Mapping areas at risk of marine invasion from biofouling

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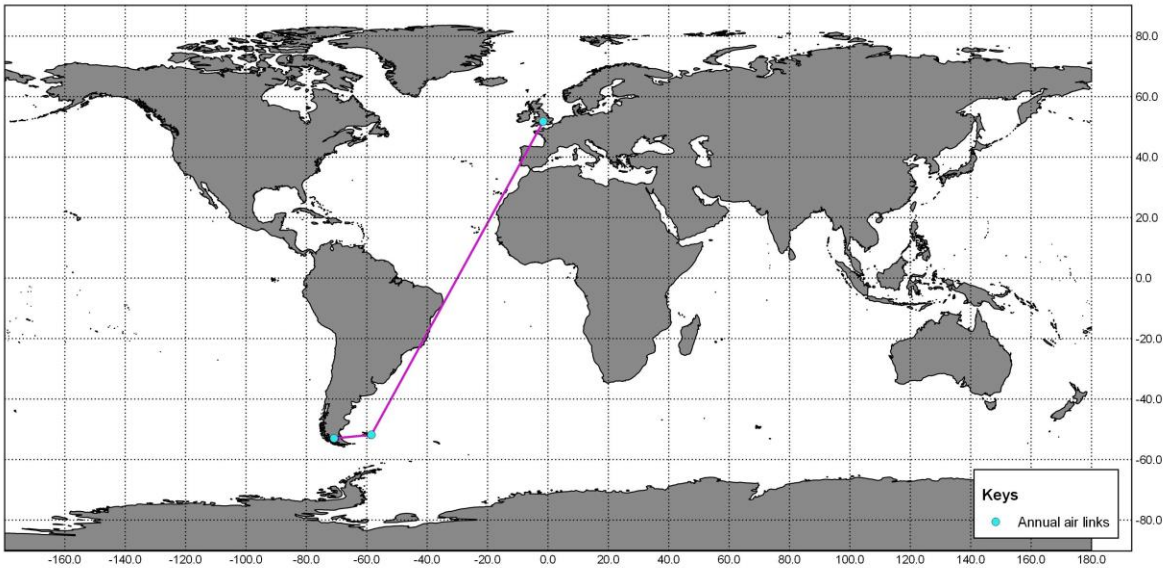
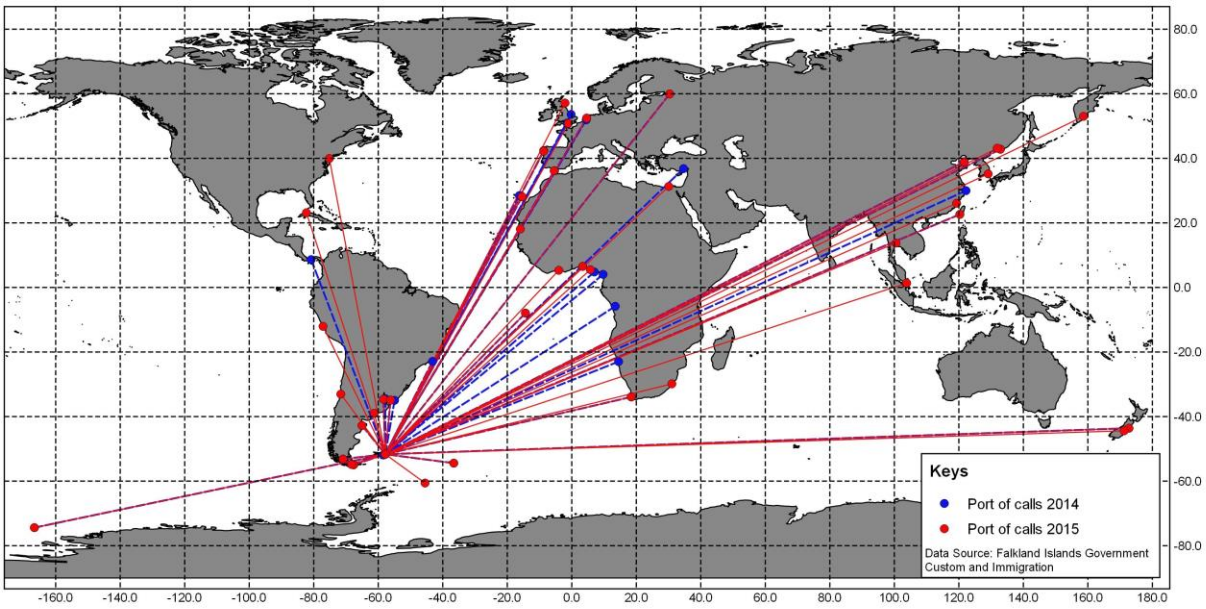
In the recent blog (Marine Spatial Planning: There is more traffic in the sea than you think!), it was revealed that the Falkland Islands, although remote, actually receive a considerable amount of marine traffic. More than a thousand different vessels (tankers, cargo ships, supply vessels, fishing boats, cruise liners, yachts etc) entered the Falklands Conservation zones from May 2014 to May2015.

