

# Marine spatial planning, GIS and biofouling risk assessment

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SAERI



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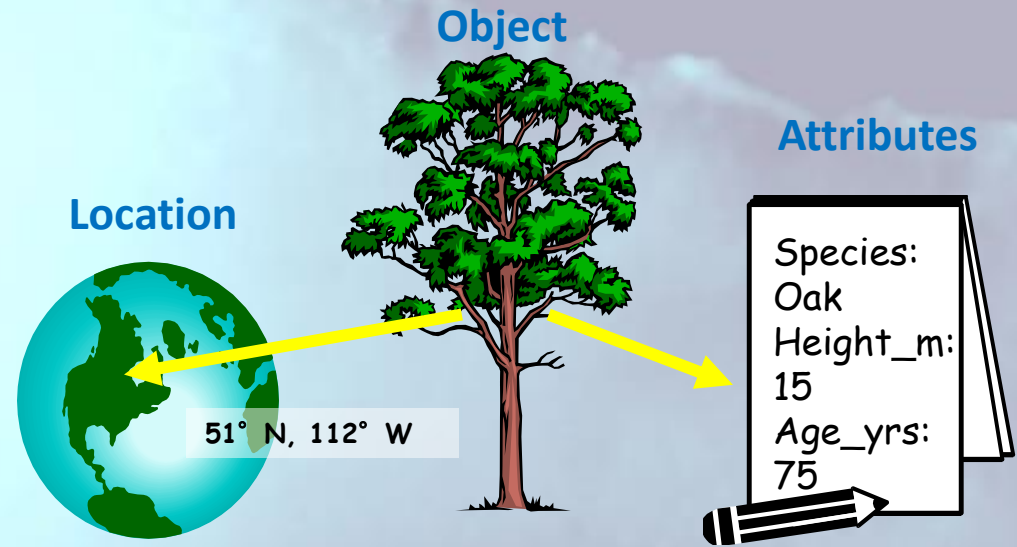
Project: 'Marine  
Spatial Planning  
for the Falkland  
Islands'

# Geographic Information System (GIS):

A system designed to capture, manipulate, analyse, manage and visualise spatial data.

## Spatial data:

Information, such as location and attributes about objects on earth.



## Marine Spatial Planning (MSP):

A process of developing a strategic plan for regulating, managing and protecting the marine environment that addresses the multiple, cumulative and potentially conflicting uses of the sea

# Marine Spatial Planning: Why do we need it?



**ECONOMIC**

**ENVIRONMENTAL**

Many marine values to be considered and protected



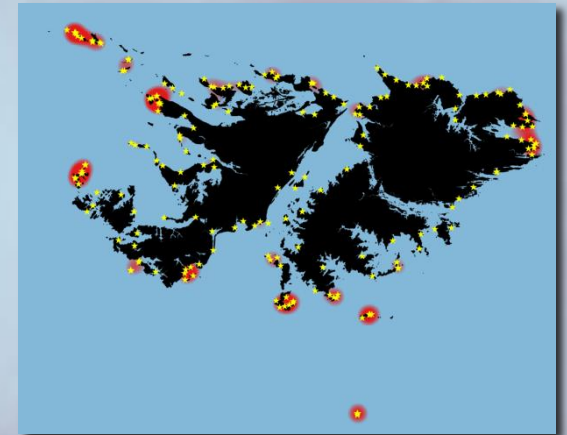
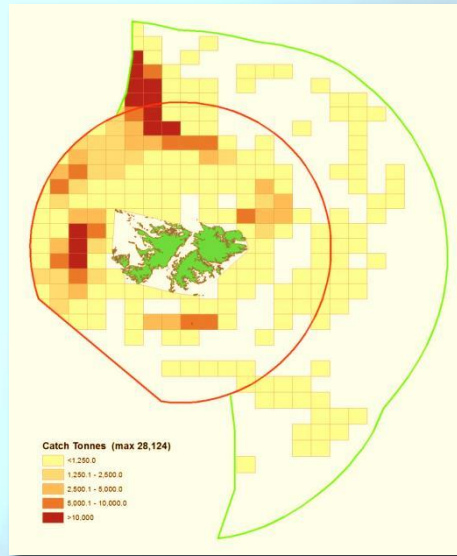
**CULTURAL**



*From Augé (in prep.) Developing tools for MSP in the Falkland Islands: Workshop report.*

# Marine Spatial Planning: What is it?

A main step of MSP is to **map** the marine environment and understand how it is used by humans and wildlife, the zones of conflicts, and the **zones at risk**



→ **GIS is a tool to support the MSP process**

GIS use spatial data to find patterns, discover relationships, map the results and provide information to help planners to make decisions.

→ **Biosecurity risks are one of the topics that can be tackled by MSP**

## Biosecurity:

Is a set of precautions to reduce the risk of introducing or spreading invasive non native species (and other harmful organisms such as diseases) in the wild. (GB Non Native Species Secretariat)

## Biofouling:

Is the colonisation of submerged surfaces by unwanted organisms such as bacteria, barnacles and algae, and has detrimental effects on shipping and leisure vessels, heat exchangers, oceanographic sensors and aquaculture systems. (Advanced Nanostructured Surfaces for the Control of Biofouling)



# Falkland Islands marine activities: current, increasing and new



**Biofouling is a biosecurity risk and is an environmental and economic concern.**

- a) It facilitates the introduction and spread of non-native species and there is a cost in eradicating them
- b) Often, eradication is impossible once established and invasive species can impact economic activities and environmental values directly or via parasites and diseases (aquaculture, fisheries and native wildlife at risk)
- c) It reduces performance of material and equipment with estimated costs for the industries of hundred of thousands pounds per year.

(Advanced Nanostructured Surfaces for the Control of Biofouling)

# Case study: Biofouling risk assessment using GIS



## Risk of introduction and diffusion of marine Non Native Species

Last port of calls (before the Falklands)

### 1) Pathways

All boat traffic over one year (AIS data)

Data on tourism (total vessels and passengers)

Mooring sites

### 2) Stepping stones

Ports and jetties

### 3) Environmental sensitivity assessment

Environmental data



Through the MSP process, AIS, tourism and some environmental data had been identified as missing for efficient planning and obtained.

