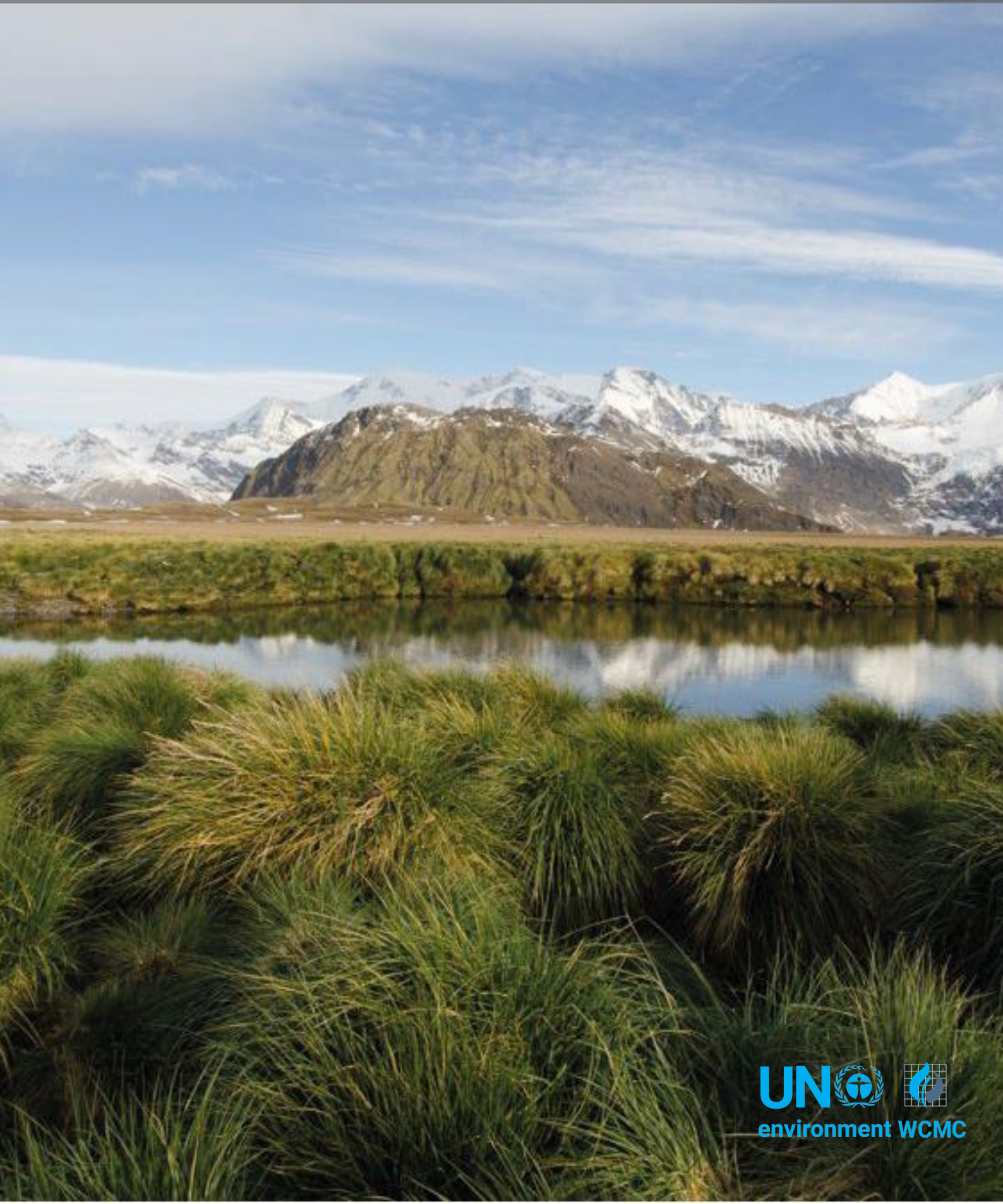


A review of terrestrial protected areas

South Georgia and the South Sandwich Islands



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Executive summary

This report was commissioned by the Government of South Georgia and the South Sandwich Islands (GSGSSI) with the aim of reviewing terrestrial protection and ensuring it met a series of defined conservation goals as defined by GSGSSI and stakeholders.

Currently a lot of conservation focus centres on the efficacy of protection in the marine realm whilst the territory's terrestrial realm has not been reviewed for almost two decades. It is an opportune time to undertake this study as the territory's MPA undertakes its first five-year review, and the territory prepares to contribute towards the UK's sixth national report to the Convention on Biological Diversity (CBD). Beyond 2018 is the redrafting of the territory's biodiversity action plan and broader strategy.

The project ran from March 2017 to September 2018 and was a desk-based approach that utilised several consultative steps with which to solicit input from stakeholders. The stakeholder input was invaluable for the final options for consideration, often grounding the initial ideas in reality.

This report showcases that the territory faces many threats but that several of the most severe, such as fishing, pollution and climate change largely stem from outside the territory's borders. Terrestrial threats also occur, primarily through the interlinked risks of invasive species incursion and the potential disturbance caused by humans, both of which may become more severe in the future with the predicted increase of tourism.

This report also highlights that the territory already has many mechanisms in place with which to address these threats. Furthermore, these existing measures are compared to other Sub-Antarctic islands which are considered effectively protected and asks stakeholders their opinions on the territory's existing protection. Both indicate that—for the most part—the islands' terrestrial natural heritage is effectively protected from current threats.

This project therefore lists only ten options for consideration which largely centre on mechanisms with which to strengthen and standardise these existing measures in the face of future threats. These options span the entirety of the territory but focus on the terrestrial protected areas, of which this project lists nine for consideration as well as several more which would require further research.

The project re-emphasises the regional and global significance of the territory as a hotspot for species, most notably for bird species, but also as a territory which, now free from invasive mammalian species, increasingly supports representative Sub-Antarctic habitats that are re-establishing themselves throughout the territory.

The territory is undergoing and will continue to undergo significant flux over the coming years as the absence of invasive mammals and climate change result in modified distributions of species and habitats. Ensuring that this changing landscape remains in as natural a state as possible in the face of potentially increasingly severe threats will be a key challenge for GSGSSI in the years to come. The possible terrestrial protected areas listed here are a key part of the approach to mitigate these threats but they are just one part of a multi-dimensional approach that needs to continue to be integrated into all aspects of the territory.

1 Natural and cultural heritage

1.1 Physical environment

South Georgia and the South Sandwich Islands are a collection of exceptionally remote islands in the Southern Atlantic. Although considered as one entity they represent two physically distinct island groups, with the South Georgia cluster ranging between 560 and 800km west of the South Sandwich Island arc (Figure 1).

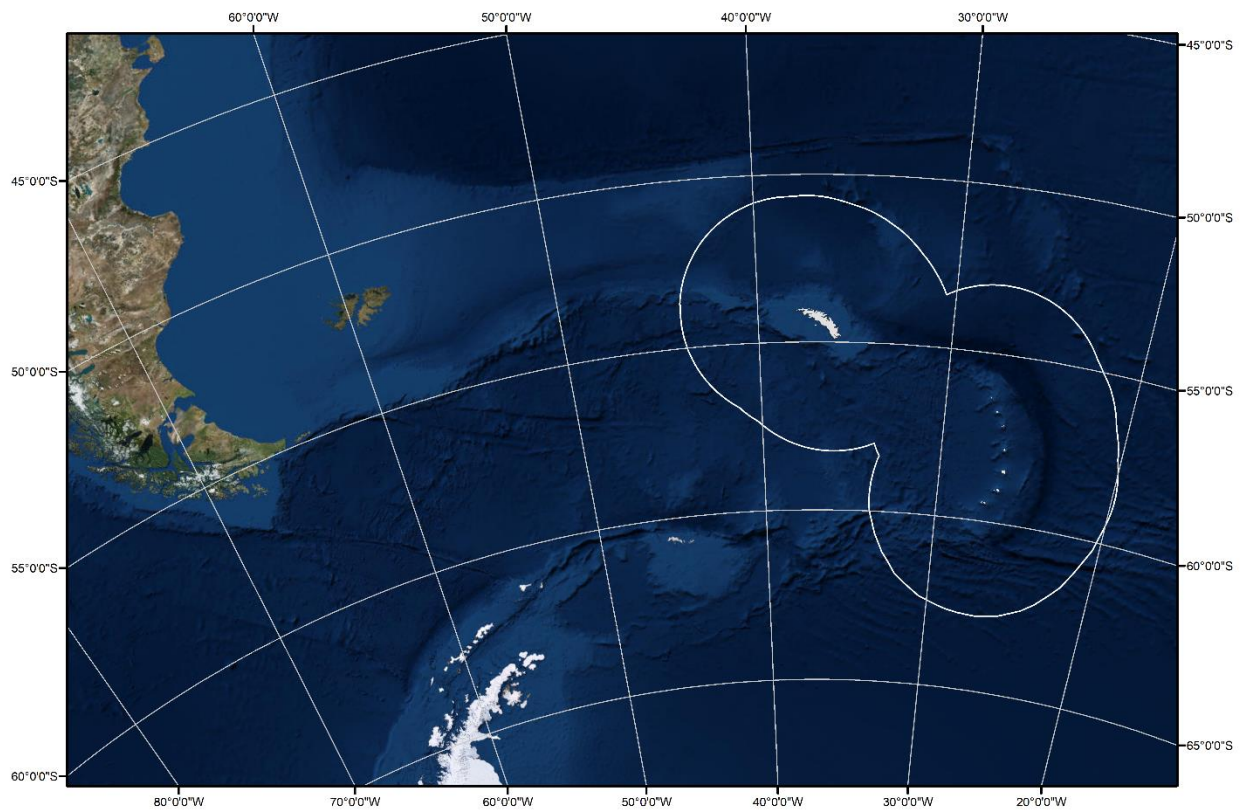


Figure 1: South Georgia and the South Sandwich Islands represent one of the most southerly, remote and disparate of the British overseas territories*.