Biosecurity is a set of precautions to reduce the risk of introducing or spreading invasive non-native species (NNS), and other harmful organisms such as diseases, in the wild. Biosecurity is a hot topic in the Falkland Islands because the characteristic of being remote does not exclude the risk of invasion from NNS that in such isolated islands and pristine environment can be very detrimental to the local habitats and their unique native species.

The Falkland Islands can be reached either by plane or boat. It means that in terms of biosecurity, introduction and spreading of invasive NNS can occur via both. The maps below show the connections from the rest of the world to the Falklands by air and by sea. It is evident that biosecurity control on ships is more crucial considering the annual number and the various locations from which the boats depart before reaching the Falklands, compared to the more regular and limited air connection.



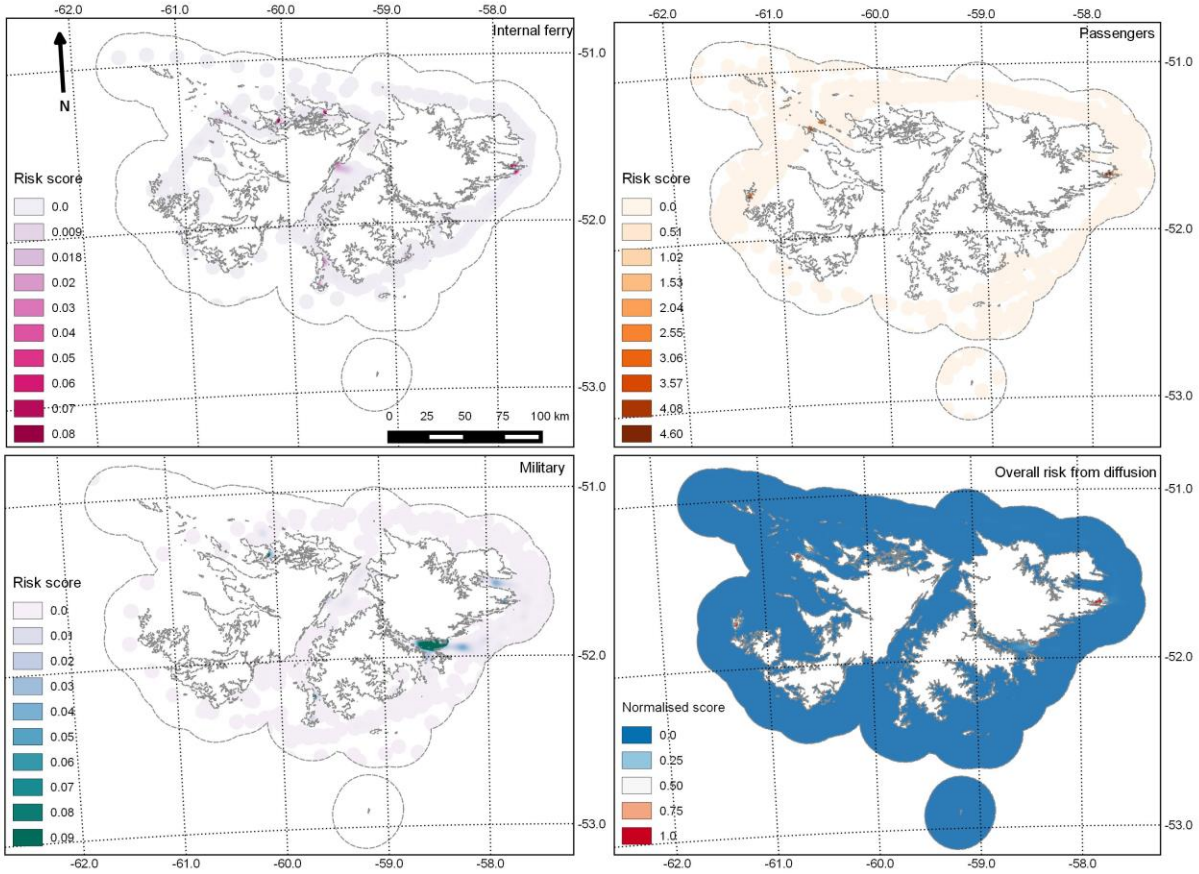