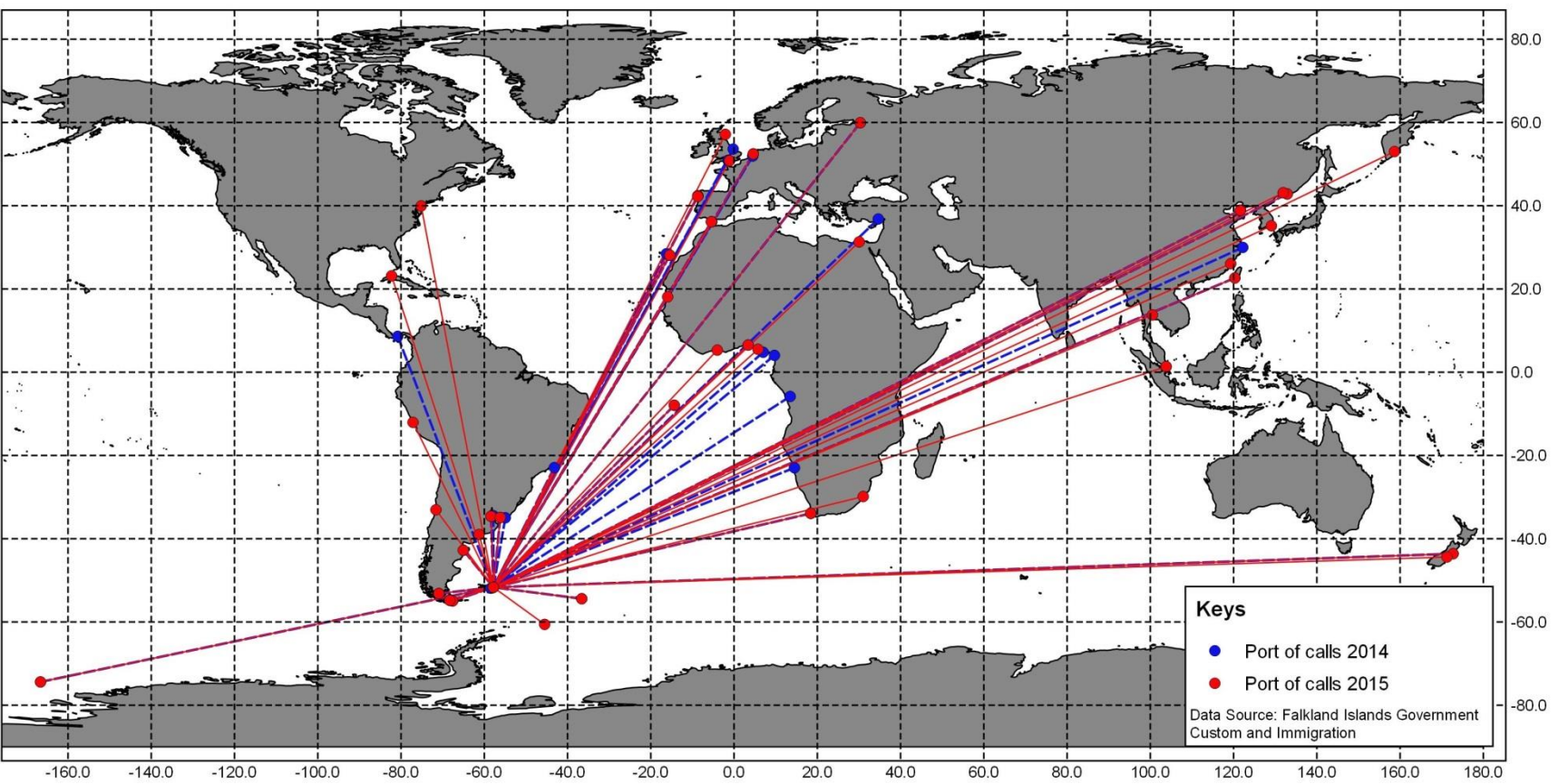
# Last port of calls – mapping Falklands international links

## What data tell:

44 and 46 last port of calls counted in 2014 and 2015

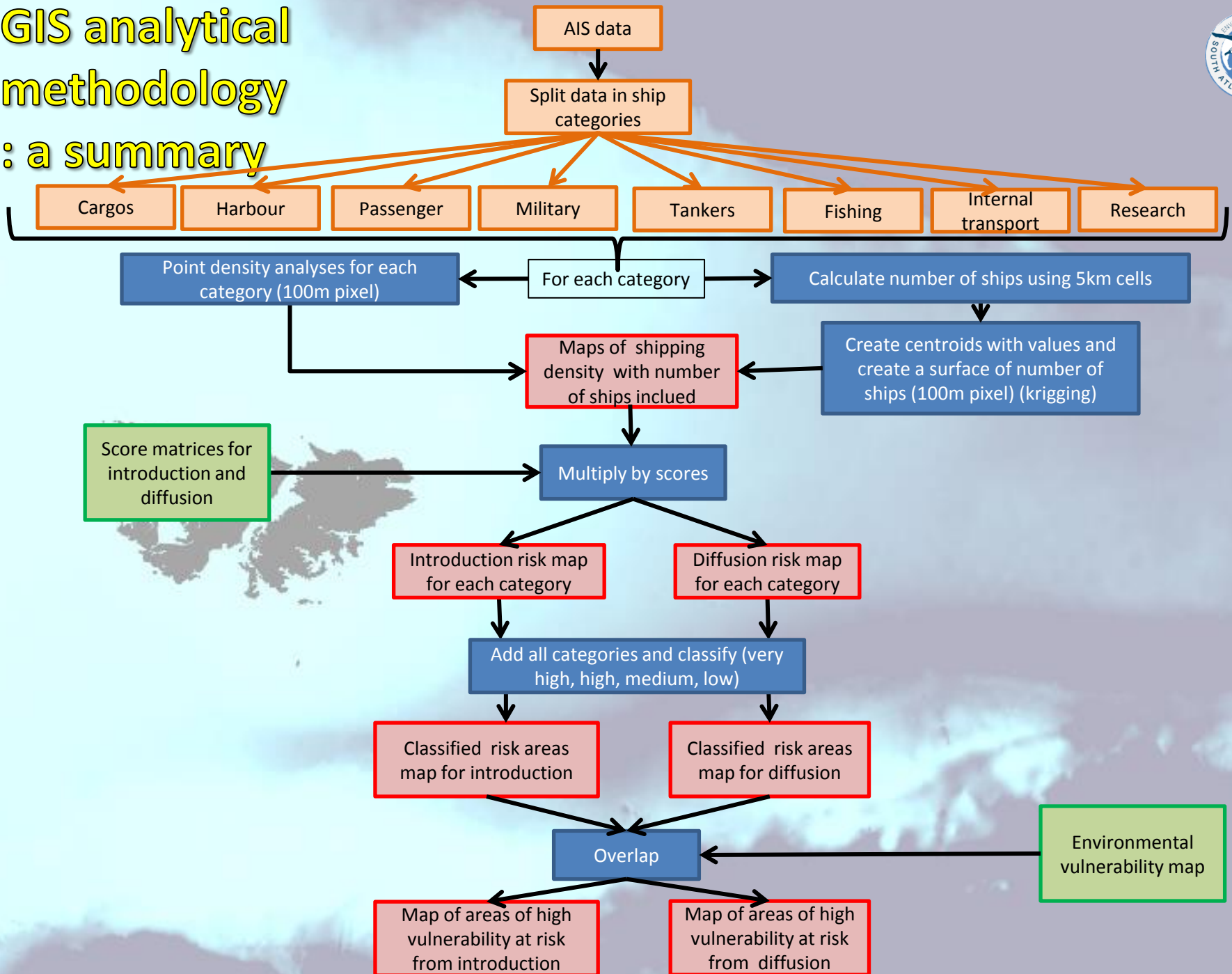
The remote Stanley is actually connected with places from the 7 continents