South Georgia, at approximately 175km long and between 2-40km wide covers around 3,755km². Surrounding South Georgia are numerous smaller islands, islets and rock outcrops, all of which are within 250 km of South Georgia and are all individually under 14km². The Salvesen and Allardyce mountain ranges on South Georgia, which include 12 peaks over 2,000m a.s.l, form the island's central spine, although the topography of the coast is no less dramatic with high sea cliffs being punctuated by over 100 glaciers and numerous fjords (Headland 1984; Cook et al. 2010).

The climate is characterised by cold, wet and windy weather. Mean winter temperatures at King Edward Point (KEP) fluctuate around 1.8°C but winter minimums can reach -19.4°C (Rogers et al. 2015). Despite harsh winters the austral summer on South Georgia is significantly milder, with summer maximums of ~26.3°C. Gales are common throughout the year, with wind speeds approaching 100 knots recorded even on the sheltered side of the island. The territory receives in the region of 1,600 mm of precipitation

* The territory is currently disputed by Argentina who also claims sovereignty.

annually, much of which falls as snow, resulting in an austral summer snowline at around 300m a.s.l. Consequently, in the region of 60% of the island is perpetually under snow or ice with only the lower

altitudes around the island's coast remaining snow-free in the summer months. The presence of ice is reflected in the marine realm where icebergs drift up from the south and which can be routinely seen throughout the year.

The South Sandwich Islands archipelago forms the northern limit of the maritime Antarctic, known as the Scotia Arc (Convey et al. 1999; Convey & Lebouvier 2009). They consist of 11 major volcanically active islands, isolated from the continental land masses in the Southern Ocean by thousands of kilometres of open ocean (Convey et al. 2000a; Lynch et al. 2016). The South Sandwich Trench lies to the east and north-east of the islands, with depths reaching 8000m. The seabed and coastline are subject to intermittent topographical changes, with the South Sandwich plate subducting underneath the South American plate (Government of South Georgia and South Sandwich Islands 2006). Recent eruptions have been recorded on some of the islands: Zavodovski and Bristol in 2016, Montagu in 2007, Candlemas and Southern Thule prior to 2000 (Global Volcanism Program 2017). Largely covered by ice and snow, the islands also have weather conditions that make approaching by boat very difficult (Petit & Prudent 2008). In the winter months they are surrounded by sea ice and temperatures continually fluctuate around freezing.

2,934 m

Height of the territory's highest peak,
Mount Paget.

~60%

Proportion of the territory under
permanent snow/ice cover.

1.2 Ecological importance

The territory is perhaps best known for being a globally important hotspot for seabirds and marine mammals, with estimations exceeding 100 million seabirds on South Georgia alone (Rogers et al. 2015). The territory's fauna is thought to include: 70 bird, four mammal and ~200 invertebrate species (Burton & Croxall 2012) whereas the flora is estimated to include 25 higher plant, ~125 moss and 85 liverwort species (Greene 1964; Burton & Croxall 2012). At present there are also thought to be ~200 lichens and 50 fungi within the territory though these taxa are considerably less studied (Øvstedal & Smith 2001; Shirihai & Kirwan 2008).

1.2.1 Avifauna

The territory hosts 30 species of breeding bird and 40 species of non-breeding bird spanning twelve taxonomic families. Five of these species are classed as threatened by IUCN: grey-headed albatross (EN), wandering albatross (VU), white-chinned petrel (VU); macaroni penguin (VU) and rockhopper penguin (VU), and an additional two species are considered near-threatened. Seven species are listed under the Agreement on the Conservation of Albatrosses and Petrels (ACAP). The territory represents a globally important stronghold for several of the ACAP species, for example the grey-headed albatross (*Thalassarche chrysostoma*: EN) as well as less threatened species such as the Antarctic prion (*Pachyptila desolata*: LC) which has over 85% of its global population at South Georgia. Despite the territory's remote location, there are only two endemic bird species: The South Georgia pipit (*Anthus antarcticus*: NT) and the South Georgia pintail (*Anas georgica*: LC), though it should be noted that baseline endemism in the Southern Ocean is low.

The South Sandwich Islands are also an area of high conservation and biological importance, providing the nesting grounds for a significant proportion of procellariiform seabirds (Chown et al. 1998; Hilton & Cuthbert 2010; Hart & Convey 2018). Like South Georgia, the South Sandwich Islands also support globally

* The territory is currently disputed by Argentina who also claims sovereignty.

significant proportions of certain species, for example, Antarctic fulmars (*Fulmarus glacialisoides*: LC) (Creuwels et al. 2007). However, it is not only the relative representation but also the actual size of the populations that is of note, Zavodovski Island supports the largest population of chinstrap penguins (*Pygoscelis antarcticus*: LC) in the world, possibly more than 1.5 million pairs (Burton & Croxall 2012).

1.2.2 Mammals

There are three resident mammal species: the fur seal (*Arctocephalus gazella*: LC), the elephant seal (*Mirounga leonina*: LC) and the Weddell seal (*Leptonychotes weddellii*: LC), though several additional species visit the territory. Despite its exploitation in the 18th and 19th Centuries, the fur seal is now by far the most abundant of these with population estimates in excess of three million, approximately 95% of the global population (Burton & Croxall 2012). Conversely, the Weddell seal is by far the least abundant, with fewer than 100 individuals limited to the shores of Larsen harbour.

The South Sandwich Islands support the same mammalian species but at significantly lower levels, a factor in the islands not being so exploited by the sealing industry in the 19th Century (Hart & Convey 2018).

1.2.3 Invertebrates

Around 200 invertebrate species are thought to inhabit the islands, around half of which occur in freshwater environments. The territory's invertebrate richness is low considering its size though this number is expected to increase with further research and it is higher than some other Sub-Antarctic islands (Dartnall 2005; Burton & Croxall 2012). Nonetheless, the territory's isolated and harsh climatic conditions limit the population to only those species highly resistant to freezing temperatures and harsh conditions. The overall paucity of information results in uncertainty over the level of endemism amongst invertebrates (Erséus & Grimm 2002).

The invertebrate diversity of the South Sandwich Islands is even less studied, with information primarily stemming from two expeditions in the last couple of decades (Hart & Convey 2018). Approximately 30 invertebrate species have been recorded, none of which are considered endemic (Convey et al. 2000a; McInnes & Convey 2005). The harsh conditions and changeable presence of species, for example, around geothermally warmed ground, has led to questions around the ephemeral presence of invertebrates on the island arc (Hart & Convey 2018).

1.2.4 Higher Plants

There are 25 native species of higher plant on South Georgia and one endemic hybrid, the hybrid burnet (*Acaena magellanica x tenera*). Additionally, there are also another 60 introduced species around 40 of which are considered to have been naturalised (Burton & Croxall 2012). The distribution of both native and introduced plant species is poorly understood. Native plants have predicted ranges mapped in 5km grid cells throughout South Georgia whilst recordings for the introduced flora are mostly limited to the peninsulas around KEP.

Due to the islands' volcanic nature, isolation and harsh climate, which is classified as semi-desert, the flora on South Sandwich Islands is considered to differ from other Antarctic regions (Convey et al. 2000b; Peat et al. 2007). Only one phanerogam has been recorded (*Deschampsia antarctica*) with the vast majority of the floral diversity represented by bryophytes (Hart & Convey 2018).

