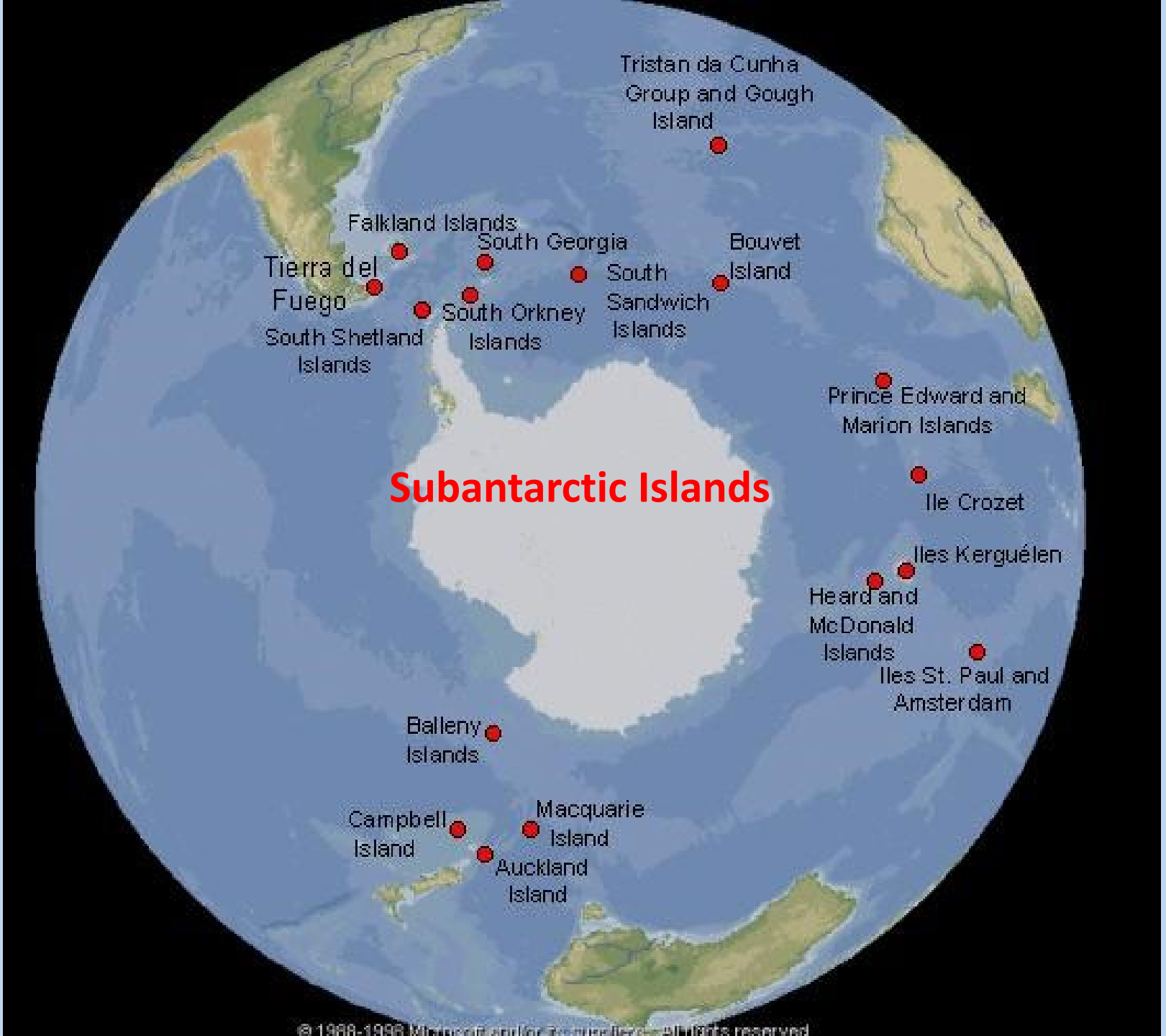
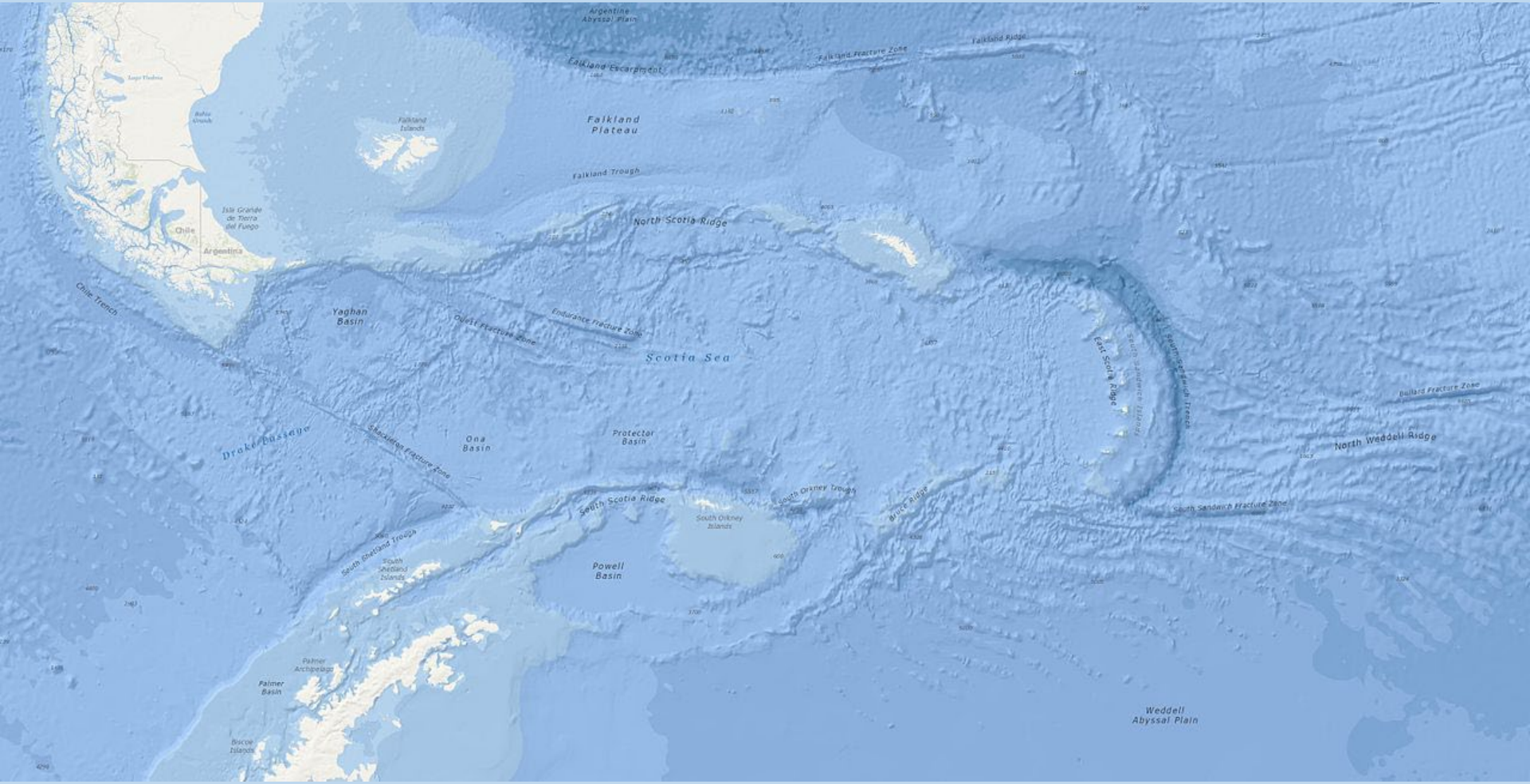

Tristan da Cunha Group and Gough Island
Falkland Islands
South Georgia
Bouvet Island
Tierra del Fuego
South Sandwich Islands
South Orkney Islands
South Shetland Islands
Prince Edward and Marion Islands
Subantarctic Islands
Ile Crozet
Iles Kerguélen
Heard and McDonald Islands
Iles St. Paul and Amsterdam
Balleny Islands
Campbell Island
Macquarie Island
Auckland Island