**What biosecurity regulations are in place in these countries and in the Falklands?**



# GIS analytical methodology

## : a summary



# Pathways – Vessel movements around the Falklands



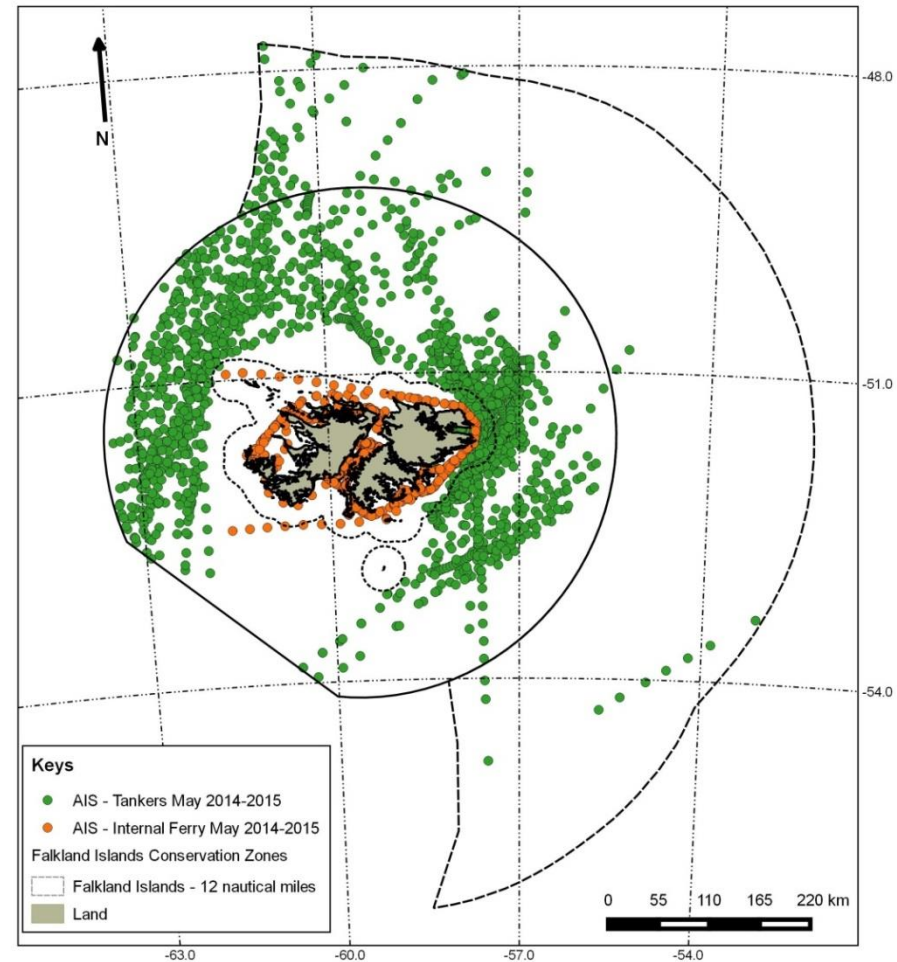
## What data tell:

A year worth of AIS data allowed the identification of 10 different types of vessel categories and mapping their distribution.

## Were people in the Falklands aware of it?

**No!**

AIS number	Vessel type
match was made using the name of the vessels: Shackleton and James Clark Ross	Research
30; 31; 32; 33	Fishing
50; 51; 52; 53	Harbour
70; 71; 74; 77; 78; 79	Cargo
80; 81; 82; 83; 84; 89	Tanker
36; 37	Pleasure Boating
35	Military
60	Passengers
match was made using the name of the vessel: Concordia Bay	Internal Ferry
All the rest of AIS data*	Others



# Biofouling: introduction and diffusion risks - 1



Biofouling introduction and diffusion risk scores were calculated on the basis of four identified criteria:

- Probability of introduction assessed from 1(remote) to 5 (definite)
- Probability of diffusion assessed from 1(remote) to 5 (definite)
- Frequency assessed from 1(one off) to 5(continual)
- Confidence in data assessed from 1(low) to 3(high)

Vessel category	A	B	C	B+C	TOTAL	score
cargo	5	5	2	7	35	<b>0.875</b>
harbour	1	5	2	7	7	<b>0.175</b>
passenger	4	5	2	7	28	<b>0.7</b>
Pleasure boating	5	5	2	7	35	<b>0.875</b>
military	3	5	2	7	21	<b>0.525</b>
tanker	5	5	2	7	35	<b>0.875</b>
fishing	2	5	2	7	14	<b>0.35</b>
Internal ferry	1	5	2	7	7	<b>0.175</b>
research	3	5	2	7	21	<b>0.525</b>
others	3	5	2	7	21	<b>0.525</b>

Where:

A = probability of introduction

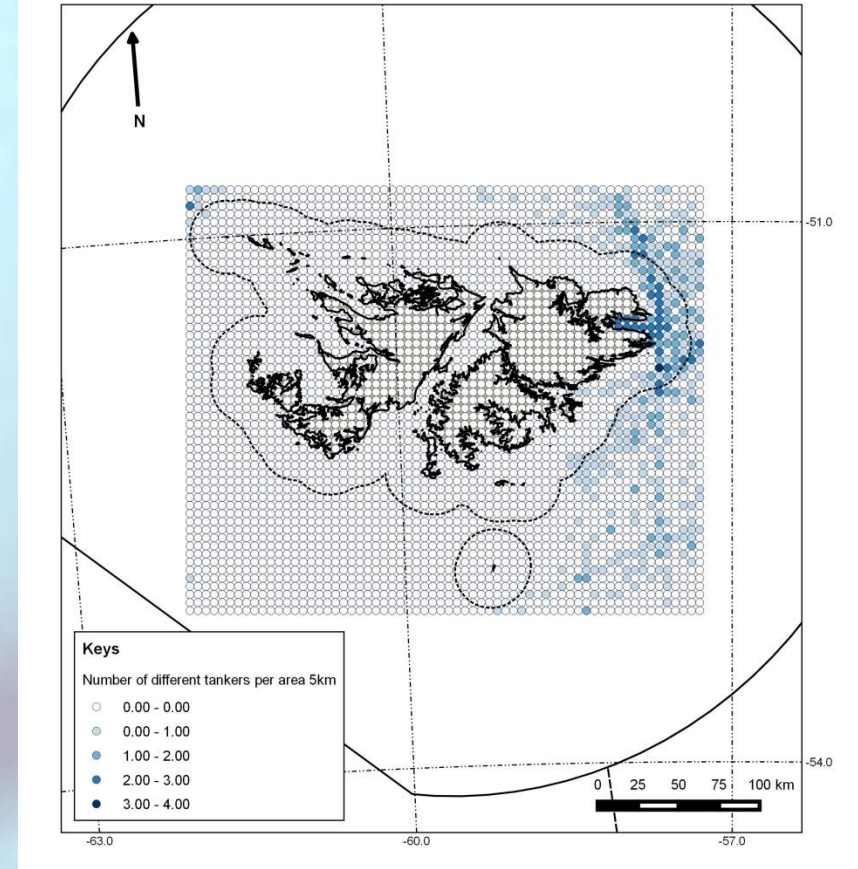
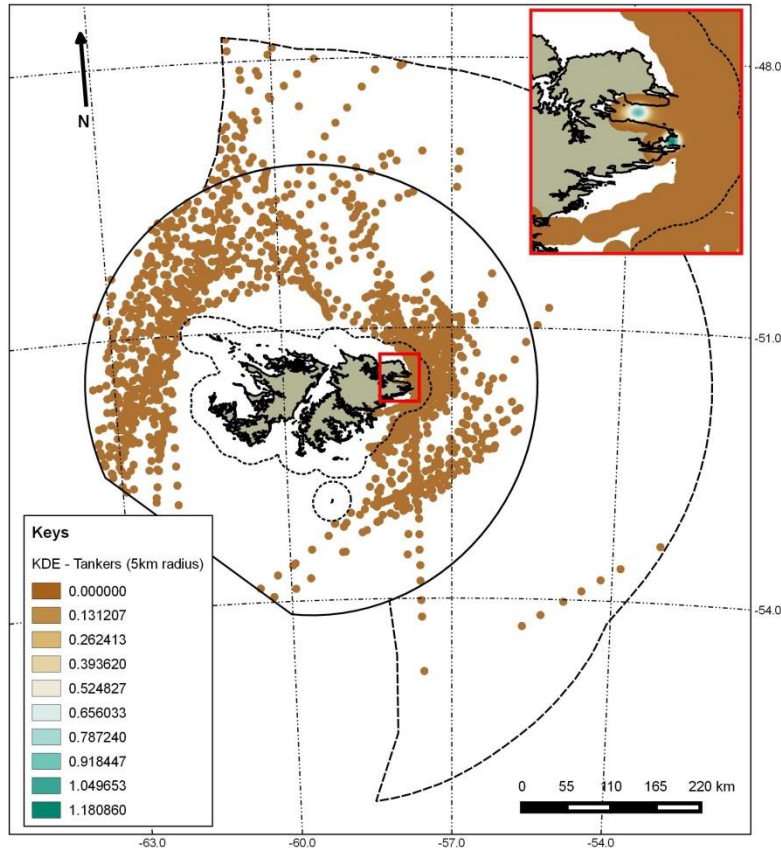
B = frequency of activity

C = data confidence

# Biofouling: introduction and diffusion risks - 2



With GIS, a **Kernel Density Estimation (KDE)** analysis was applied to map densities of vessels per category over a radius of 5km.

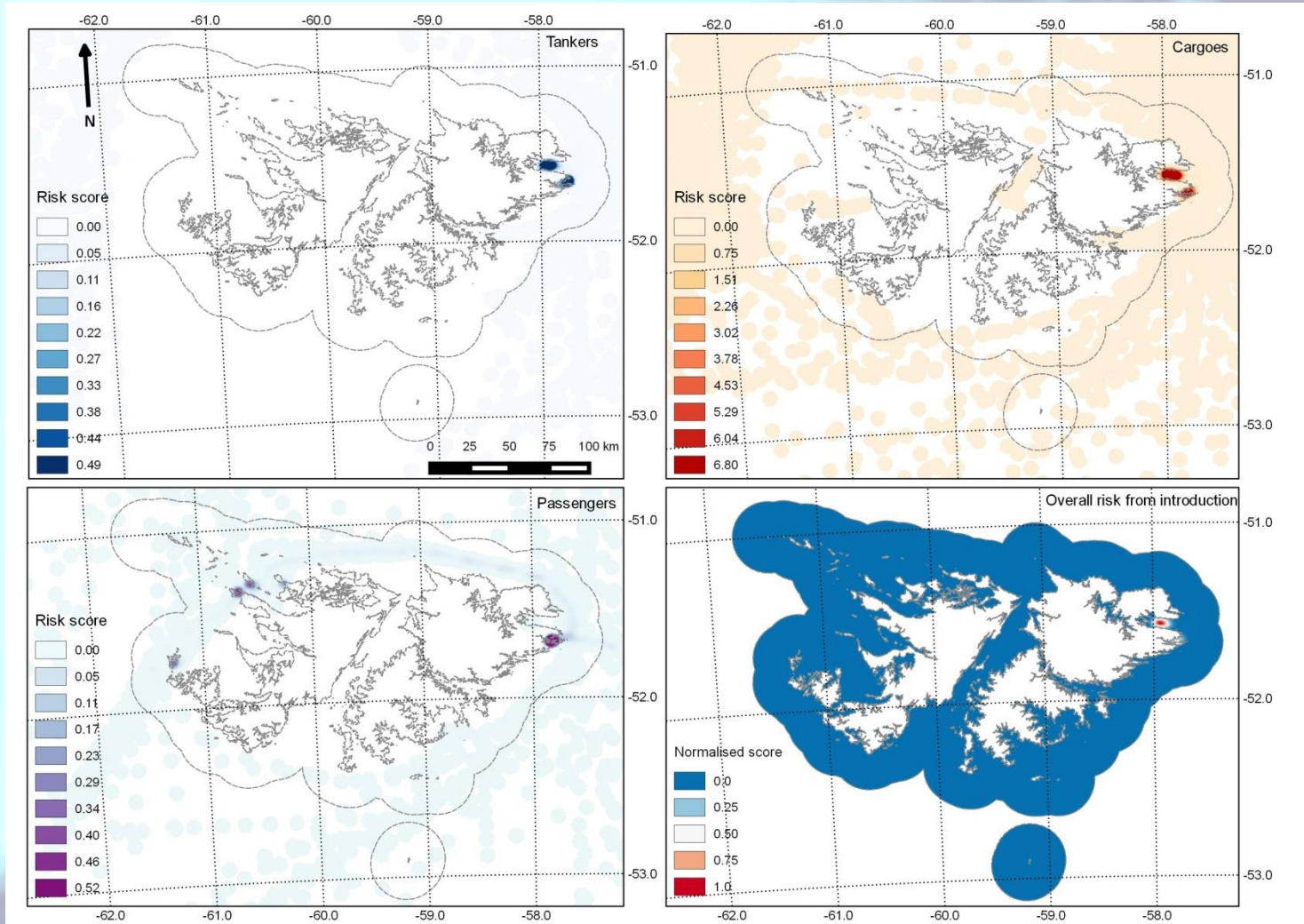


Within GIS a 5 km grid was created in order to count the number of different vessels per area. In the assessment of biofouling risk both **density** and **diversity** of vessels were considered key variables.