1.2.5 Lower plants

Around 120 mosses and 100 liverworts, which are often found together, have been recorded in the territory. Less than 5% of either are considered endemic (Burton & Croxall 2012). Very few have common names and are difficult to identify without microscopic investigation, making their identification and mapping very challenging. A total of 1262 herbarium specimens have been recorded on the South Sandwich Islands, comprising lichens, mosses, liverworts and a phanerogam (Peat et al. 2007). These specimens span 38 known moss species and eleven liverworts (Hart & Convey 2018).

>700

Number of species known to inhabit the territory

1.2.6 Fungi and lichen

Lichen species are notably difficult to identify without microscopic examination. In the region of 25% of the lichen species present are thought to be endemic to the territory (Burton & Croxall 2012) but these species are not considered endangered or requiring any special forms of protection (Øvstedal & Smith 2001). The several dozen macro fungi known to occupy the territory are generally found in the bog-like habitats at lower altitudes.

There are five basiomycete fungi, 41 lichenised fungi and 16 diatom species recorded on the South Sandwich Islands. Of these, approximately 80% and 50% are thought to be regionally endemic respectively (Hart & Convey 2018).

1.2.7 Habitats

Only 8% of South Georgia’s land mass is suitable for plants, of which only 3% is fully vegetated (Government of South Georgia & South Sandwich Islands 2016). This thin green halo, which follows the coastline, contains eleven major plant community types (Table 1), yet they are often considered to represent varying quantities of the same species as opposed to uniquely different taxonomic assemblages (Greene 1964; Burton & Croxall 2012).

Table 1: The major vegetative communities on South Georgia

Habitat name	Description
Replacement grassland	Areas previously grazed by reindeer are dominated by ‘lawns’ of invasive annual meadow grass (<i>Poa annua</i>). The grass is still spread through the disturbance of fur seals and is primarily found on outwash plains below glaciers.
Tussac grassland	The most abundant vegetative community on South Georgia and the preferred habitat for several species of seabirds. The muddy peat bases are often eroded by seals but support a foliage of around a metre above them.
Dry grassland	Often found on dry hillsides above the tussac-fringed coastline. It is a species-rich community dominated by brown or tufted fescue.
Wet grassland	Occurring mostly on raised beaches, glacial outwash plains or other flat coastal areas this habitat is dominated by Antarctic hair-grass.
Bog	Found in waterlogged valley floors, rock basins and coastal flats. The bryophyte dominated vegetative communities decay and form acidic peat several metres deep in places.

Mire	Similar to bogs with the exception that peat is not formed to the same extent and the habitat is less acidic. The habitat is dominated by bryophytes and rushes.
Herbfield	Occurring on slopes dominated by greater burnet that are moist, sheltered and well-drained.
Fellfield	Considered a pioneer community, fellfield occurs on the dry and stony areas such as glacial outwash plains and moraines. Vegetation is sparse and notable species include brown fescue, alpine cat's-tail and Antarctic hair-grass.
Flush (bryophyte) communities	The thin band of bryophytes that buffer the territory's streams and ponds. Floating mats can occur several metres into ponds and lakes.
Moss turf banks	Habitats dominated by two particular species of moss (<i>Polytrichum strictum</i> and <i>Chorisodontium aciphyllum</i>). These turf banks accumulate through the gradual decay of moss, forming a loose peat like substrate.
Lichen and rock communities	Rocky areas devoid of other vegetation are often partially or fully covered by highly zonal lichen communities. Distinct communities can form downwind of bird colonies, benefiting from the nitrogen-rich atmosphere.

The habitats on the South Sandwich Islands more clearly reflect Antarctic climates compared to South Georgia, with many islands having over 90% permanent ice cover. In ice-free areas, vast differences occur between heated and unheated ground, with the former forming habitats akin to maritime and Sub-Antarctic climates and the latter being akin to Antarctic fellfield communities (Convey et al. 2000b). Zavodovski and Visokoi Islands are often ice free all year round, while the southerly islands are rarely ice free (Murphy et al. 2007).



1.3 Cultural history

South Georgia has the longest history of interaction with humans of all the Sub-Antarctic islands (Clarke et al. 2012). It remains uncertain whether it was first discovered in 1675 by the London merchant Anthony De La Roche or by a Spanish commercial ship in 1756 (Paul 2018). The first landing was made by Captain Cook on the HMS Resolution in 1775, who described the islands as “wretched” but did note the incredible abundance of seals (Rogers et al. 2015). It wasn’t until the late 18th Century that sealing started in earnest with the arrival of the British vessel Lord Hawkesbury. By 1835 the fur seal population had collapsed due to overharvesting and it wasn’t until the 1930s that breeding Antarctic fur seals were seen again (Bonner 1968). Whaling started on South Georgia at the turn of the 20th century with the seven whaling stations representing the first permanent human presence on the islands. The rather short-lived period of whaling at South Georgia meant that several of these settlements were only used until the 1930s. Leith Harbour was the last to close in 1965. In the mid to late 20th century the economic focus moved to fish, notably rock cod and Antarctic krill. Fishing is now regulated by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and has been since 1982. Current fisheries focus on Patagonian toothfish, mackerel ice-fish and Antarctic krill.

Early expeditions to South Georgia did not solely centre on the exploitation of natural resources. The island was famously part of Shackleton’s rescue attempt as part of the Imperial Trans-Atlantic Expedition, and the Shackleton traverse remains as one of the most popular routes on the island (Government of South Georgia & the South Sandwich Islands 2017). Expeditions, though infrequent, remain a key element of the island’s activities. Historically, expeditions have been key in establishing South Georgia as a globally important research site. The first biological investigations began in the early 19th century, between 1822-1883 and later by Skottsberg in 1902 but with little further investigation on land in the early 20th century. The territory is now regarded as a nexus of scientific research due to the presence of permanent research stations at Bird Island and KEP. These changeable base staff, which number approximately 30 in summer and 15 in winter represent the closest thing the territory has to a permanent population.

The South Sandwich Islands were discovered by Captain Cook in 1775. Their remote location, lack of safe harbouring points, rough seas and occasional volcanism have meant they have remained largely free from anthropogenic influence. The most notable anthropological presence on the islands was the establishment and later destruction of the Corbeta Uruguay Argentine station on Thule Island between 1976 and 1983. The station’s destruction has led to large debris field around the site (Rogers et al. 2015).

2 Threats

Despite geographical remoteness, especially for the South Sandwich Islands, the territory has faced and still faces multiple definable threats (Figure 2).

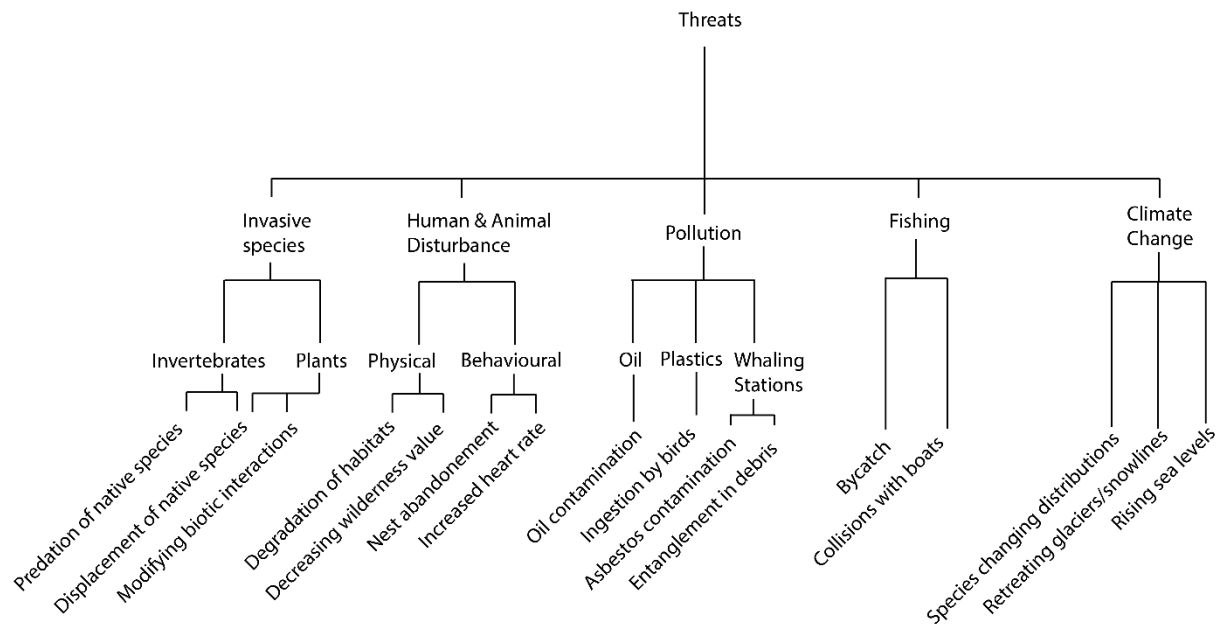


Figure 2: The terrestrial natural heritage of the territory is faced with five key threats, several of which originate well beyond the territory's coastline.