One of the main biosecurity risks associated with boats is biofouling which is the colonisation, and the transport on the submerged surfaces of the boats, of unwanted organisms such as bacteria, barnacles and algae. These organisms travel on the ship hull and can be released and introduced in a new area where, as NNS, they may become invasive and damage the native marine environment or its resources. Ship biofouling is therefore a marine biosecurity risk that needs to be managed. Site monitoring in areas known to be at risk can also help detecting invasive NNS and remove or eradicate them before they spread.

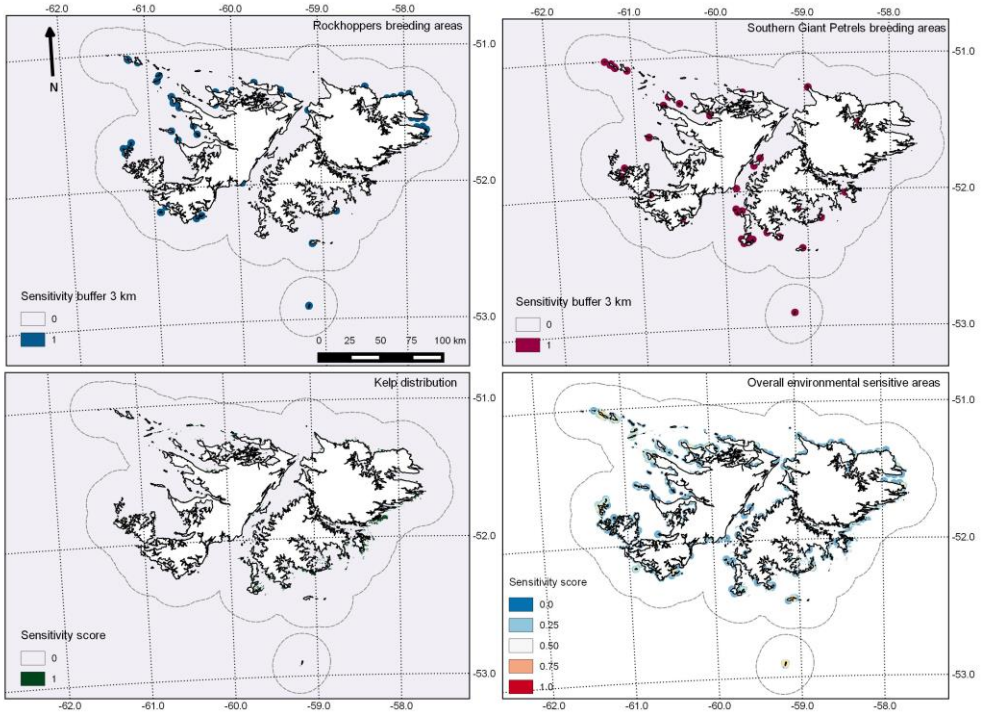
It is therefore important for the Falkland Islands to identify the most susceptible areas of introduction of NNS. In the context of Marine Spatial Planning, GIS were used as analytical and mapping tool to provide useful information for biosecurity policies. Mapping areas at risk of invasive NNS from biofouling was a collaborative work between the GIS specialist (Dr iLaria Marengo) and the Marine Spatial Planning project leader (Dr Amélie Augé) at SAERI.