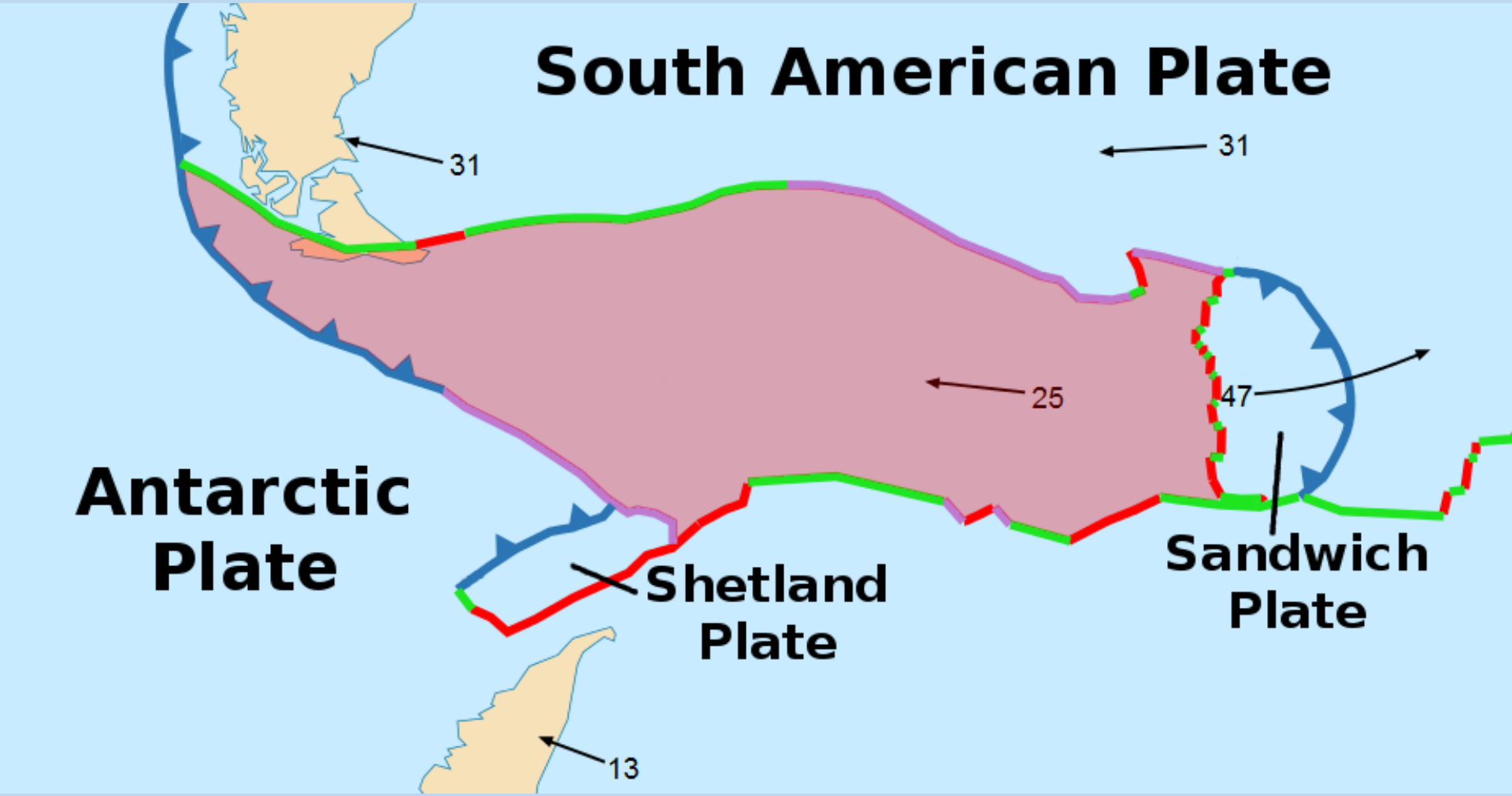
Scotia Arc



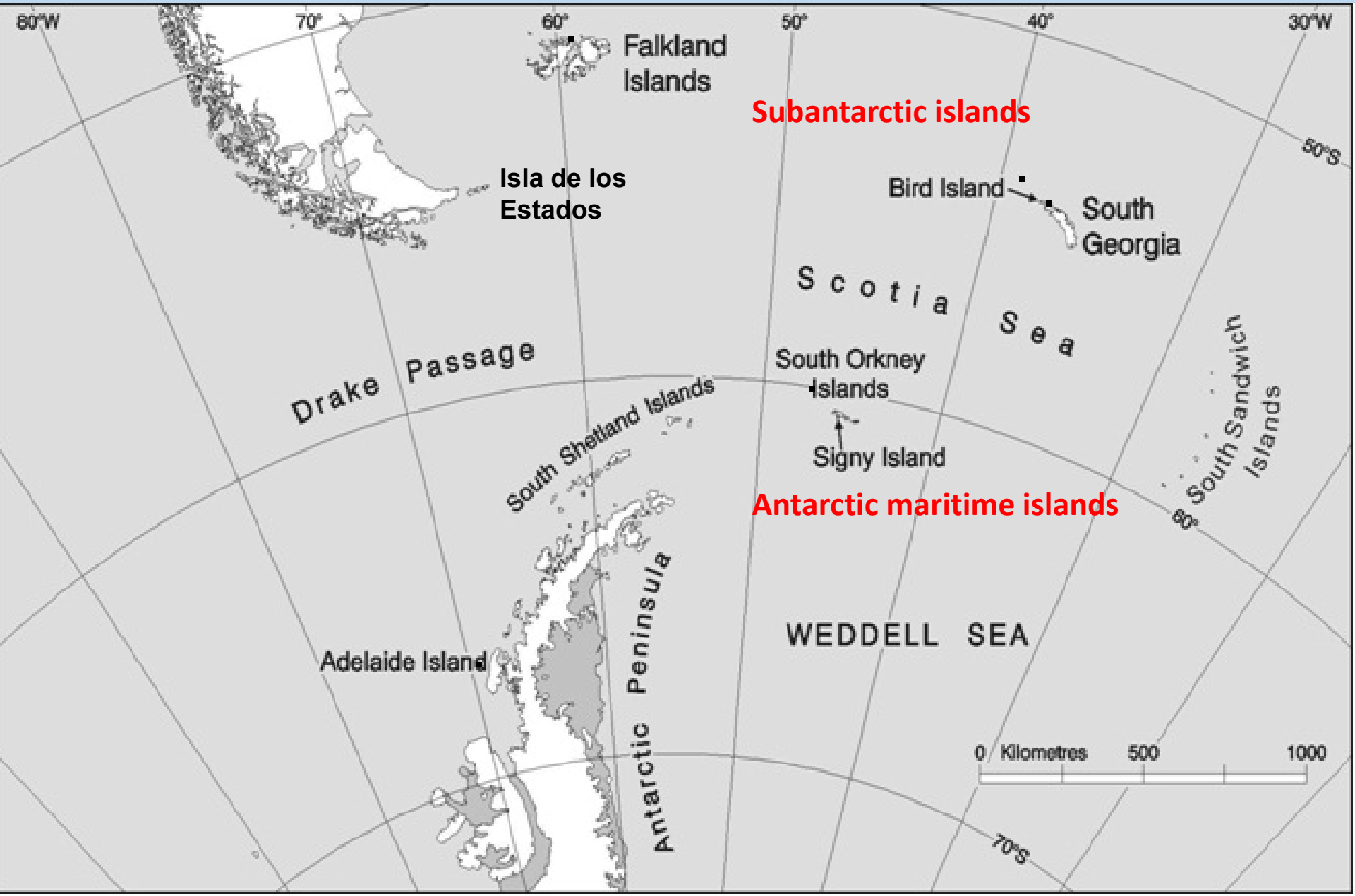
https://upload.wikimedia.org/wikipedia/commons/2/2e/Scotia_Sea_NOAA.jpg