2.1 Invasive species

The early exploration and habitation of the territory resulted in the introduction of horses, pigs, sheep, cats, dogs and other domestic animals to the territory. Along with these intended introductions came the inevitable incursion of unintended invasive species, in particular the brown rat (*Rattus norvegicus*) and house mouse (*Mus musculus*). Most of these introductions occurred in the 18th century but some, such as the reindeer (*Rangifer tarandus*), occurred as late as 1925. Brown rats were responsible for the predation of ground-nesting sea bird eggs, having a particularly significant impact on burrowing species. The endemic pipit was so adversely affected as to be excluded from any rat occupied areas (Martin 2017). The house mouse has reportedly affected albatross species on other Sub-Antarctic islands (Ryan et al. 2015) but there is limited to no causative impacts associated on South Georgia. The reindeer caused significant overgrazing of tussac habitats along the north-east coast, affecting native plant species and aiding the spread of the dominating annual meadow grass (*Poa annua*) (Leader-Williams et al. 1989). The invasive invertebrate fauna, though less studied, remains a threat. Alien carabids can prey on native invertebrates and hoverflies can act as pollinators for the introduced plant species (Convey et al. 2011).

Although introduced fauna is often the more readily identifiable, introduced flora can be the more difficult to identify and control, with some species becoming so widespread as to prevent any realistic means of their removal (Government of South Georgia & South Sandwich Islands 2016). Early settler practices such as placing a handful of soil from the home country of the deceased in cemeteries was no doubt a contributing factor, but the primary spread was likely from the importation of materials, livestock and fodder (Government of South Georgia & South Sandwich Islands 2016; Upson et al. 2017). Introduced plant species can affect nutrient cycling, biotic interactions and soil dwelling organisms (Upson et al. 2017). Approximately 70 species of flowering plants have been introduced of which 37 are still extant.

Currently there are no introduced non-native species on the South Sandwich Islands marking them as a rarity amongst Sub-Antarctic islands (Convey et al. 2000b). Biosecurity is such an acute threat at the South Sandwich Islands for three reasons: i) resident species are often poorly suited to compete with invasive species, ii) visitors to the islands must first check in at KEP, a known hotspot for invasive plants and iii) the islands are so rarely visited that introduced plants could conceivably easily get to a stage where their control is not easily achieved (Government of South Georgia & South Sandwich Islands 2016; Hart & Convey 2018).

2.2 Fishing practices

The main cause of mortality for the territory's seabirds is through becoming bycatch in fishery related activities (Gonzalez-Solis et al. 2000; Croxall & Wood 2002; Xavier et al. 2004; Robertson et al. 2018). Pelagic and demersal longline fishing has been linked to the global decline of albatrosses and petrels, killing approximately 100,000 albatrosses and 200,000 other seabirds each year (Schiavini 1998; Nel et al. 2003). As well as longline fishing, trawl fishing can also cause mortality in seabirds through collision with trawl wraps and cables, as documented in the Falkland Islands (Islas Malvinas*) where 1,400 black-browed albatrosses were killed during the 2002/2003 fishing season (Reid & Sullivan 2004). Illegal, unreported and unregulated (IUU) fishing for Patagonian and Antarctic toothfish threatens serious depletion of the bird populations. Furthermore, this IUU involves further by-catch of endangered seabirds that go unreported (CCAMLR 2017).

Fisheries in the territory are strictly regulated through measures set by GSGSSI and CCAMLR. This is underpinned by fisheries research carried out by the British Antarctic Survey (BAS) and analysed by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) to inform catch limits in fisheries. CCAMLR also conducts risk assessments of all fisheries in order to minimise the negative effects of fishery activities on seabirds. Annual seabird bycatch information is recorded and submitted under ACAP legislation (Saunders et al. 2017). CCAMLR also requires independent observers aboard all vessels fishing for toothfish, the use of net monitor cables, and the prohibition of offal and discards during shooting and hauling of gear (CCAMLR 2016). All of these measures have significantly reduced the amount of bycatch, proving to be effective mitigation tools (Saunders et al. 2017) however the risk of fishing remains outside of GSGSSI's jurisdiction in particular South America's eastern coast, South Africa and areas beyond national jurisdiction (ABNJ).

2.3 Human and animal disturbance

The presence and behaviour of animals and humans can affect the territory's natural heritage. Both animals and humans can cause two forms of disturbance: physical and behavioural. Physical impacts from animals are widespread and largely stem from the abundant population of Antarctic fur seals which can trample tussac (Berrow, Croxall and Grant 2003). Physical disturbance from humans is less widespread, currently limited and documented at only a few visitor sites (Government of South Georgia and South Sandwich Islands 2015a, 2015b). The physical disturbance from humans largely takes the form of path formation, trampling of delicate habitats - such as lichen patches - or the formation of divots on moss beds. The full extent of this physical disturbance is not well documented and not at all quantified. The 2016/2017 season saw 8,946 visitors reach South Georgia and this is increasing on average by 370 visitors a year (Government of South Georgia & the South Sandwich Islands 2017). In the coming decade this is predicted to increase significantly. If the territory is to ensure physical impacts do not become more frequent and severe then consideration should be given to maintaining environmentally sensitive use of visitor sites.

Behavioural impacts are more difficult to assess due to the multitude of aspects affecting species behaviour and the resources required to undertake such an extensive and long-term study. The impact of human

*A dispute exists between Argentina and the UK over the sovereignty of the Falkland Islands (Islas Malvinas).

presence and behaviour around many of the species found on South Georgia, and in particular avifauna, is well documented (Martín et al. 2004; Holmes et al. 2006; Lee et al. 2017). So too are the behavioural responses of certain species to animal disturbance, such as the predatory skuas or giant petrels (Lee et al. 2017). The behavioural responses to humans and certain animals can include: increased heart rate, altered behaviour, nest abandonment and overall reduced breeding success (Wilson et al. 1991; Chupin 1997; De Villiers et al. 2006; Carey 2009). These responses are notably site-specific however and do not mean all populations are equally vulnerable (Cobley & Shears 1999). Whilst behavioural responses to natural predators is unavoidable and part of the natural ecosystem functioning these behavioural responses to anthropogenic pressures should be minimised as much as possible.

The physical and behavioural impacts on the South Sandwich Islands are almost non-existent. Although tourism activity has significantly increased on the Antarctic Peninsula, commercial cruise ships to South Sandwich Islands remain rare (Lynch et al. 2016). Only three cruise ship visits were recorded since 2010. There have been more visits by yachts (16 visits since 2010) but these are predominantly for scientific research, last between one and 19 hours and bring one to four people onto land each time, orders of magnitude lower than visitor sites on South Georgia (Government of South Georgia & the South Sandwich Islands 2017).

8,946

Number of tourists visiting the territory between 2016/2017

370

Average net growth in visitors each year.

2.4 Climate change

Climate change will significantly and directly affect the local flora and fauna of the territory, resulting in both 'winners' and 'losers' (Clucas et al. 2014). Both South Georgia and the South Sandwich Islands are expected to face similar consequences of climate change. The warming climate increases the likelihood of glacial retreat, and the ability of non-native species to take hold, as has been witnessed on several other Sub-Antarctic islands (Frenot et al. 1997, 1998). With the southerly South Sandwich Islands usually covered with ice for much of the year (Murphy et al. 2007), changing snowlines could drastically change the characteristics and dynamics of the islands, potentially having a negative impact on the species that rely on the islands for breeding and foraging (Lynch et al. 2016). The glacial retreat could however also provide benefits, as seen on Heard and MacDonal Islands where glacial retreat has increased the number and size of wetlands, important habitat for wetland bird species (BirdLife International 2011). Rising sea temperatures have been suggested to be the main cause for the reduction in the abundance of krill in the Southern Ocean, a primary food source for penguins and will likely lead to changes in distributional range (Fraser & Hofmann 2003; McWilliams 2009). Rising sea levels are also a high risk for the islands (JNCC & DEFRA 2012).

2.5 Pollution

There are three main sources of pollution in the territory: marine plastics, collapsing whaling stations and potential fuel leaks from vessels. Marine plastics represent an increasingly recognised global threat for all species that feed in the marine realm (Law 2017). In the context of the territory it represents an acute threat for several birds, including ACAP species (Arnold et al. 2006). The whaling stations on South Georgia are known to be heavily contaminated by asbestos, and still contain residual amounts of oil (Purcell 2017). The use of heavy fuel south of 60° S is prohibited, and many cruise ships already use lighter fuels, however, fishing vessels continue to burn heavy fuels, which gives rise to concerns of a major oil spill (Government of South Georgia and South Sandwich Islands 2016). The South Sandwich Islands fauna are as much at risk of marine plastics as South Georgia but terrestrial pollution is most evident in the

leftover waste metal and wood from the base on Thule. Initial surveys suggest these remnants do not pose an immediate threat to wildlife, but they could cause entanglement in the future, and currently detract from wilderness values (Government of South Georgia and South Sandwich Islands 2016).