# Biofouling: introduction and diffusion risks - 3



In GIS the single maps were multiplied by the risk score and clipped to the 12 nautical miles. Then the risk maps were added to each other to retrieve the overall map of biofouling risk of introduction.



# Biofouling: diffusion risk - tourism



IAATO data on passenger vessel were processed with GIS in a way that the “footprint” of each visiting vessel could be mapped.

The area of the footprint was calculated as a buffer of 2km from the mooring location and the risk of diffusion of NNS assessed as:

- Biofouling at the mooring station and through the back/forwards of the zodiacs
- Walks done by the tourists (in this case spread of unwanted species/bugs on land)

## Sites visited by IAATO vessels

Barren Island  
Bleaker Island - Sandy Bay  
Carcass Island  
Grave Cove  
New Island - Ship Harbour  
New Island - South Harbour  
New Island Settlement  
Saunders Island - Neck  
Sea Lion Island  
Stanley  
Steeple Jason  
Volunteer Point  
West Point Island

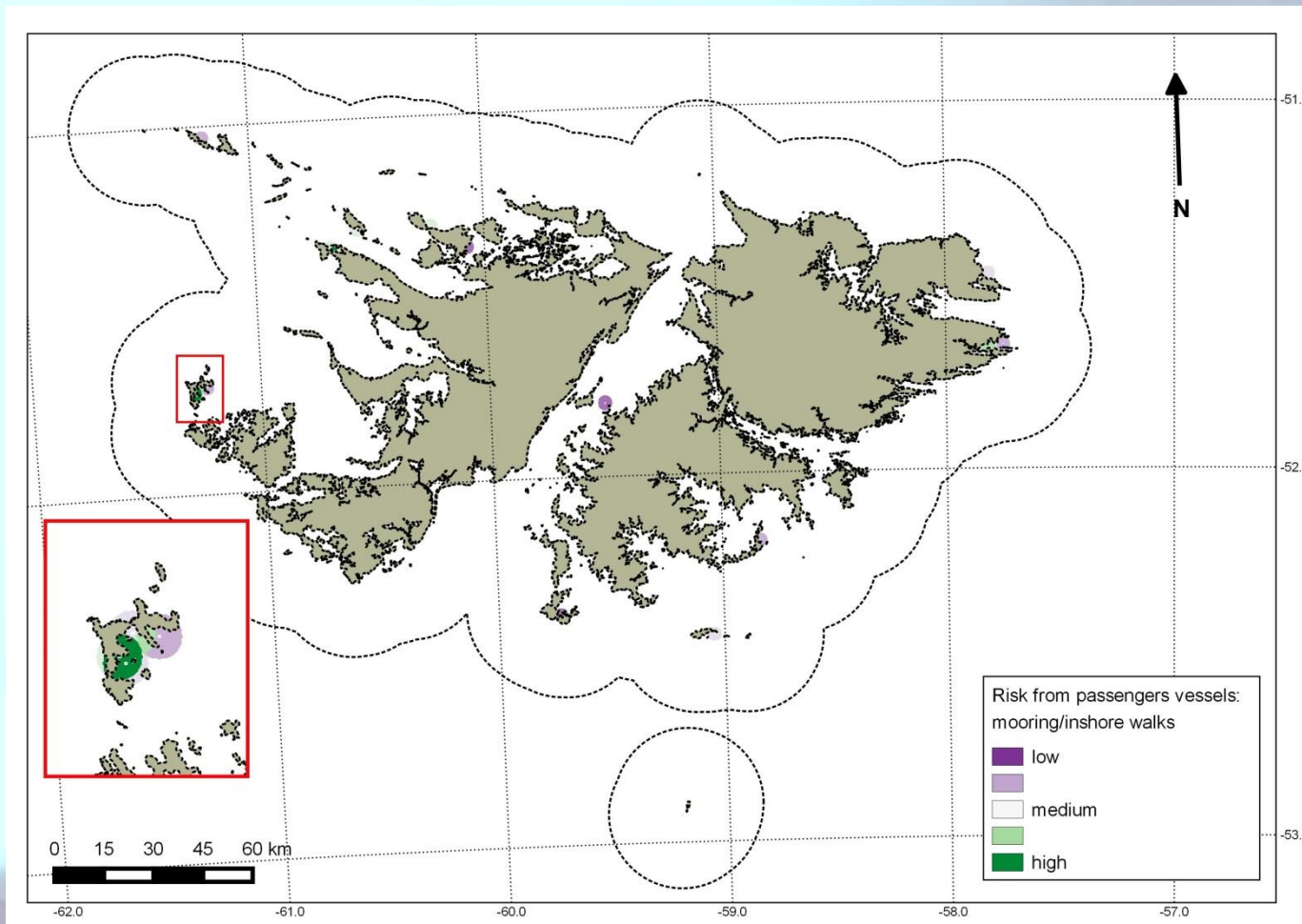
## 2015 IAATO vessels figures

islands	Total_passengers	count_vessels
Bleaker Island - Sandy Bay Landing	131	2
Carcass Island	2128	10
Grave Cove	557	4
Gypsy Cove	498	4
New Island - North Harbour	196	1
New Island - Ship Harbour	569	4
New Island - South Harbour	224	1
New Island Settlement	1228	4
Saunders Island - Neck	1903	9
Sea Lion Island	231	3
Stanley	5301	18
Steeple Jason	57	1
Volunteer Point	65	2
West Point Island	1766	11

# Biofouling: diffusion risk - tourism



The risk of diffusion of NNS ranged from 1 (small) to 5 (high) taking into account the number of boats anchoring in the same location and number of passengers taken from 2012 to 2015. The five layers were added to each other to provide the final map of risk of diffusion from tourist sites.