Scotia Arc has the only island chains that link Antarctica to another continent

The Scotia Plate formed ~40 Ma when Antarctica was separating from Gondwana and formed Drake Passage



https://en.wikipedia.org/wiki/Scotia_Plate

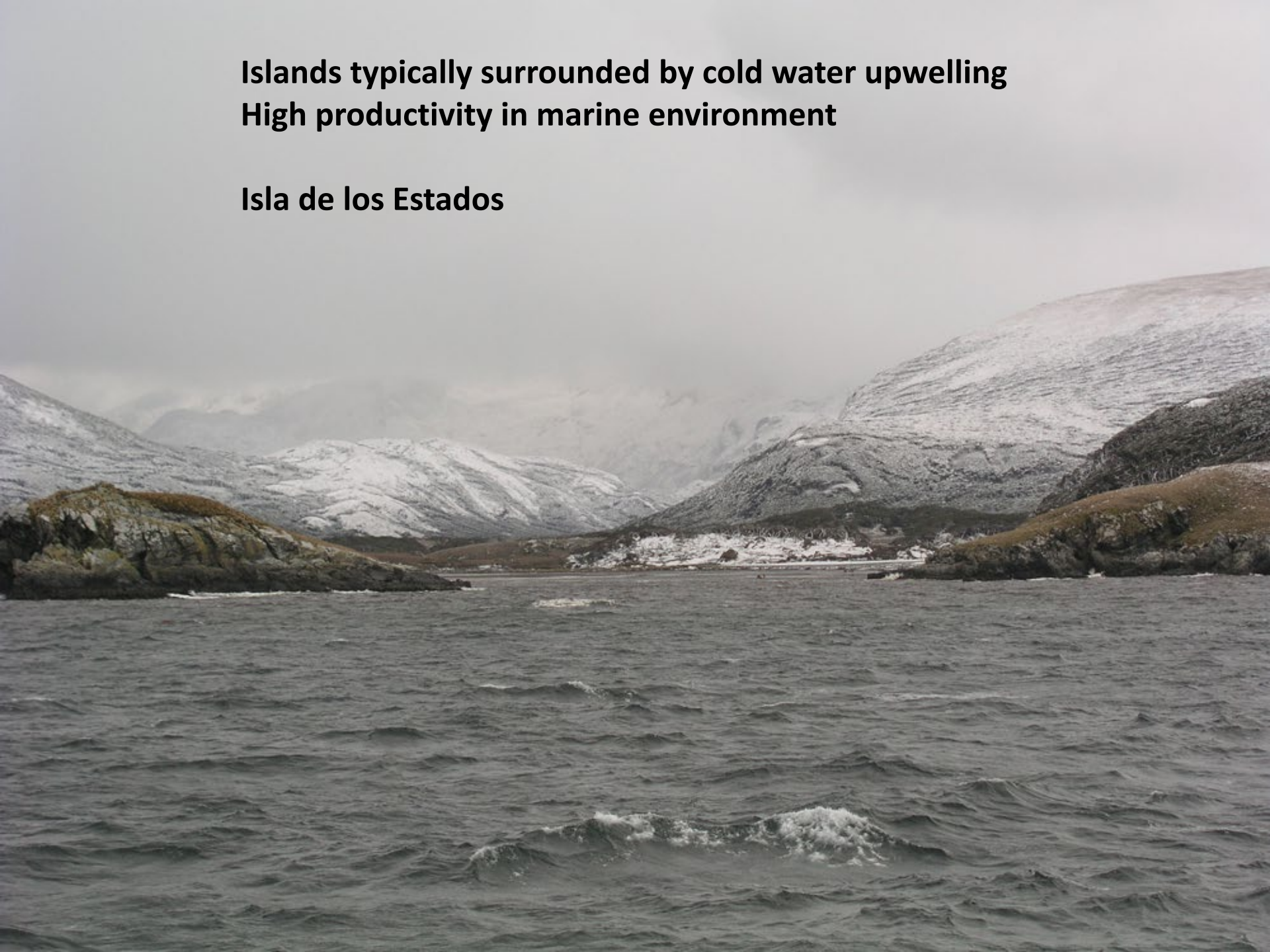

80°W
70°
60°
50°
40°
30°W
Falkland Islands
Subantarctic islands
Isla de los Estados
Bird Island
South Georgia
50°S
Scotia Sea
Drake Passage
South Orkney Islands
South Shetland Islands
Signy Island
Antarctic Peninsula
South Sandwich Islands
Antarctic maritime islands
WEDDELL SEA
Adelaide Island
0 Kilometres 500 1000
70°S

Subantarctic Islands are characterized by:

Moderate climate north of Antarctic convergence
Strong westerly winds
Precipitation (rain or snow) higher, 25-30 inches per yr
Mountains and some with permanent glaciers
Tussock grass communities dominate, few or no trees
Support most of earth's seabird and seal populations

Islands typically surrounded by cold water upwelling
High productivity in marine environment

Isla de los Estados



Soon after discovery of many of these islands, they were heavily exploited by whalers and sealers

Rich bounty of penguin and seals harvested for blubber and oil

Whaling stations established to more efficiently exploit the Southern Ocean

Damage from these activities is still evident and species recovery still ongoing

Grytviken, South Georgia Island

Only scientists and tourists visit these islands


South Atlantic Ocean
Scotia Sea
38° 00W
37° 00W
36° 00W
54° 00'S
54° 30'S
Willis Islands
Bird Island
Elephant
Church Bay
Cape North
Right Whale Bay
Welcome Islets
Cape Buller
Cape Wilson
Cape Constance
Sunset Fjord
Bay of Isles
Prince Olav Harbour
Possession Bay
Antarctic Bay
Fortuna Bay
Fortuna Glacier
Leith Harbour
Stromness
Stromness Bay
Husvik
Jason Peak
Larsen Point
Sappho Point
Barff Point
Cumberland West Bay
Cumberland East Bay
Grytviken
Godthul
Ocean Harbour
Hound Bay
Cape Vakop
St Andrews Bay
Cape Harcourt
Royal Bay
Cape Charlotte
Brocken
Mount Brocker
Ross Glacier
Hindle Glacier
Iris Bay
Cape Vahsel
Cooper Island
Cape Disappointment
Mt. Normann
Drygalski Fjord
Kupriyanov Island
Novosilski Glacier
Salvesen Range
Allardyce Range
Nordenskjold Glacier
Nordenskjold Peak
Mt. Paget
Christoffersen Glacier
Mt. Sugartop
Jacobsen Bight
Cape Darnley
Annenkov Island
Rocky Bay
Undine South Harbour
Brögger Glacier
Pickersgill Islands
Mt. Fraser
Mt. Paterson
Cape Paryadin
Ice Fjord
Wilson Harbour
Bomford Peak
Mt. Ashley
Schleper Bay
Cheapman Bay
King Haakon Bay
Mt. Cunningham
Esmark Glacier
Queen Maud Bay
Cape Nunez
Jossac Bight
Keilhau Glacier
Neumayer Glacier
Newark Bay
South Georgia
Heights in Feet
0
40 km
© Paul Carroll 1998
(paulc@wndrland.demon.co.uk)


South Georgia is typical of subantarctic islands
Hundreds of thousands of penguins, seals, fur seals breed here
Rich tussock grass community
Whaling stations established in 1904 – 1917
Reindeer introduced for food in 1911, rats had arrived on ships
King Penguins
NATIONAL GEOGRAPHIC
PHOTOGRAPH BY ROBERT MCRAE | NATIONAL GEOGRAPHIC TRAVELER PHOTO CONTEST 2014
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Tussock Grass community


The tussock has a thick growth of leaves from a fibrous pedestal
Highly tolerant of salt from sea spray
Forms a habitat for numerous species of birds, invertebrates
On Falklands, 42 of 62 spp. of birds feed or nest in tussock


Soil is typically acidic, peat builds up over time
Grasses receive most nutrients from bird guano