3 Existing terrestrial protection

A broad array of spatial and non-spatial measures already exists, many of which are well established and are considered to be highly effective in addressing the threats to the territory's biodiversity. These measures begin in the marine realm. The whole territory is surrounded by one of the world's largest marine protected areas, which in itself includes multiple spatial and temporal zones of protection. At time of writing this marine protected area was undergoing its own five year review and will not be discussed further here. For more information on the MPA please refer to GSGSSI's website.

3.1 Legislative

There are two primary pieces of legislation that dictate which activities are or are not permissible in the territory. These are the Wildlife and Protected Areas Ordinance (2013) and the Prohibited Areas Act (2013). The former makes it an offence to: kill, injure, capture, handle, molest or administer poisons to a wild animal, damage or destroy a bird's nest or breeding site, take or destroy eggs, disturb breeding or moulting birds, uproot/damage any native plants, introduce non-native species or cause 'significant damage' to any habitat or wild animal (Government of South Georgia and South Sandwich Islands 2011). The latter makes it an offence to enter the four prohibited areas without express permission from GSGSSI (Government of South Georgia and South Sandwich Islands 2013).

3.2 Social

The territory has a dedicated and highly knowledgeable community which share GSGSSI's objective of ensuring safe and environmentally sensitive visits. GSGSSI wishes to make visitors ambassadors for the territory and as there is no permanent human population everyone is theoretically a visitor and by extension an ambassador. This sense of community and shared values was particularly apparent, emphasising that social mechanisms for sustainable protection are and will continue to be extremely important in the territory's protection.

3.3 Biosecurity

A good example of how important it is to have a community with shared values and objectives is the measures required for biosecurity. Biosecurity measures are integrated into practically all facets of visiting the territory and begin on vessels even before entry into territory's waters. Multiple measures, such as rat monitoring stations, are required at all times (Government of South Georgia and South Sandwich Islands 2018). Additional requirements include cleaning boots with biocide and checking clothing is required for every instance an individual goes ashore or between sites. Visitor sites which have jetties or infrastructure have even further mechanisms of biosecurity, including checks on all fresh produce entering the territory (Government of South Georgia and South Sandwich Islands 2018). Although the territory's biosecurity handbook is updated in consultation with stakeholders annually there are still some suggestions for mechanisms with which to strengthen the territory's biosecurity, such as prohibiting mooring unless essential, rodent-proof fencing around cargo areas at KEP/Grytviken and rodent-proof containment area for shipping containers at KEP (Richardson 2018).

The stringent measures in place are essential for ensuring the vast efforts undertaken over the last decade to eradicate invasive mammalian species do not go to waste. The remaining invasive species on South Georgia now include only plants and invertebrates. A plan already exists for invasive plant species, which runs until 2020 (Government of South Georgia & South Sandwich Islands 2016) whilst the distribution of invasive invertebrate species remain so poorly known to make any plan for their management currently impossible.

3.4 Spatial zoning

All vessels visiting South Georgia require a permit sent from GSGSSI to the vessel's expedition leader or yacht skipper requesting access. Applications must be sent to GSGSSI 60 days before arrival or an additional fee is occurred. Receiving a permit to land on the territory does not enable an individual to roam freely throughout the islands. Recent management has somewhat organically resulted in the formation of several key zones, which - although ill-defined - stratify levels of access to the territory such that the vast majority (~96%) is limited access or no access. These zones largely reflect those used by other protected areas on other Sub-Antarctic islands (Table 2).

Table 2: South Georgia and the South Sandwich Islands - which lack a territory-wide terrestrial protected area - already have an unofficial zoning plan that stratifies access throughout the territory similar to other islands that are entirely protected

Island	'Open' access		'Controlled' access		'No' access	
Macquarie	Services zone	Tourism Management Areas	Limited Access Zone	Special Management Areas		
Heard and McDonald	Main Use Zone	Visitor Access Zone	Wilderness Zone	Heritage Zone	Restricted Zone	
Prince Edward and Marion	Service Zone	Natural Zone	Wilderness Zone	Limited Access Zone	Protected Area	
South Georgia and the South Sandwich Islands	Visitor Sites		Natural Zone	South Sandwich Islands	Specially Protected Areas	Prohibited Areas

Visitor sites

All marine vessels visiting the territory must first stop at Grytviken unless they have special dispensation from GSGSSI. Further visits are only permitted at the 40 prescribed visitor sites which allow landing, two of which (Cape Rosa and Prion Island) have additional restrictions (Figure 3;(Government of South Georgia and South Sandwich Islands 2018)). The 40 open visitor sites are split into three categories: those allowing IAATO category 1 vessels (< 201 pax/vessel; 40 visitor sites), those allowing category 2 vessels (<501 pax/vessel; 8 visitor sites) and those allowing CR category vessels (>500 pax/vessel; 1 visitor site). There are eight additional visitor sites which are currently closed or do not permit landing (Government of South Georgia and South Sandwich Islands 2018).

Visitor sites occupy around 4% of the territory's terrestrial area. Only 20% of the visitor sites currently have a management plan but those that do state restrictions for vessels, including: maximum number of vessels per day, visitor quotas per visit, closed areas within the visitor site, enforced walking routes, suggested walking routes, visitor to guide ratios and seasonal closures. Following a visit, operators are also required to produce a post-visit report (PVR), stating the number of visitors and the activities they did at each visitor site (Government of South Georgia and South Sandwich Islands 2018).

Additionally, all visitors must abide by the code of conduct and IAATO wildlife watching guidelines which clearly state measures such as minimum approach distances for species. If individuals wish to undertake certain activities, for example the use of drones, then they will have to undertake a regulated activity permit. These permits have three tiers, receiving increasing levels of scrutiny by the government,

3: Existing terrestrial protection

expedition panel or external experts as appropriate. Some activities, such as littering, are banned throughout the entire territory.