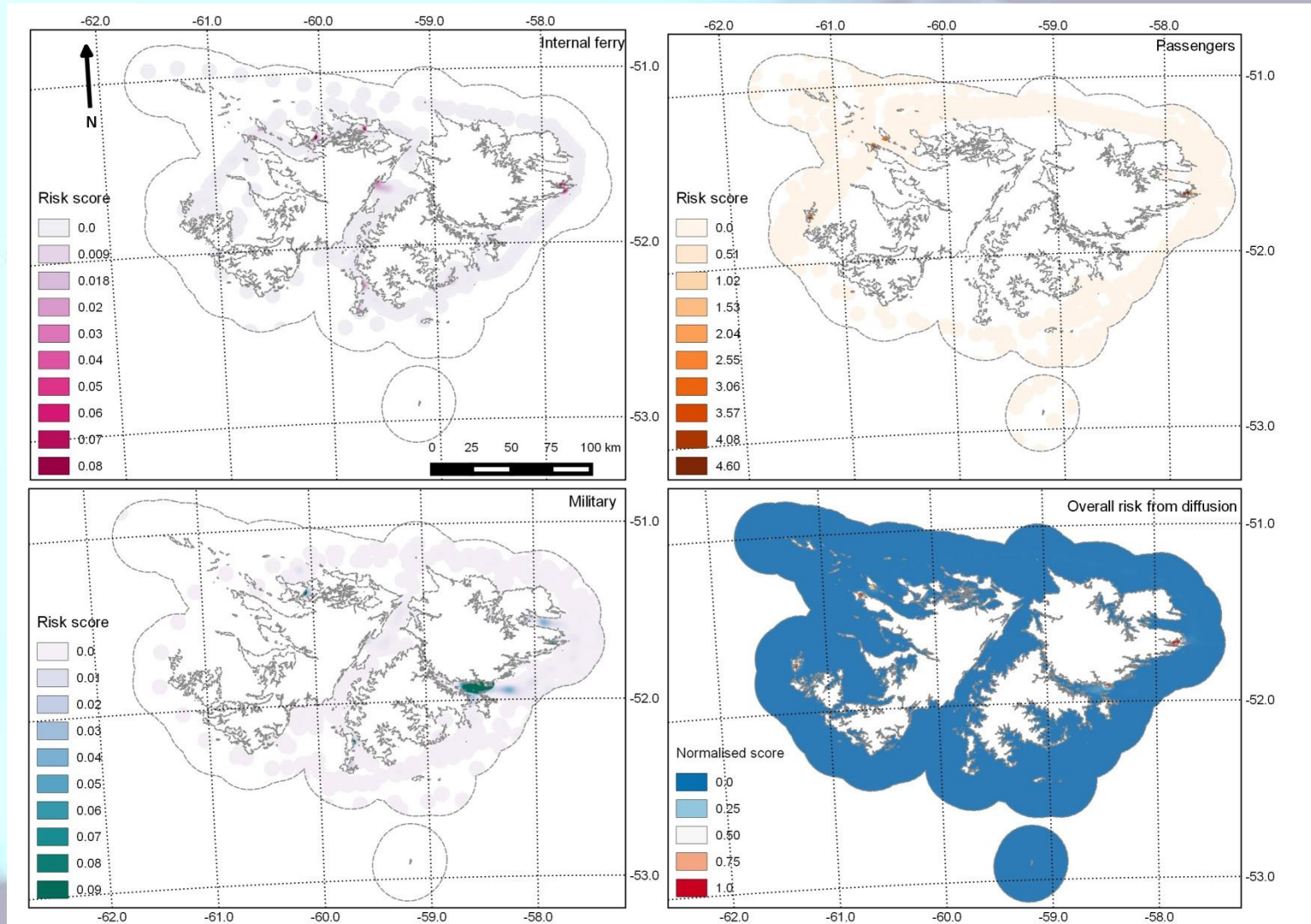
# Biofouling: diffusion risk overall map



The risk of diffusion of NNS was calculated for each vessel category:

**KDE \* diffusion score \* tourism footprint** (this applied for passengers vessels only)

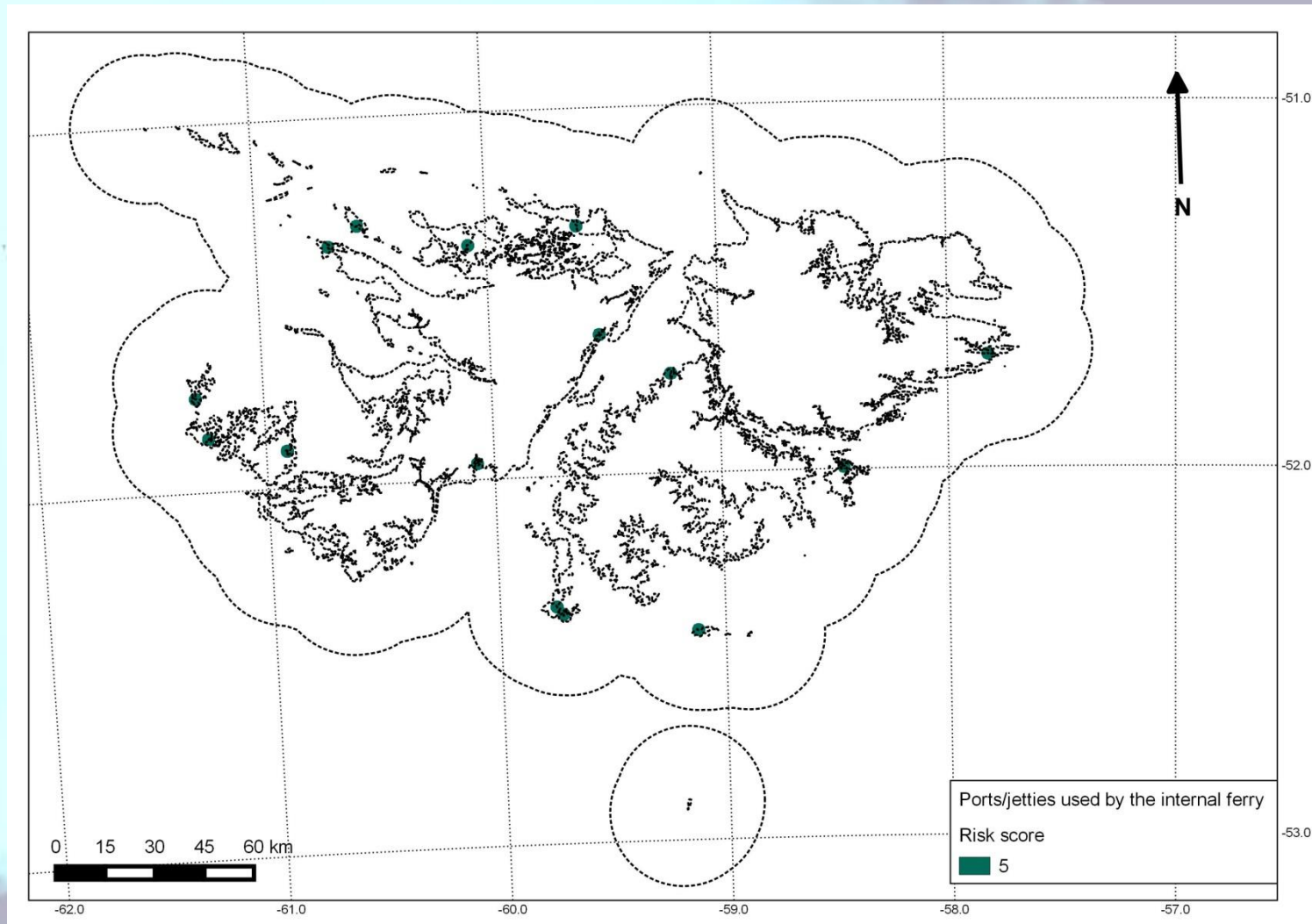
The overall diffusion risk map was the addition of all the individual risk layers



# Biofouling: Stepping stones



Ports and jetties, act as variable for introduction and diffusion.  
The risk was assessed with a buffer of 500 metres and scored as 5 (high).  
The layer was multiplied at the end to obtain the final risk maps.