Mix of sea spray, guano, and warm temperatures volatize nitrogenous compounds that rise and spread over the entire community, serving as a nutrient source
Southern Rockhopper Penguin

Tussock communities are mainly restricted to a narrow band around the coast, less dense and smaller more inland and higher in elevation

Introduced species cause considerable damage to the tussock community

Include mice, rats, cats, pigs, goats and even reindeer

Marion Island

House mice (*Mus musculus*) accidently introduced by sealers in the 19th century

Marion Island: 5 cats brought in to solve mouse problem in 1949

By 1977, 3400 cats, devastating to burrowing seabird colonies

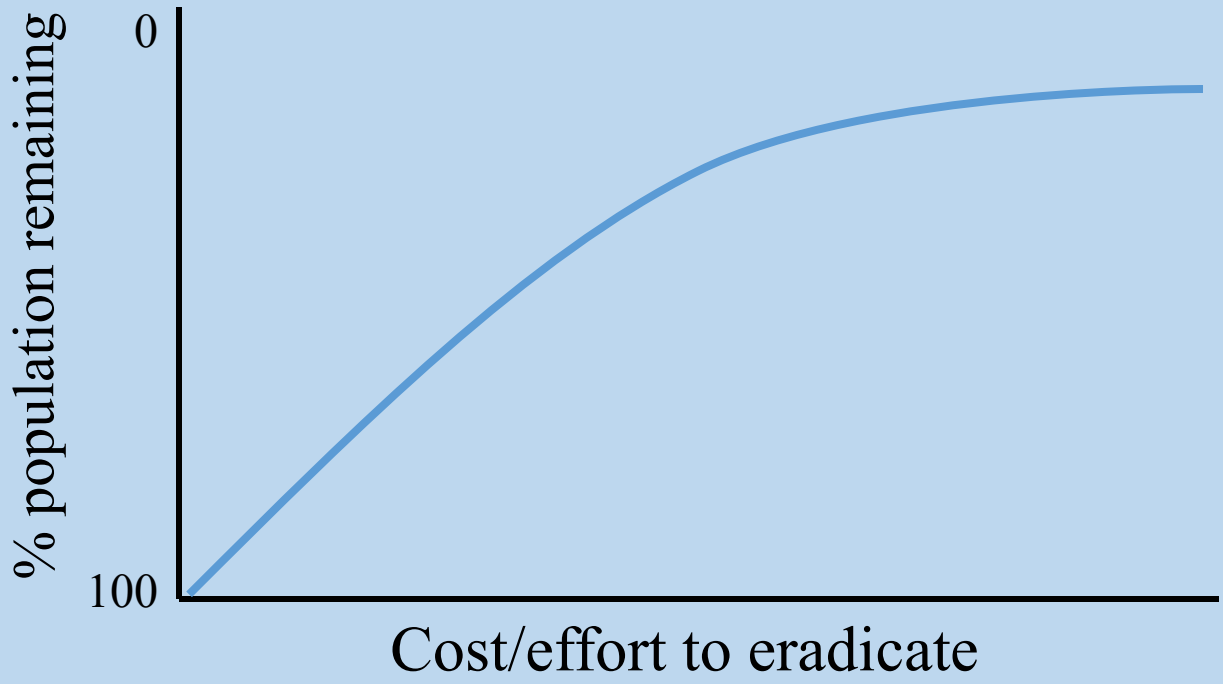
Eradicated with introduced disease, trapping and hunting by 1991

https://www.iol.co.za/news/marion-islands-plague-of-mice-1563686

Mouse damage to albatross chick that ultimately is lethal

Eradication

- Once a species becomes established, can be very difficult to eradicate




Reindeer on South Georgia Island
Intense eradication efforts have been successful at South Georgia
© keith thompson

Reindeer exclusion pen, South Georgia Island

http://www.sgisland.gs/index.php/%28h%29South_Georgia_Newsletter,_January_2013

Only place in the world where you could see penguins intermixed with reindeer

Reindeer numbers remained low as long as whalers were present to hunt them

In 1960s, whalers had all left and reindeer numbers grew

Erradication began in 2013, thought there was about 3000, but actually there were 6690 killed by 2015

Meat distributed to the Falklands, cruise ships

Total cost of eradication was 756,000 pounds

Rats were introduced on South Georgia with whaling ships

Devastating to ground nesting birds, including an endemic songbird (South Georgia Pipit), petrels, and penguins

Rat eradication began in 2011 by spreading poison pellets over the entire island where rats were known to occur

Largest island eradication ever attempted for this

South Georgia rat eradication

Eradication by South Georgia Heritage Trust, world's largest rodent eradication program, targeted three areas separated by glaciers to sea, but warming trend was melting glaciers and connecting them.

Eradicate one area, it would be recolonized by another. Total cost was 7.5 million pounds, or about $10 million U.S.

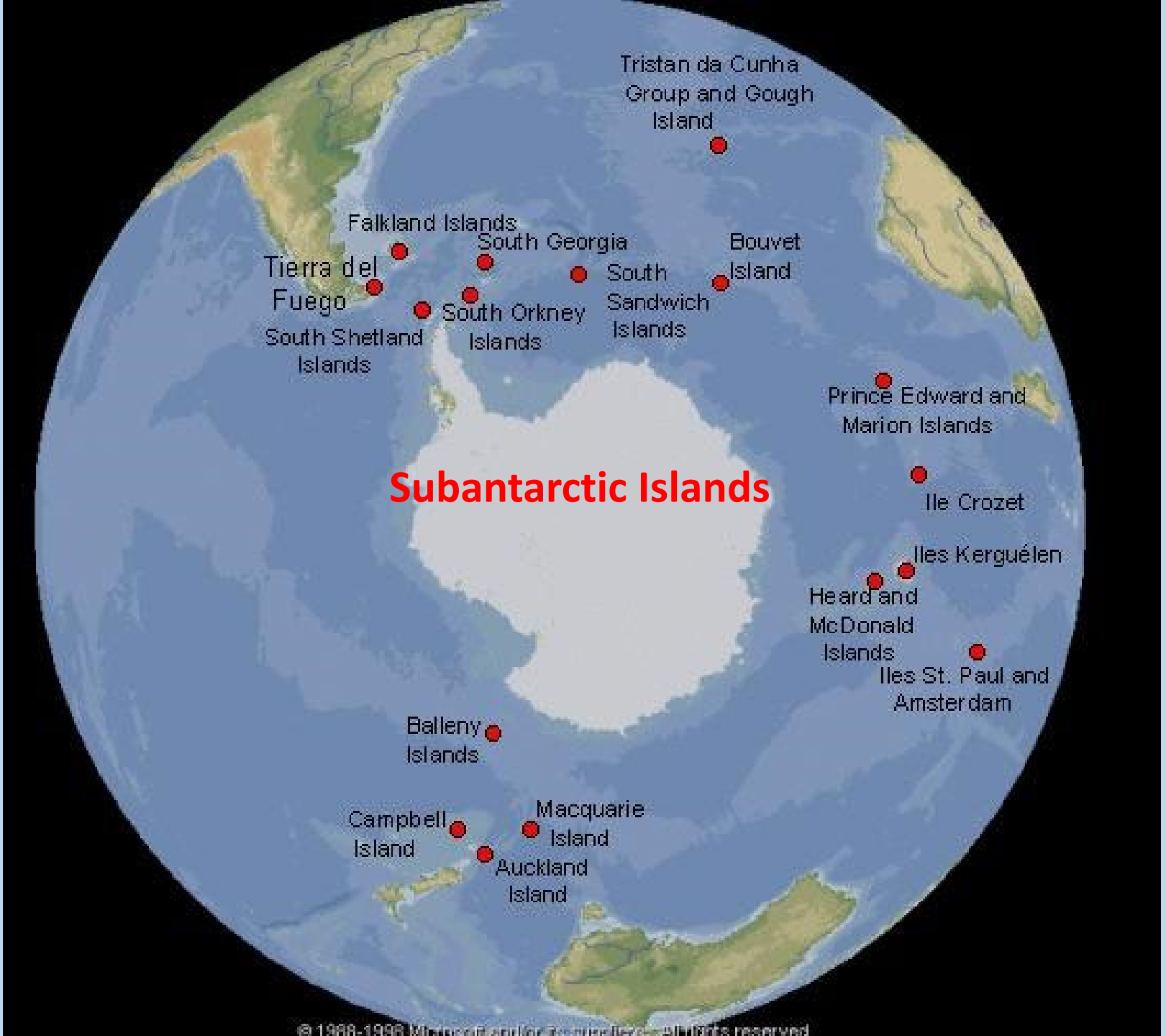
South Georgia Pipit

Most southerly nesting songbird

First nesting record in living memory in 2015, after rats eradicated

South Georgia restored

http://www.independent.co.uk/


Tristan da Cunha Group and Gough Island
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Subantarctic Islands
Ile Crozet
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Heard and McDonald Islands
Iles St. Paul and Amsterdam
Balleny Islands
Campbell Island
Macquarie Island
Auckland Island