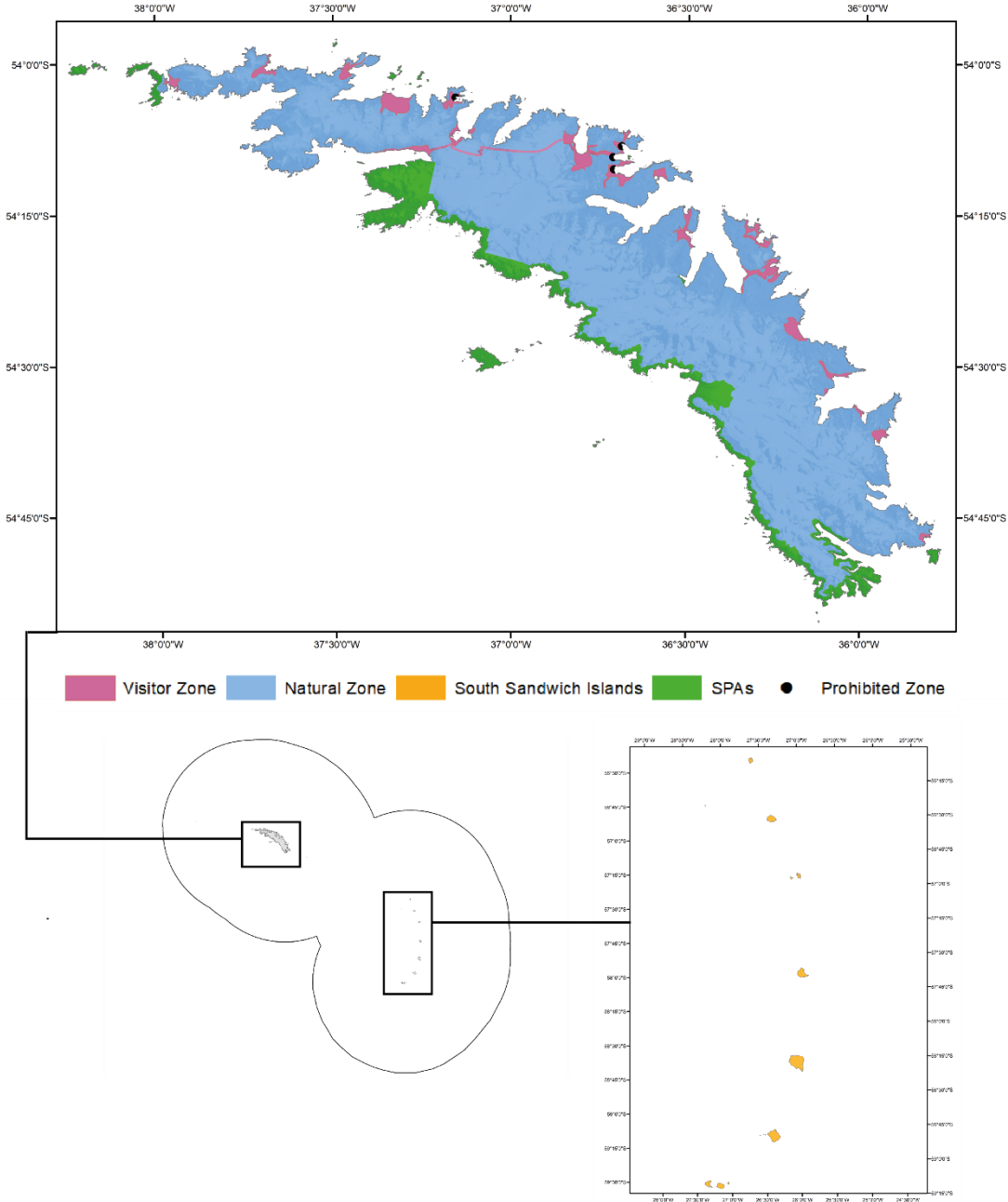


Figure 3: The territory’s five informal zones effectively stratify access so that the vast majority of the territory is kept in an almost entirely natural condition.

Natural Zone

Beyond the visitor sites is the natural zone, poorly defined spatially but occupying approximately 86% of the territory’s terrestrial area. Entry into the natural zone is only permitted following the approval of a regulated activity permit (RAP) for the intended activity, most often an expedition. Expeditions are defined as an activity which requires spending the night ashore and are always reviewed by the expedition panel. Expeditions place limits on group sizes, have an enforced use of guides and mandatory safety and environmental plans, all of which help ensure expeditions are safe and low-impact. Entry into the natural zone requires a category 3 RAP.

3: Existing terrestrial protection

Approval of these permits takes between 2-12 months, costs £1000 and is subject to an external review process. Category 3 RAPs are one of the highest forms of protection implemented in the territory and makes the natural zone one of the most actively and stringently protected parts of the territory.

South Sandwich Islands

The South Sandwich Islands are infrequently mentioned in the territory's environmental plans (Supplementary Information 1 – see Annex I). This is understandable considering their acute remoteness, exceptionally low levels of anthropogenic disturbance and significant data gaps on their natural heritage. There is no formal management plan for the island arc, and they are not designated as SPAs, but as with other zones, access is based on permission from GSGSSI. The natural barriers for access, such as their remoteness and inaccessibility, are effective in controlling visitation.

Specially Protected Areas (SPAs)

The SPAs represent some of the most pristine parts of the territory. The exact number of SPAs is uncertain as none are officially designated under the territory's Wildlife and Protected Areas Ordinance. If counting all five contiguous SPAs on the South Coast as separate then there are 14 (Figure 4). The historic management of SPAs is uncertain as only one, Prion Island, has a management plan. Despite all being classed together, SPAs in their current form are also seemingly fairly heterogeneous in their presumed objectives, with Prion Island facilitating visits and Bird Island accommodating a research base whilst Annenkov Island is a strict no-go site. Access to the SPAs is limited via regulated activity permits, which require the demonstration of 'exceptional circumstances' for access into generally historically rat-free sites. The current assemblage of SPAs represents a reactive network largely based on outdated criteria.

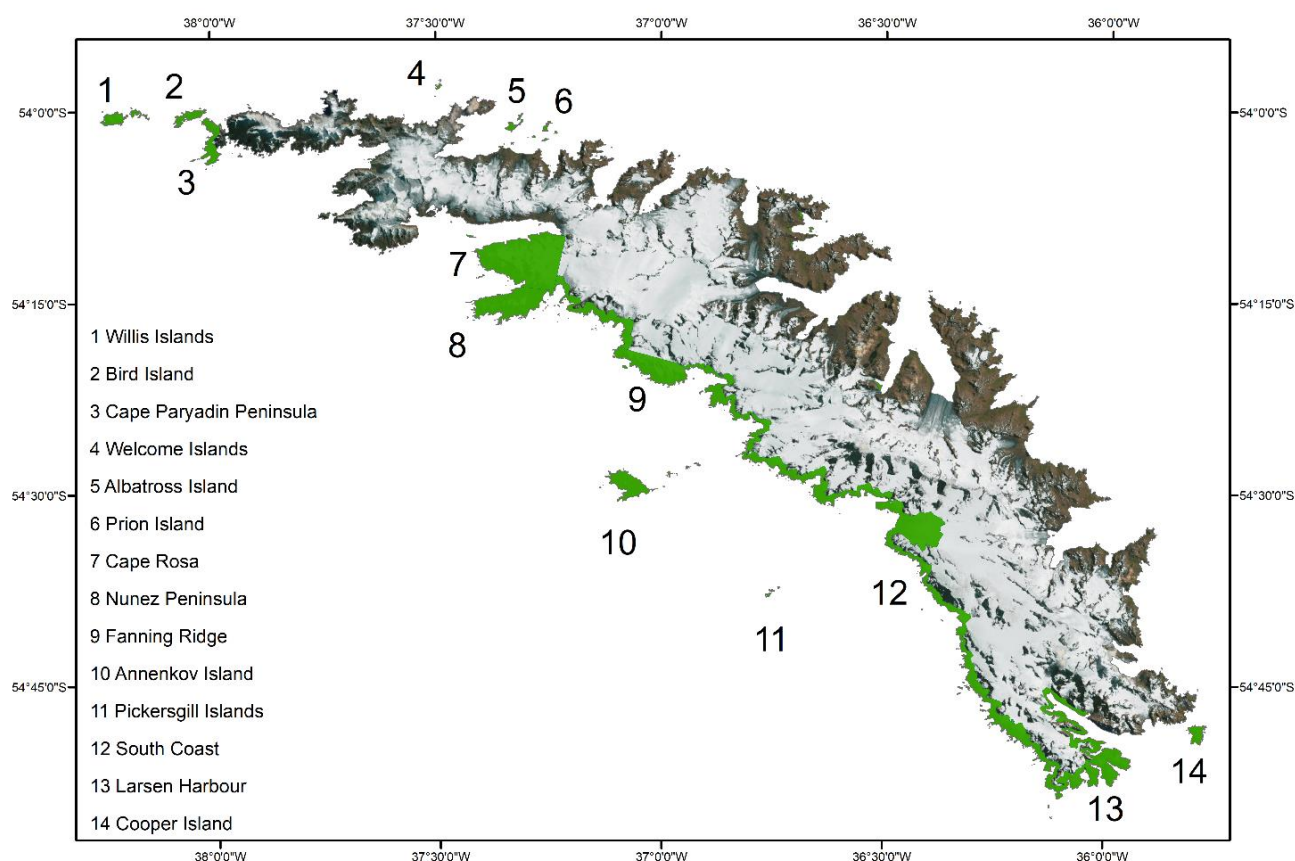


Figure 4: Existing SPAs on South Georgia are not officially designated but are treated as such in day-to-day management of the territory.



Prohibited Areas

The most strictly protected sites in the territory are the four prohibited zones: the whaling stations at Leith, Stromness, Husvik and Prince Olav Harbour. Despite a slight exception at Stromness (Government of South Georgia and South Sandwich Islands 2015c), no entry is allowed within 200m of these sites due to safety concerns. These sites are designated under the Prohibited Areas Act (Government of South Georgia and South Sandwich Islands 2013).

3.5 Rationale for the study

South Georgia and the South Sandwich Islands already have many forms of protective management in place that control where visitors can go and what they can do. South Georgia and the South Sandwich Islands, without being a protected area, implement a similar level of protection to other Sub-Antarctic islands that are officially designated, the primary difference being that other islands consolidate protective management into island-wide management plans.

Currently a lot of conservation focus centres on the efficacy of protection in the marine realm (Pew Bertarelli Ocean Legacy Project 2017; Hart & Convey 2018; IUCN WCPA 2018). Although the existing forms of terrestrial protection for South Georgia and the South Sandwich Islands are many, they have arisen and become established in a somewhat organic manner and have not been subject to a review for almost two decades (Poncet 2003). It is an opportune time to undertake this study as the territory's MPA undertakes its first five-year review, and the territory prepares to contribute towards the UK's sixth national report to the Convention on Biological Diversity (CBD). Beyond 2018 is the redrafting of the territory's biodiversity action plan and broader strategy. This study aims to review the current spatial forms of terrestrial protection in the territory and provide a series of options for consideration designed to increase the suitability and efficacy of these measures.