# Biofouling: environmental sensitivity map



The marine and coastal environment in the Falkland islands is where the majority of the local wildlife thrives.

Hence it is an asset that needs careful management and planning. How the analysis of spatial data can help to assess the environmental sensitivity?

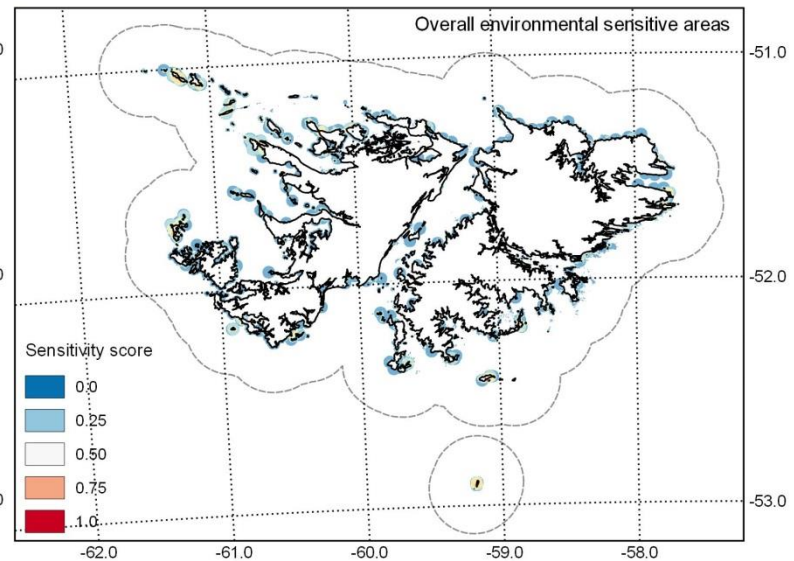
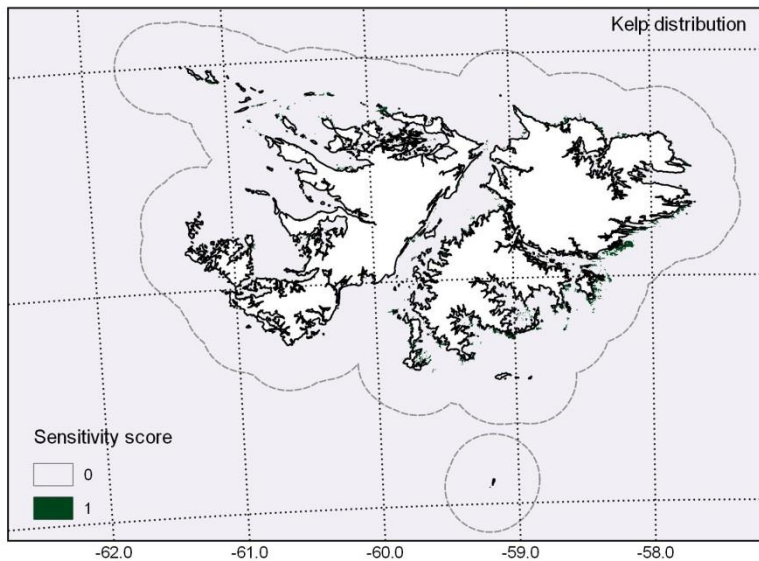
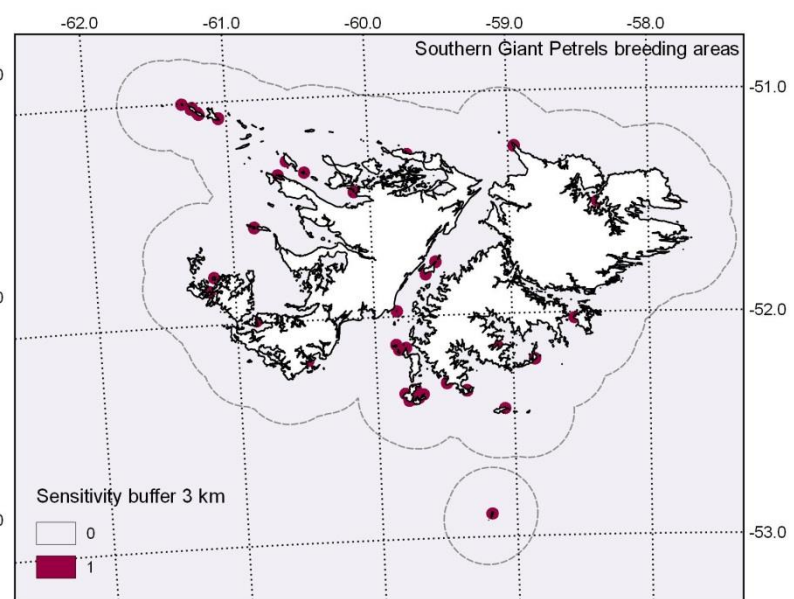
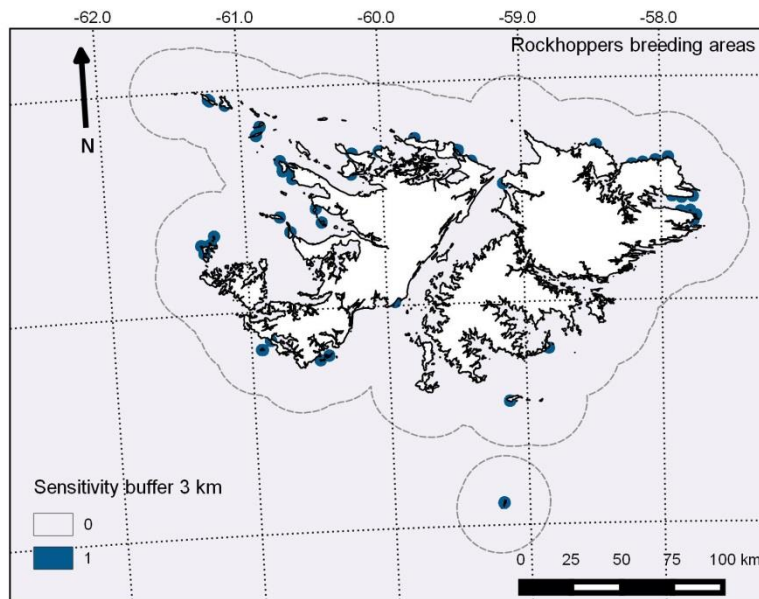
A series of environmental variables were considered for the analysis