Like South Georgia, Macquarie Island is home to thousands of penguins, seals, and fur seals

More of an isothermal island with equable temperatures year-round with monthly averages at 4-10 ^{o}C

3.5 million breeding seabirds of 13 species

Also exploited heavily by whalers and sealers beginning in 1810

Macquarie Island is the only place where Royal Penguins breed

Sir Douglas Mawson used it as a base for his 1911-1914 expedition to Antarctica

He saw the impact of whalers and sealers, near extinction of species

Lobbied in Australia for protection, sealing licenses revoked in 1916

Island became a sanctuary in 1933 and a permanent scientific station was established there in 1948

Station currently being rebuilt, reduced footprint

Sealers brought cats and introduced rabbits for meat in 1800s

Also rats and mice accidentally, from ships

Rabbit population at ~150,000 by 1979
Myxomatosis disease introduced, 90% of rabbits died

In 1985, cats were eradicated and rabbits came back to ~130,000 by 2008

Rabbits ate most of the grasses, caused erosion, loss of bird nesting habitat

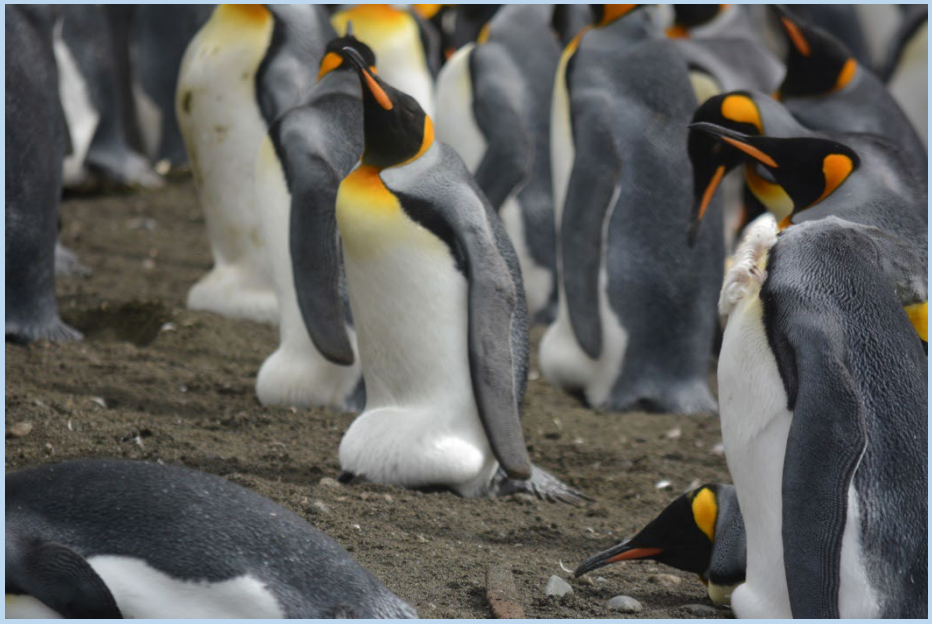
Macquarie is located at edge of two plates: Australian and Pacific

Only place in Pacific Ocean where mantel rocks are exposed at sea level

Designated a World Heritage Site in 1997

Eradication of rodents and rabbits began in 2007 but poison was also killing seabirds

Finally finished eradication by 2014 and island is pest free

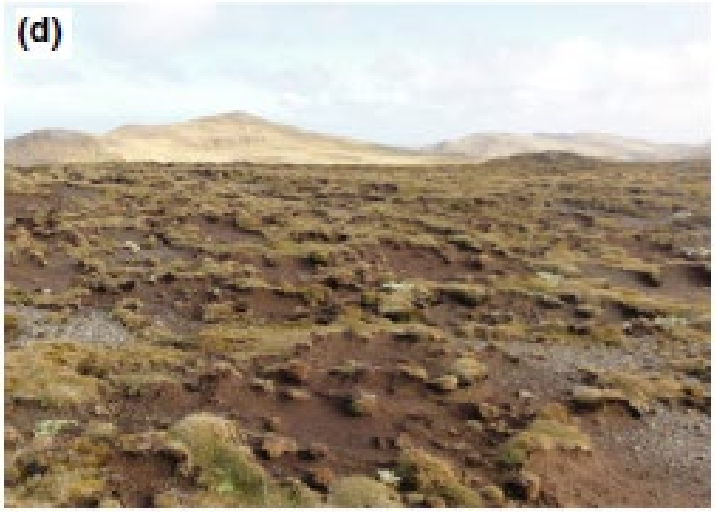


Macquarie Island Pest Eradication

Dogs that saved Macquarie

https://en.wikipedia.org/wiki/Azorella_macquariensis

Cushion Plant (*Azorella macquariensis*)



Damage to cushion plants on Macquarie Island, 2008-2012
From Bergstrom et al. (2015)