The shipping data were split by vessel category and were classified into groups with a high risk of introduction (from overseas) of NNS such as cargo ships, tankers, cruise ships and pleasure boats, or with a high risk of diffusion (within the islands) of NNS such as cruise ships, harbour, military and internal ferry. The risk of introduction and diffusion generated by each vessel category was scored according to the likeliness of biofouling, and the frequency of activities.

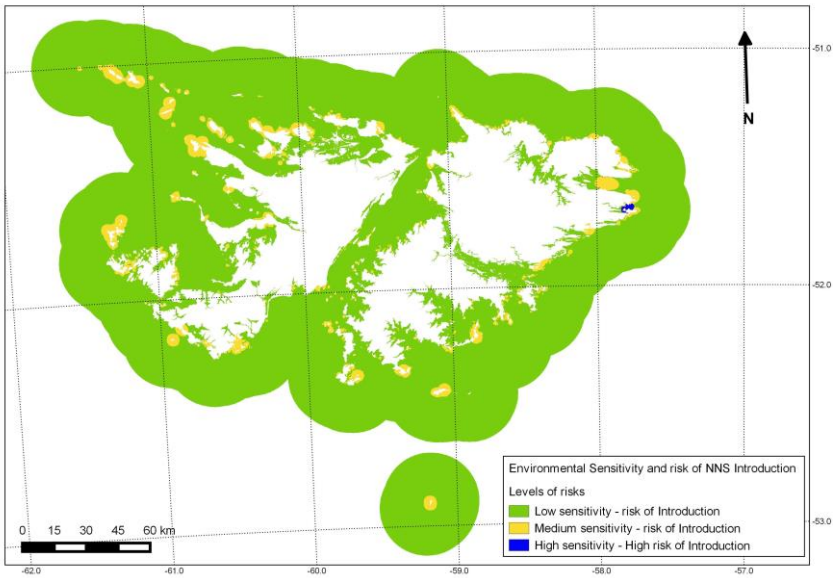
QGIS was used to conduct all the analyses and mapping. A Kernel density analysis was performed for each vessel category to map the density of boats for 5km cells within the territorial sea (12nm from shore) all around the islands. Density was multiplied by the number of different vessels occurring in the same area because variety, along with the quantity, of boats will have an impact in terms of risk of introduction of NNS. The resulting values were then multiplied by the risk scores. Finally, the maps for each vessel category were added to each other to create the final map of risk of introduction and diffusion of NNS in the Falkland Islands.