Sensitivity areas	Buffer extent (m)	score
IPAs	1000	1
RAMSAR sites	1000	1
Tussac Islands	500	1
Kelp	entire area	1
Albatross breeding areas	3000	1
Southern Giant Petrels breeding areas	3000	1
White Chinned Petrels breeding areas	3000	1
Gentoo penguins breeding areas	3000	1
Rockhopper penguins breeding areas	3000	1
King penguins breeding areas	3000	1
Southern Fur seals breeding areas	1000	1
Sea Lion breeding areas	1000	1
Elephant seals breeding areas	1000	1

The risk was assessed with a buffer of variable distance and scored as 1 (high). The layer was multiplied at the end to obtain the final risk maps.

# Biofouling: environmental sensitivity map

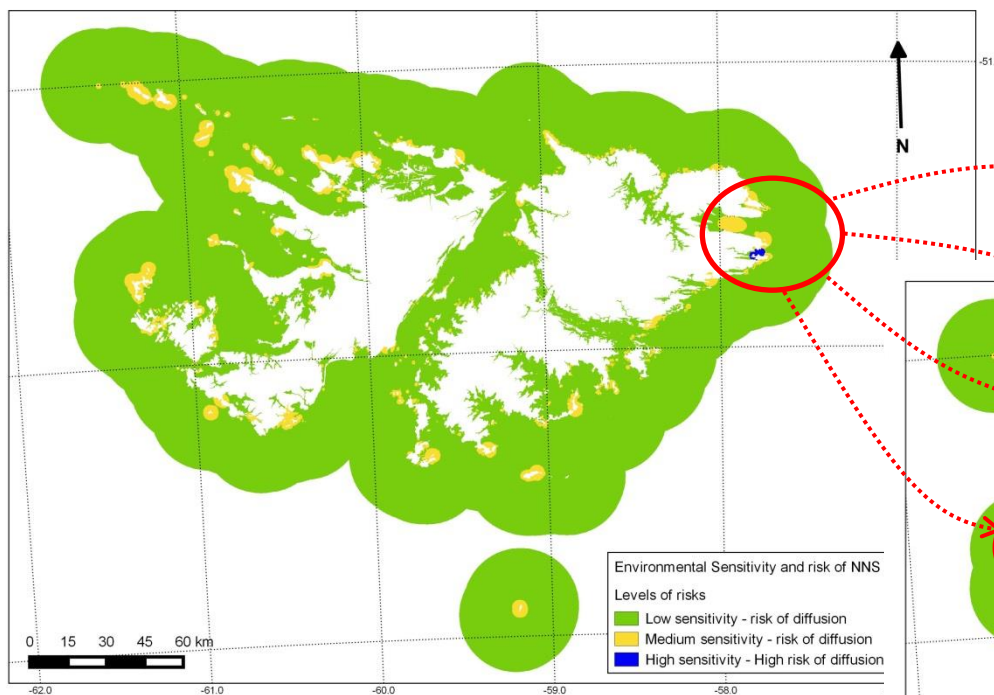


# How the 3 maps are combined and used by the MSP?

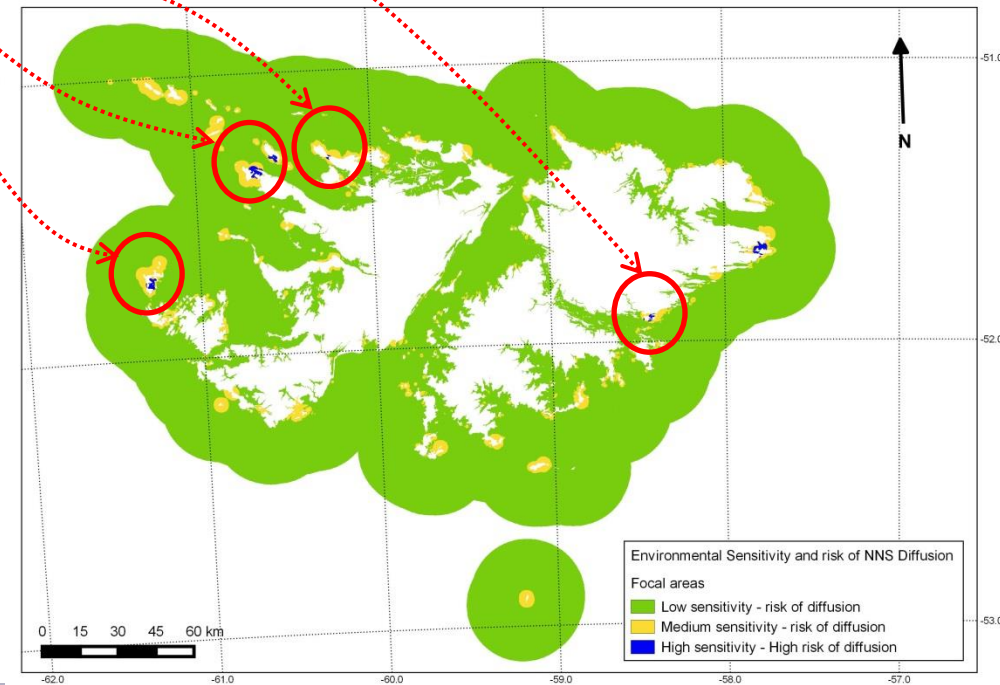


The layers with normalised risk scores (0-1) of introduction/diffusion and env sensitivity were added to each other to provide final maps of focal areas where high, medium and low level of risk and sensitivity overlap.

## SENSITIVITY and RISK from INTRODUCTION



## SENSITIVITY and RISK from DIFFUSION



## Conclusion:

- The maps show which areas should be considered **priorities to manage biosecurity** risks due to biofouling (cleaning, checking bots and monitoring).
- The maps are preliminary outcomes and further analyses will be needed to **improve the models** (e.g. types of invasive at port of calls, diffusion patterns of known invasives, overlap with aquaculture development areas etc).
- The MSP process benefits from the GIS analyses of spatial data as the current maps are starting points for **developing strategies and plans** for biosecurity.
- The local authority and stakeholders will take advantage of the MSP process as they will receive the tools for a better management and key information to make **informed coordinated planning decisions** across all marine activities.

*Part of the Marine spatial planning process*

**Spatial data => GIS => tools for planning and management**

# We would like to thank:

- JNCC/FCO for funding iLaria's work for the IMS/GIS Centre project
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# Thanks



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