4 The approach

This project utilised a desk-based approach with the objective to develop options for a network of terrestrial protected areas that met a series of defined conservation goals as agreed by GSGSSI and the wider stakeholder community. The approach, therefore, had to balance quantitative components involving spatial data as well as qualitative aspects of expert opinion from the wider stakeholder community (Figure 5).

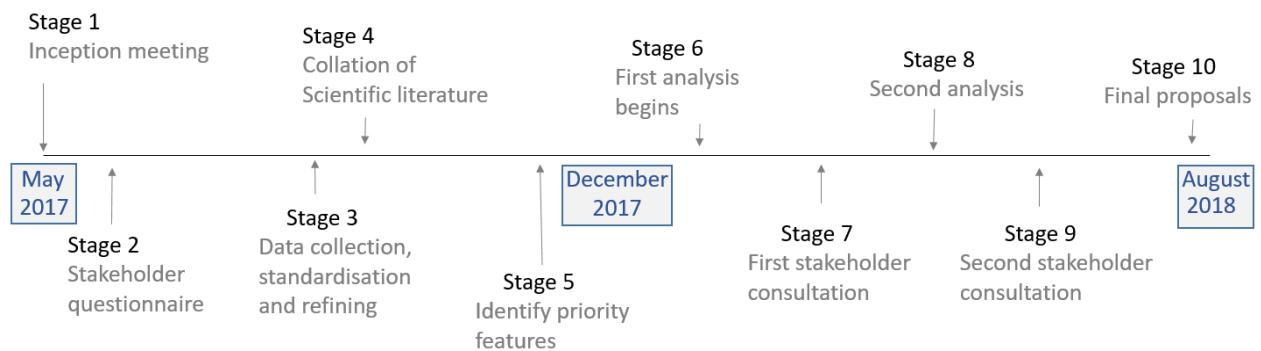


Figure 5: The project’s ten stages incorporated consultative steps with which to gather input from the wider stakeholder community.

Stage 1: Inception meeting

An inception meeting was held in Cambridge, UK in June, 2017. 21 participants joined this meeting, representing key institutions such as the GSGSSI, BAS, the Foreign and Commonwealth Office (FCO) and the International Association for Antarctic Tour Operators (IAATO). The purpose of this half-day meeting was two-fold: i) to introduce the project’s objectives and timeline and, ii) to discuss with stakeholders their perspectives on the project, notably regarding feasibility and specific topics for consideration. After a morning session, which introduced the project, an afternoon session focussed on attempting to define areas of importance for conservation and areas of importance for other land-uses.



Stage 2: Stakeholder questionnaire

Building on from key topics raised at the inception meeting and to gather as many perspectives as possible, a questionnaire was created for wider circulation. The objective of the questionnaire was to solicit input and gather advice on several key topics from the wider stakeholder community: features of interest, the concept of wilderness, sources of biodiversity and threat data, the threat of climate change and the role of the South Sandwich Islands in the project.

Stage 3: Data collection and standardisation

The inception meeting and questionnaire highlighted that data was going to be a key challenge for the project. Spatial analyses are wholly dependent on the quantity and quality of the available underlying spatial data. These data represent all aspects of the territory, from socio-economic factors such as visitor numbers to purely ecological factors such as the distribution of a particular species of moss. Over 250 datasets were reviewed for incorporation into this project (Supplementary Information 3). Most of these data were rejected for incorporation as they derived from datasets which do not have a sufficient resolution for distinguishing priority areas within the territory.

Defining the project area

The distinct lack of geospatial data for the South Sandwich Islands meant that only South Georgia and its satellite islands within 15 km (e.g. Bird, Willis, Annenkov, Cooper) were included in the spatial analysis.

Defining the features of interest

A feature is any spatially definable object which is considered of potential interest to be included in the analysis. A feature can therefore be a single species, a habitat or even a non-biological element such as a whaling station.

Species

It quickly became apparent that global datasets on species ranges, such as the IUCN Red List of Threatened Species, would be of little help in the analysis as they covered the entirety of the territory. Territory-specific datasets do exist, the most wide-ranging being the 1996 South Georgia Atlas (Trathan et al. 1996) which predominantly provides occurrence data from the 1980s reported in 25km² grid cells. For approximately ten of the more high-profile and charismatic bird species there is more up-to-date data from field surveys post 2000 though the format is almost universally still point locations.

In order to refine the South Georgia Atlas data, all file types were updated and aligned to a more recent coastline boundary before being refined by altitude as well as habitat preference on a species by species basis based on information in the literature (Burton & Croxall 2012; Birdlife International, 2017; Supporting Information 3 – see Annex I). These refinements led to a substantial improvement in spatial accuracy but still only allowed representation of potential species distributions (see example in Figure 6). Despite the significant caveats, the refined data were still the most representative and accurate data available for many species and were, therefore, used in the analyses. Only native species were included in the analysis as features of interest.

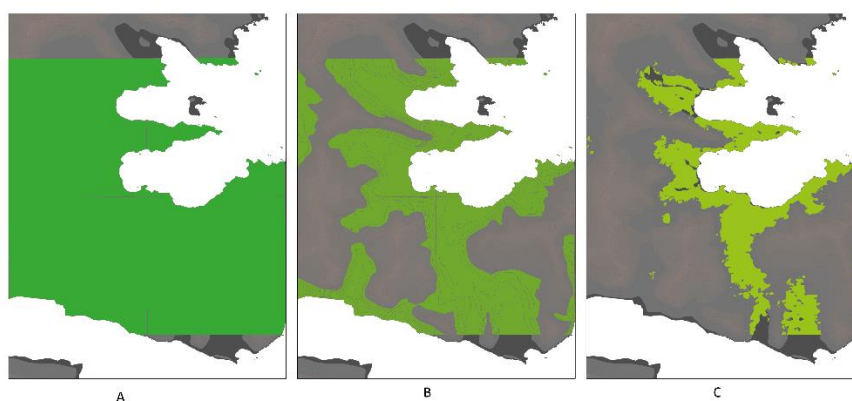


Figure 6: The South Georgia Atlas distribution of Antarctic starwort (*Callitriche antarctica*) shown in green, in its raw format (A), refined by altitude (B) and further refined by habitat (C).

Habitats

At the project's inception, the only spatially defined data on habitats that represented the whole of South Georgia was remote sensing data which categorised vegetated areas into three tiers ('sparse', 'partial' or 'full'). Since the project's inception, a project led by the South Atlantic Environmental Research Institute (SAERI) is taking significant steps in improving this baseline dataset. Early outputs of these data were used as part of the Marxan analyses (see section 4.6) but the timing of the projects did not align sufficiently to enable more integrated use of the updated habitat data.

Ecosystem Services

Ecosystem services are the benefits people derive from nature. They are a multi-faceted concept which can be categorised in several ways (MA 2005). Following discussions with GSGSSI, it was decided that ecosystem services would not be incorporated into this analysis as an input feature of interest. The rationale being that although short-term inhabitants of the territory do benefit from provisioning and regulating services, these processes are under no threat from competing land uses, and therefore do not need any additional protection.

Wilderness

Wilderness is a difficult concept to spatially define, especially in the context of a territory that is already by global standards entirely or predominantly a wilderness in both terrestrial and marine realms (CIESIN 2018; Jones et al. 2018). Methodologies measuring wilderness largely focus on physical indicators such as: population density, naturalness, land cover, land use and remoteness (Venter et al. 2016). All of these indicate the territory as wilderness, however, none particularly help in defining which parts of South Georgia are 'wild' or 'wilder' than others at meaningful spatial scales (Figure 7).