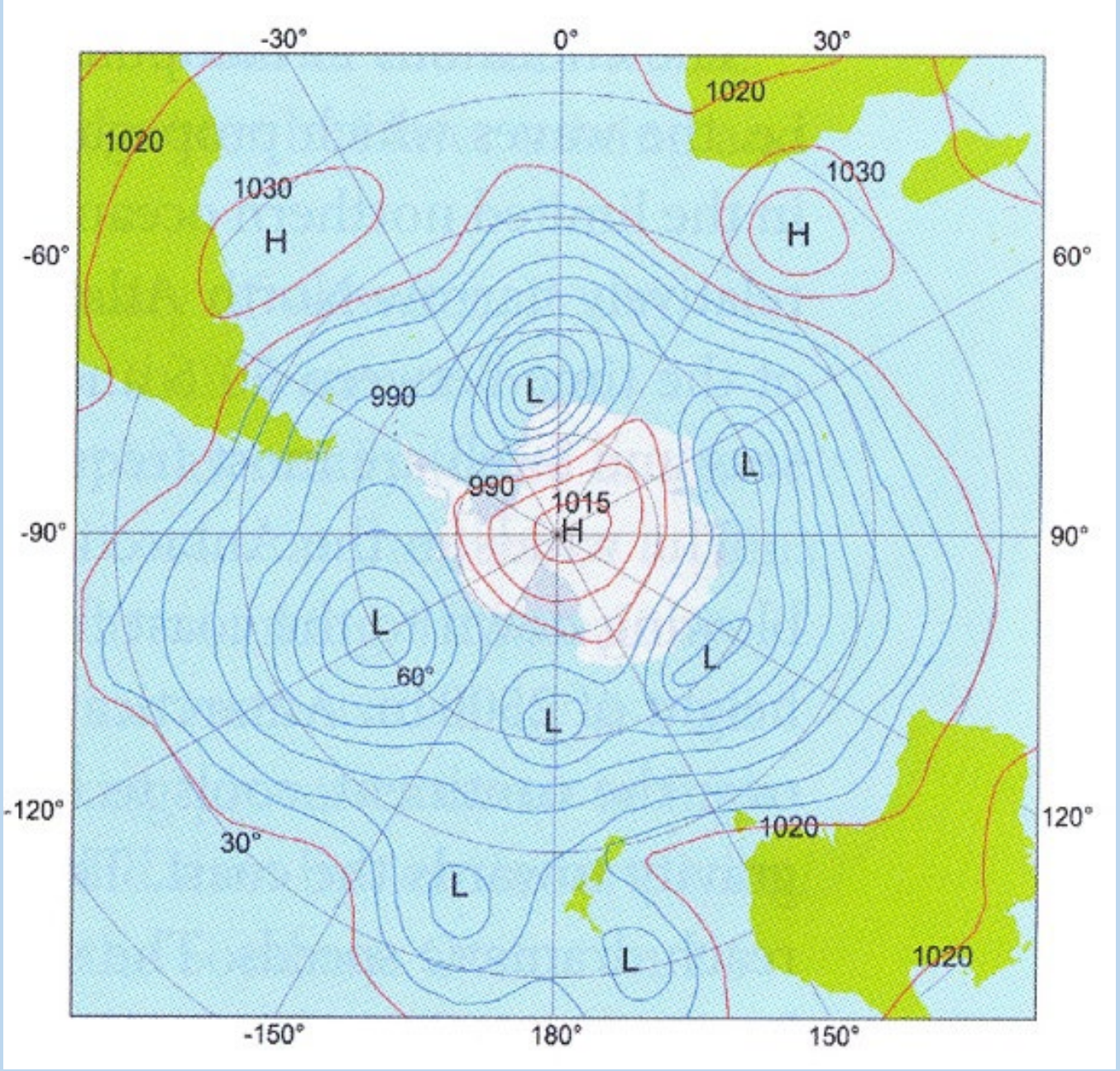


Fig. 5.2 in Walton (2013)

Conservation

New Zealand has established Marine Protected Areas (MPAs) around four of its subantarctic Islands:

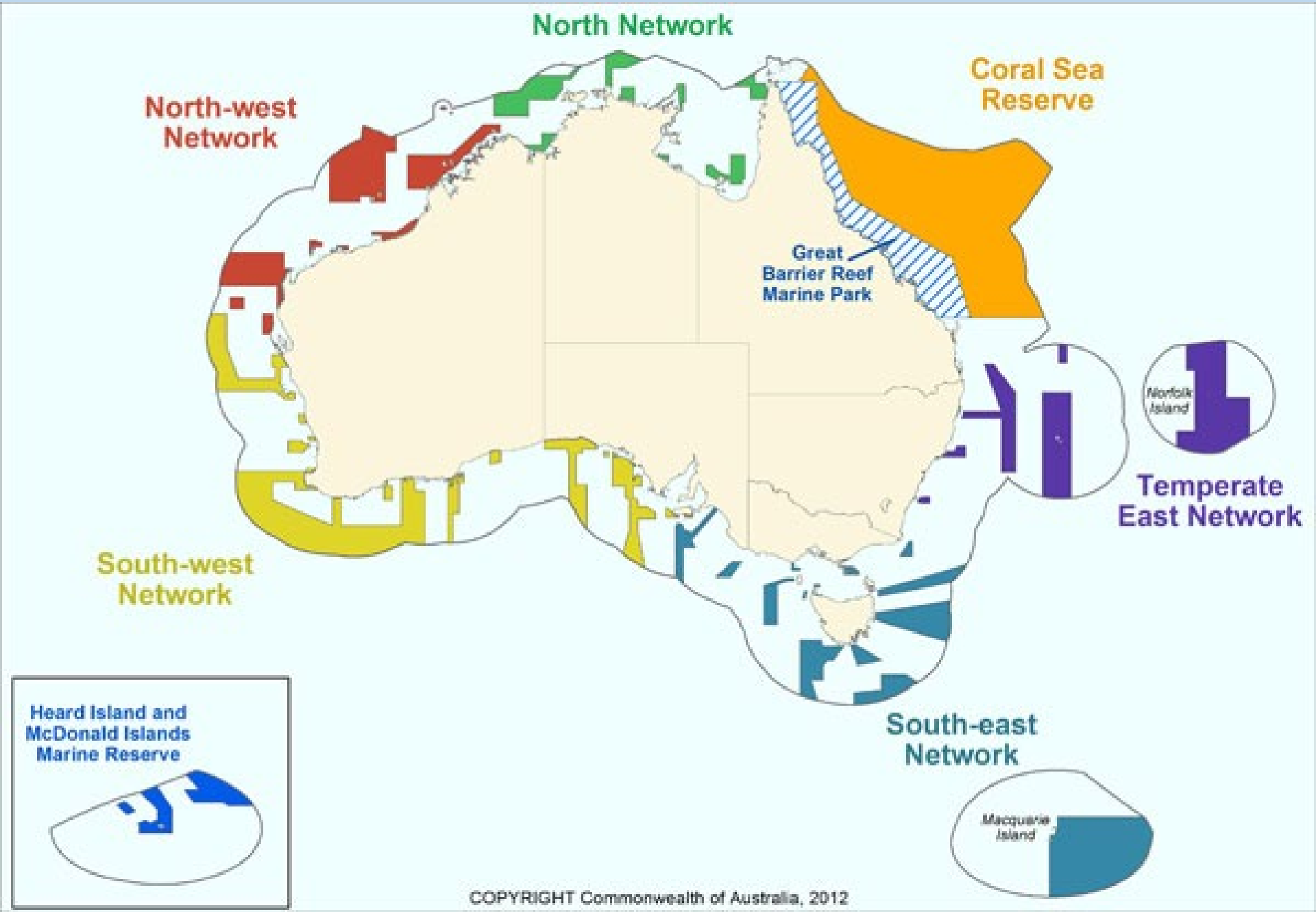
Bounty
Antipodes
Campbell
Aukland

Macquarie Island Megaherbs

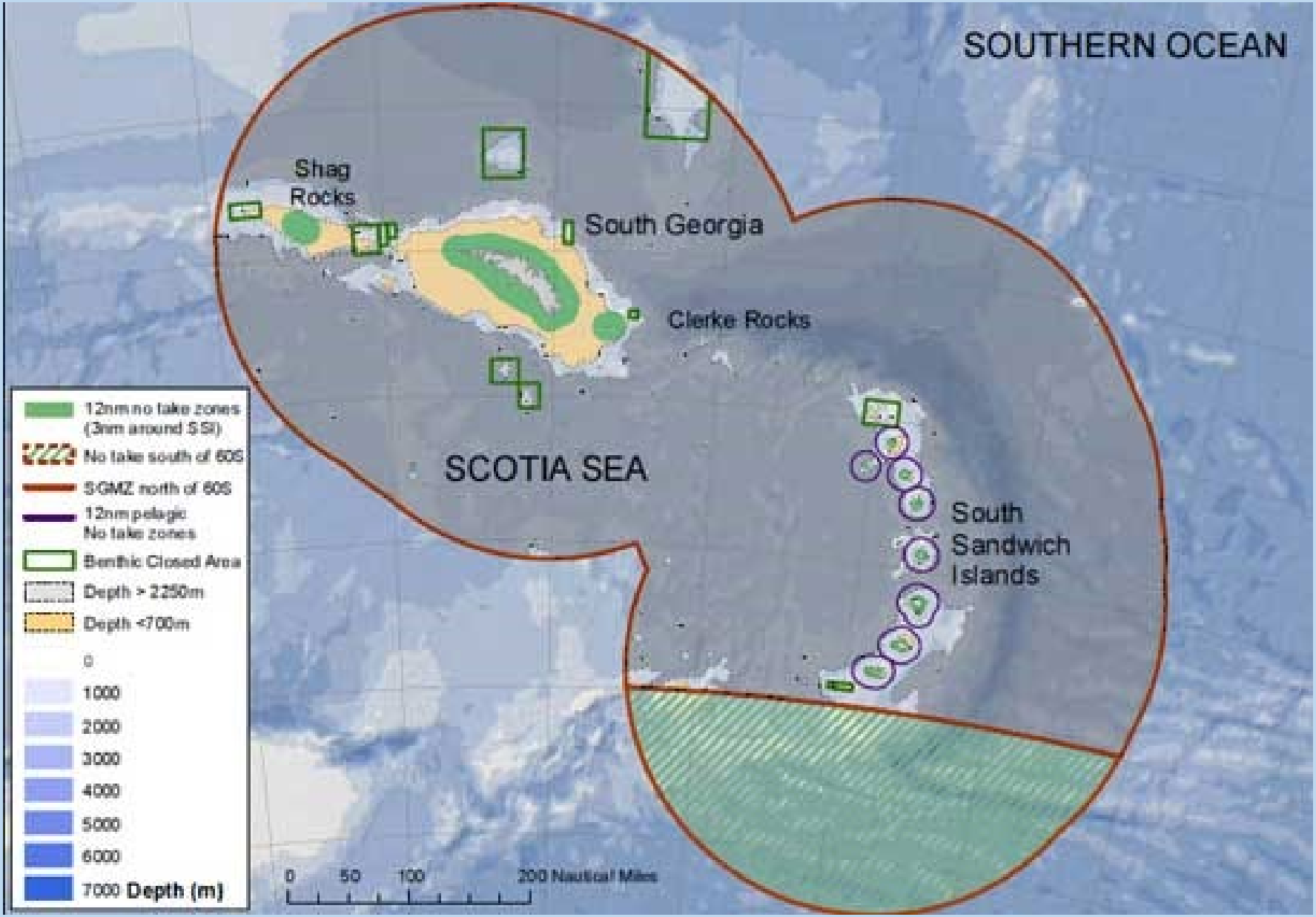
Macquarie Island Megaherbs

Enderby Island Megaherbs

Australia also now has an extensive network of marine reserves and protected areas

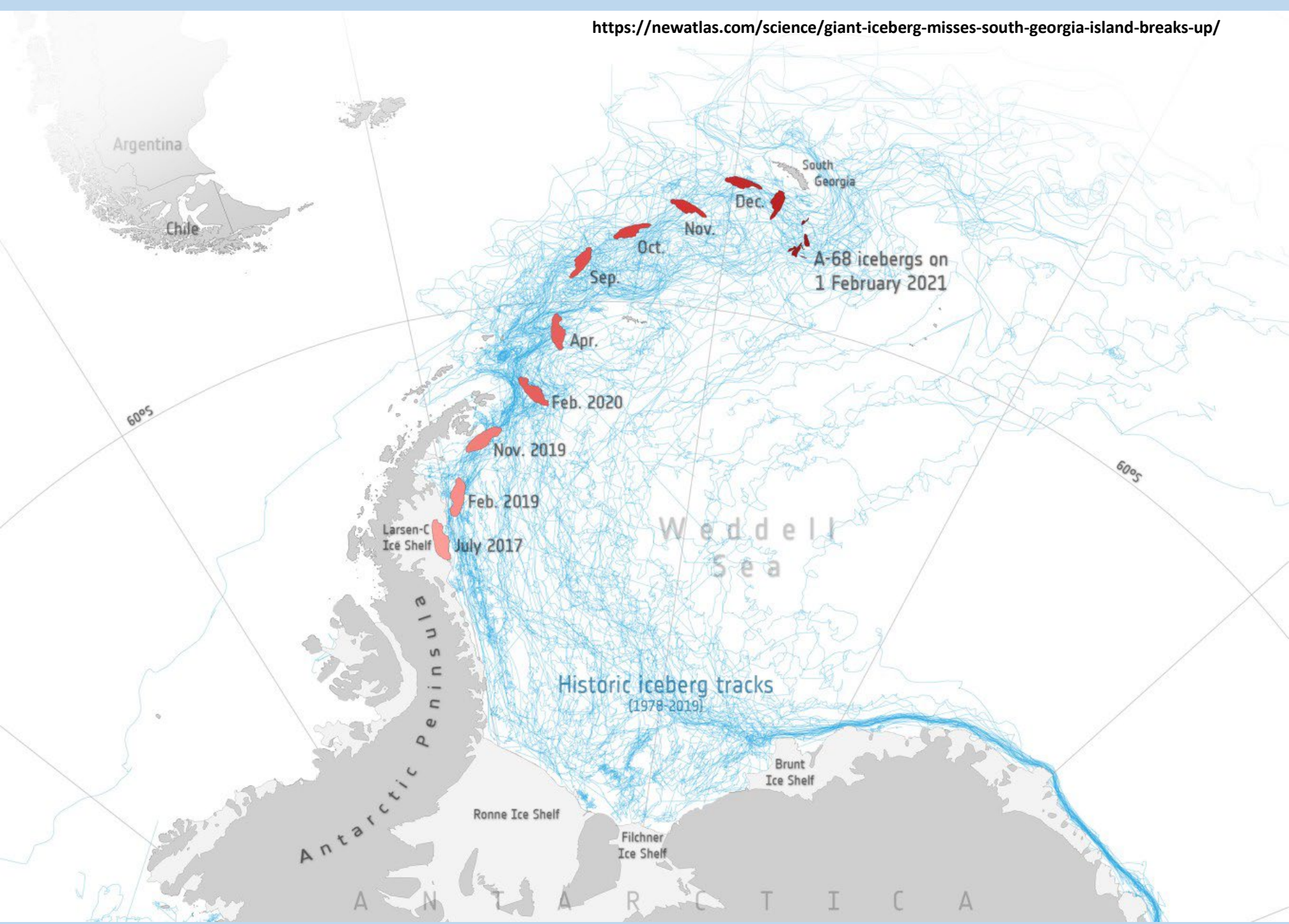


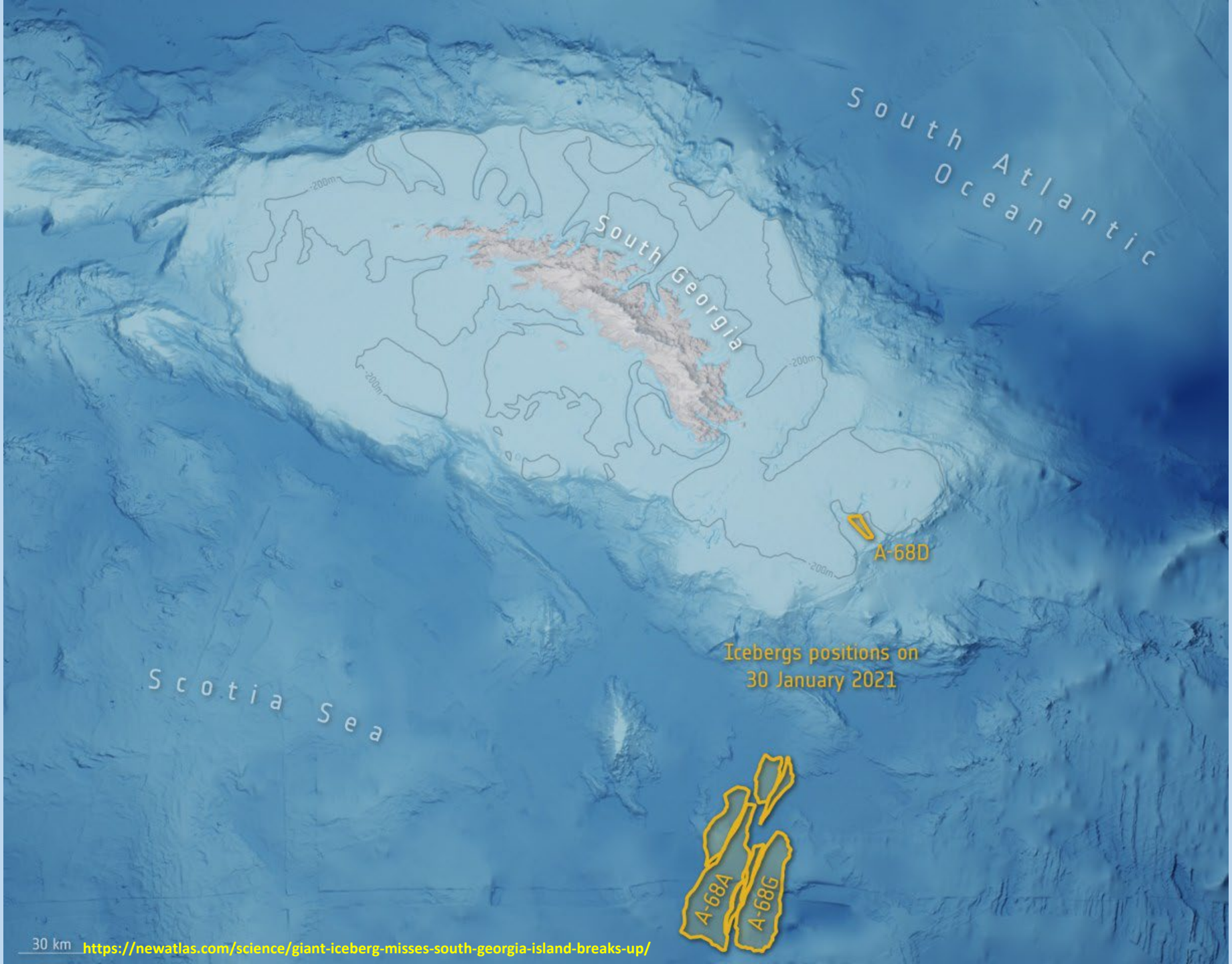
The U.K. has extended protection around South Georgia and the South Sandwich Islands



