

The Southern Ocean is the most isolated marine environment on Earth and the only global marine region without any known invasive species. But ships for tourism, research, fishing, and supply connect Antarctica to every other part of the world and may introduce non-native species that could cause drastic changes. We need to work together, across all industries, to protect these iconic environments from the dual challenges of climate change and invasive species.