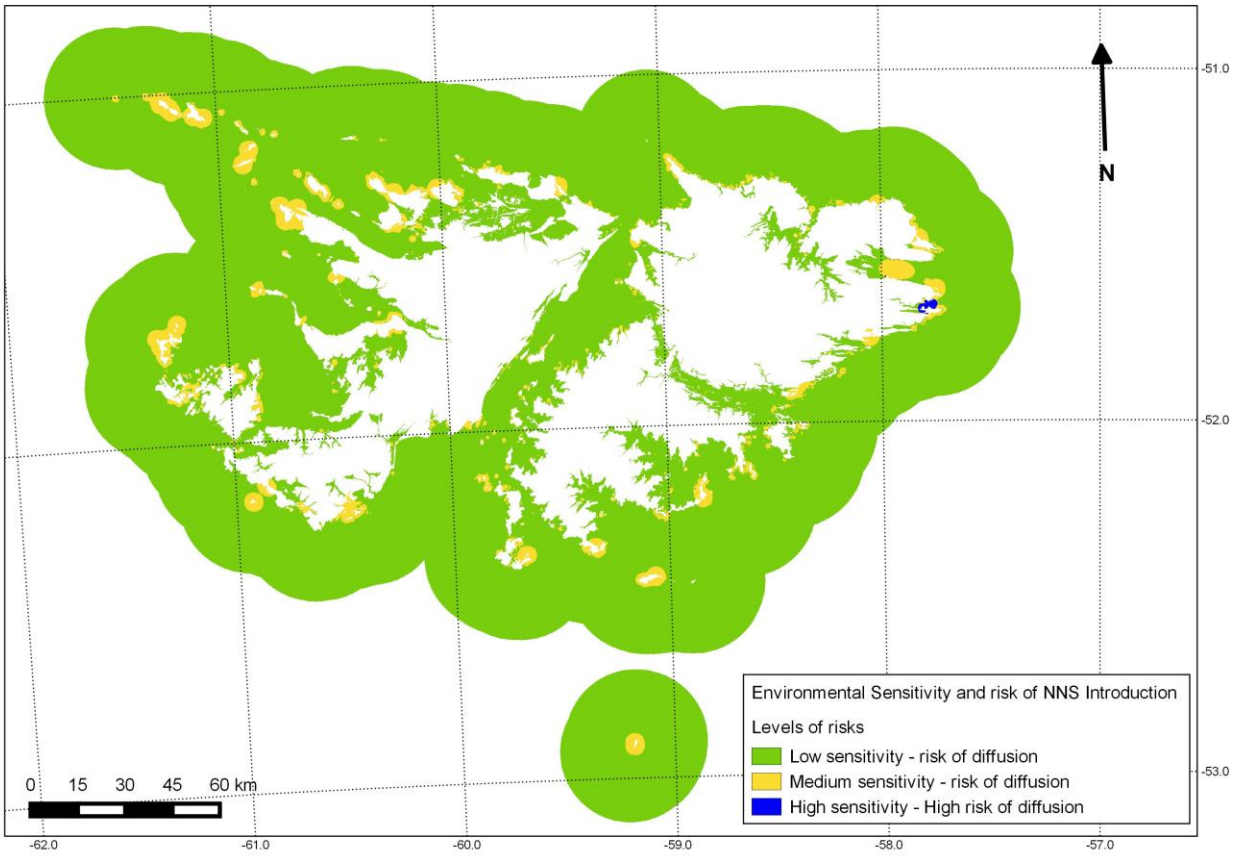


In parallel, a second GIS analysis was run to map areas with environmental features that would be sensitive to invasive NNS. The locations of breeding colonies of albatrosses, penguins, and pinnipeds were taken into account along with the distributions of kelp beds, Important Plant Areas, RAMSAR sites and tussac islands. The sensitivity of each environmental feature was mapped by creating buffers (ranging from 500m to 3 km) from the centre of the colonies or from the centre of the area. The areas of the buffers were attributed a value of 1, which corresponded to a high sensitivity score, so all the environmental variables were equally assessed as high in terms of sensitivity. The maps were added together to produce the overall environmental sensitivity map with values from 0 (low) to 1 (high).



The conclusive part of the GIS analyses was to highlight which environmentally sensitive areas are most at risk to be affected by introduction of NNS due to biofouling. The resulting maps show that the area with the highest risk of introduction of NNS is Port Williams/Stanley Harbour. This did not come as a surprise because the Shallow Marine Survey Group has already detected some invasive NNS there. The areas of high risk of diffusions are the main touristic islands since they are well known sites of seabird and marine mammal colonies. Mare harbour stood out as a likely area at risk too.





The overall conclusion of this GIS analysis is that there are significant risks of introduction and diffusion of NNS, which may damage the pristine environment of the Falkland Islands. Some sites were highlighted as most at risk of direct introduction and should be surveyed, while biosecurity measures should be taken. Other sites at risk were identified from the diffusion process all around the islands. The results are preliminary and should be taken as initial findings. They are however already good indicators of where the biosecurity officer could target efforts, and provide good information for marine spatial planning. The analysis could be refined with more data and by taking into consideration other ways of introductions of NNS such as ballast water. More in-depth analyses of potential impacts of some NNS on inshore marine species should also be explored in the future.