http://www.sgisland.gs/index.php/%28h%29South_Georgia_Newsletter,_January_2013

https://newatlas.com/science/giant-iceberg-misses-south-georgia-island-breaks-up/




South Atlantic Ocean
South Georgia
200m
200m
200m
200m
A-68D
Icebergs positions on
30 January 2021
Scotia Sea
A-68A
A-68G
30 km
https://newatlas.com/science/giant-iceberg-misses-south-georgia-island-breaks-up/

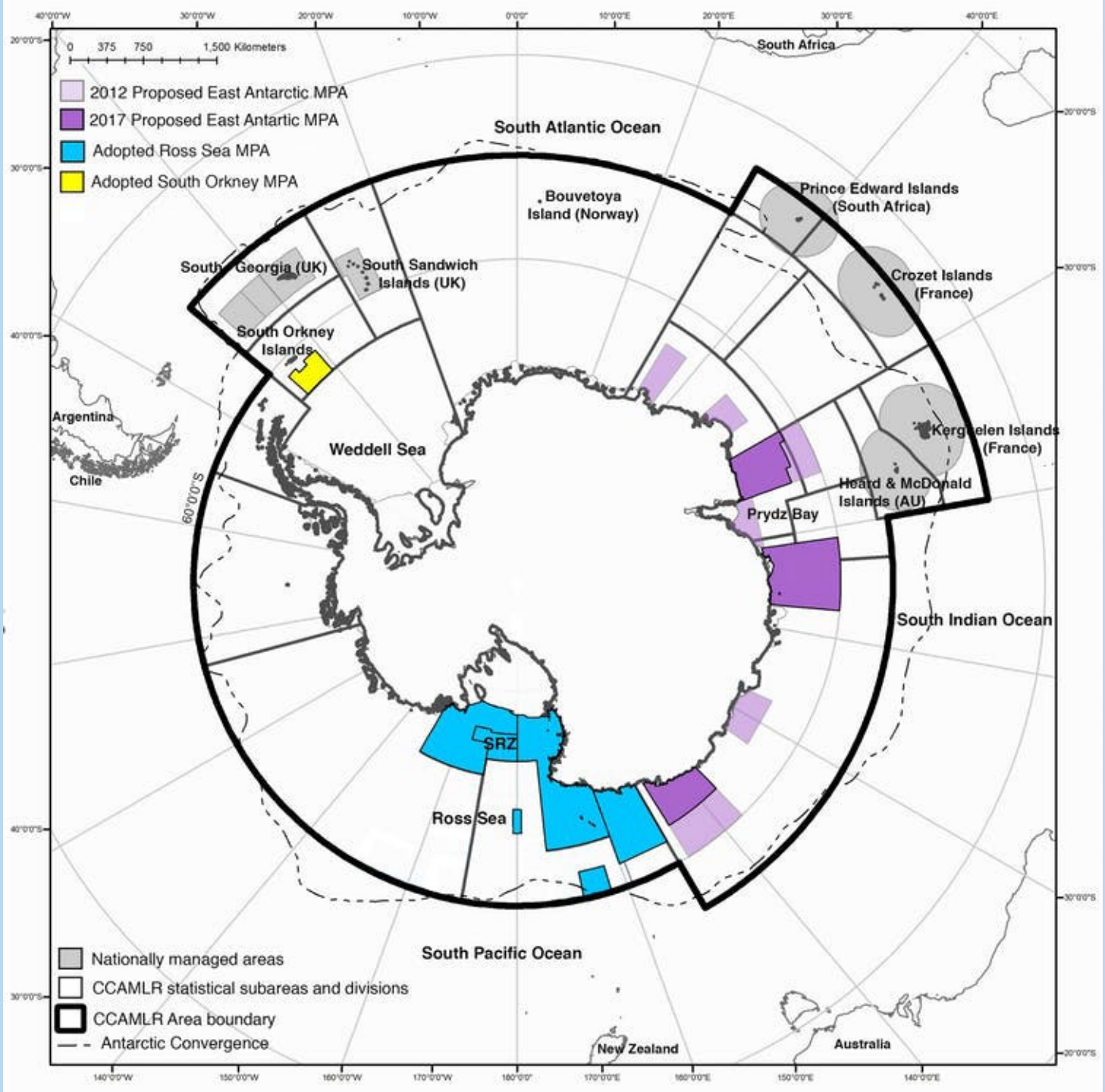
Will MPAs be effective in preserving biodiversity?

Study by Edgar et al. (2014) indicates five key features are necessary to make them successful:

Surveyed 87 MPAs worldwide and found most were not effective. Those that were had these five key features:

1. **They included a complete ban on fishing**
2. **The ban was enforced**
3. **They were relatively large**
4. **They had been established over 10 yrs ago**
5. **They had continuous habitat and were isolated from fished areas by deep waters or sand**

Edgar et al. 2014. Global conservation outcomes depend on marine protected areas with five key features. *Nature* 506: 216-220.


0 375 750 1,500 Kilometers
2012 Proposed East Antarctic MPA
2017 Proposed East Antartic MPA
Adopted Ross Sea MPA
Adopted South Orkney MPA
South Africa
South Atlantic Ocean
Bouvetoya Island (Norway)
Prince Edward Islands (South Africa)
South Georgia (UK)
South Sandwich Islands (UK)
Crozet Islands (France)
South Orkney Islands
Argentina
Chile
Weddell Sea
Kerguelen Islands (France)
Heard & McDonald Islands (AU)
Prydz Bay
60°0'0"S
South Indian Ocean
SRZ
Ross Sea
South Pacific Ocean
New Zealand
Australia
Nationally managed areas
CCAMLR statistical subareas and divisions
CCAMLR Area boundary
Antarctic Convergence

New marine protected area currently being proposed in East Antarctica by Australia

Diverse marine life and benthos

Needs protection from toothfish and other fisheries

Has proposed this MPA for six years at annual treaty meetings but Russia and China oppose it

Recent findings with remote underwater cameras is adding new information and support for the MPA

http://www.antarctica.gov.au/news/2018/underwater-cameras-light-the-way-for-southern-ocean-conservation

Quiz

1. What are the general characteristics of subantarctic islands?

2. What is the tussock grass community and how does it function?

3. How are these islands impacted by introduced species and how did these species arrive at the islands?

4. How much effort is required to eradicate an introduced species and what are some examples of a successful eradication?

5. What are MPAs and what five key features determine their success?