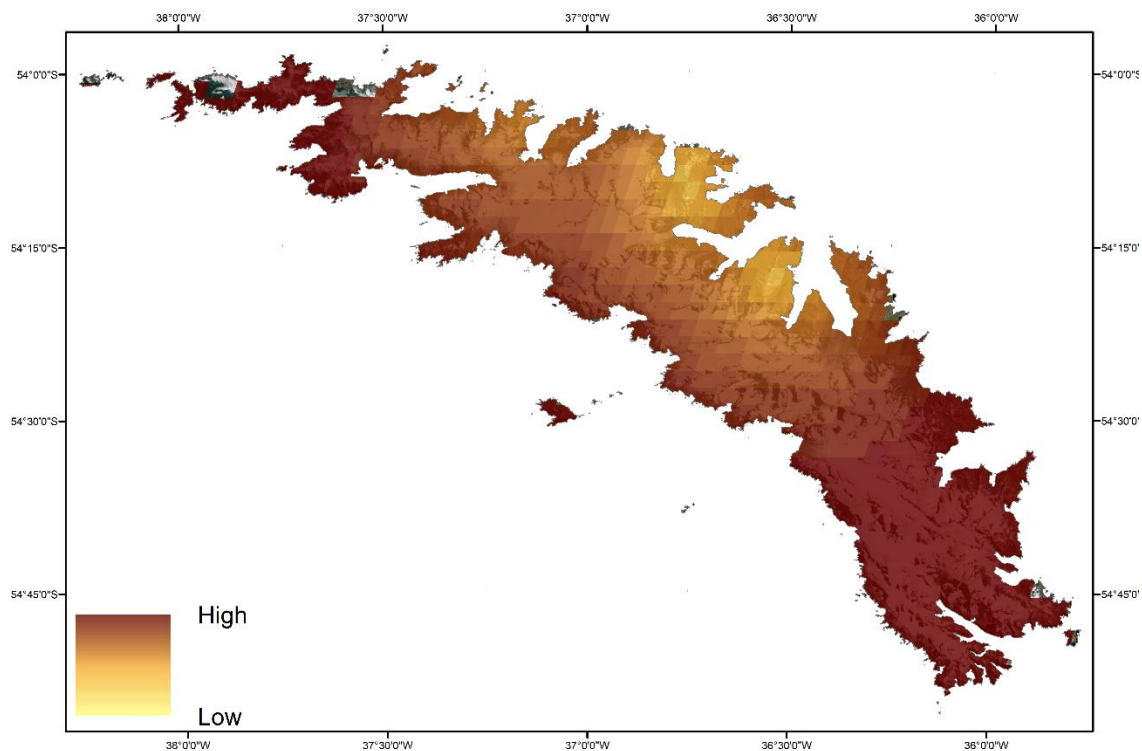


Figure 7: A spatial depiction of wilderness which simply creates a steady gradient away from areas of human activity (UNEP-WCMC 1998).

Input from the stakeholder questionnaire presented a wide spectrum of opinions on wilderness. Most definitions centre on the complete lack or minimal presence of humanity and by extension, humanity's impacts. The presence of past human impacts (notably whaling stations) brought disagreement on whether they fostered a perception of wilderness, with some in favour, noting the feeling of nature reclaiming humanity's footprint whilst others favoured a more stringent definition of no human impact at all. Many consider that although not 'pristine', that South Georgia overall is still a wilderness and emphasised the importance of accessing it so that principles of environmental engagement are strengthened. Wilderness is a concept experienced by humans differently. Its subjective nature makes it an inappropriate factor to underpin protected area designation in the context of South Georgia, as it would be impossible to create a geospatial representation of a universally agreed definition. Although there is a precedent for using the concept of wilderness in protected area criteria on South Georgia (Poncet 2003), and globally (Dudley et al. 2010) it was omitted as a feature of interest in this study.

Stage 4: Collation of scientific literature

From collating and standardising the data it became apparent that an over-reliance on spatial data would be detrimental and that having a solid contextual understanding of the territory would be key in creating possible options for strengthening protection. A targeted literature review was undertaken using a series of keywords in ISI web of Science and Google Scholar, including but not limited to species names, island names and specific thematic areas such as 'wilderness' and 'biodiversity'. Papers were collected for the territory overall as well as specifically for each species. Over 250 peer reviewed papers in addition to books, management plans and websites were collated and reviewed with the primary purpose of identifying any potential priority features (Annex I). Information was recorded for each species with a ~50-word synthesis on its population size, trend, IUCN threat category, threats and legislative importance.

Stage 5: Identifying priority features

From reviewing the literature, four priority feature categories were identified:

1. **Priority species** were defined as those in either peer-reviewed scientific papers or in the management plans of other protected areas which had a level of protection promoted above the territory's status quo. This more targeted framework was adopted as an initial approach, simply using the IUCN threat category for a species, was strongly advised against by an expert largely because a threat category applied at global scales is not suitable for local-scale prioritisation.
2. **Priority habitats** were those that were listed in the literature as being particularly susceptible to human disturbance, even if these habitats did not currently have spatial data to represent them. Although the territory's habitats have been categorised (Table 1) their individual susceptibility to human disturbance has not. The approach was to gauge feedback from experts in the first consultation to validate whether the habitats identified were appropriate.
3. **Priority cultural sites** were grade I/II sites, as recommended in the recent heritage strategy (Purcell 2017), though these sites have not been spatially defined yet.
4. **Priority scientific sites** were those areas which had long-term monitoring studies in place which were susceptible to human disturbance due to permitting visitors.

Defining feature targets

The setting of targets is central in the application of systematic conservation planning software. In the case of Marxan, the target is a numerical value which represents the percentage of the feature's distribution which is intended to be protected in the output. Target setting should be evidence-based and dependent on how much a feature requires protection but is nonetheless still essentially a value judgement based upon how the evidence is interpreted. The setting of biodiversity targets is still a

developing science in many contexts, and can become the basis for contentious and time-consuming debate amongst scientists and policy makers. It is often more efficient to use a pragmatic approach (such as a flat target of 20% of each ecosystem type) than to wait for perfect science or consensus on ecologically-based targets. Flat targets can still provide useful results, and in practice, refining targets over time as the science improves does not usually dramatically affect the assessment or prioritisation outcomes. An initial target of 20% of each ecosystem type is in line with the IUCN Red List of Ecosystems, which assigns Critically Endangered status to ecosystems that have lost more than 80% of their geographic distribution over 50 years (<http://iucnrl.org/>).

Designing Scenarios

There are no single set of targets which are ‘correct’ and as such a range of targets need to be run in the first analysis (stage 6) to understand the value and implications of networks at various degrees of protection. These various runs can be regarded as ‘scenarios’ with each scenario being a specific set of targets. Existing levels of protection and non-spatial mechanisms of protection need to be considered when setting targets (Game & Grantham 2008). The initial scenario options were reviewed by GSGSSI, two of which are shown in Table 3.

Table 3: Early scenarios designed to explore potential approaches to protect the territory’s heritage.

Scenarios	Description	Purpose
Re-design the network	If Marxan was to design a network which gave the same level of protection as the current network, where would it choose to locate SPAs?	This scenario tests whether the current SPAs are well-placed or whether other areas on the territory would be chosen under a mathematically more optimal solution to reserve location.
Expand the network to enhance representation.	Expand the network to be more representative of the territory’s biozones, e.g. incorporate 20% of each biozone.	An approach for expansion that ensures that populations and habitats are represented from all over the territory and not just the two biozones of the current network.

Stage 6: First analysis

As the quote below shows, confidence in the underlying South Georgia Atlas data creating accurate outputs is low, even if using refined data and Marxan (Trathan pers. Comm).

"The principal weakness of the methodology is its reliance on GIS data which are not site-specific. This applies particularly to the biodiversity data – and notably that for seal, bird and plant species - which are related to 5 km square land areas and not to specific sites" (Scott & Poncet 2003)

The two scenarios in Table 3 were run in Marxan as a means to test the approach. Marxan is a decision support tool for conservation planning, developed by the University of Queensland and extensively used in spatial prioritisation exercises with over 2,600 individuals and 1,500 organisational users in 110 countries (Ball et al. 2009). Marxan is designed to resolve the “minimum set problem” when designing a reserve network or solving a conservation planning issue. This problem arises when there are a great number of potential sites and manual calculation of the best options is highly complex. Marxan software runs simulated annealing algorithms to identify near-optimal sets of sites for meeting targets for each

conservation feature at the lowest possible cost (Ball & Possingham 2000). Cost may refer to area, financial costs, social costs, environmental costs, or level of threat.

Stage 7: First consultation

Having taken on feedback from stages one and two, the first consultation presented the results from stage three to stage six. This included a summary of the data (stage 3), a bibliography (stage 4), a list of possible priority species (stage 5) as well as outputs from the first analysis (stage 6). The first consultation ran from May to June, 2018. The full consultation document is found in supplementary information 1. The consultation materials were in two formats: an online format with interactive maps and a static offline version as a PDF. Both formats were used by stakeholders although the online version was the more popular option. The consultation included 40 questions specifically tailored to help develop options and ideas for strengthening terrestrial protection. These questions accompanied the consultation materials and also came in both online and offline-friendly formats.

Stage 8: Second analysis

The second analysis was originally planned as a mechanism with which to improve the first analysis using feedback from the first consultation. In reality, the feedback from the first consultation reinforced the message that significant additional analysis was not required at this stage. The reasons for this were two-fold: firstly, there was insufficient rationale for additional terrestrial protection beyond the already considered SPAs and secondly, the ability of Marxan to identify additional areas with the existing data was limited. The second analysis primarily centred on attempting to refine the SPAs already considered.

Stage 9: Second consultation

The second consultation was released in August 2018. As with the first consultation the materials were formatted into an interactive online version as well as a static offline version. The online version is available in supplementary information 1. These materials presented the feedback from the first consultation, the response to this feedback and the updated options for consideration from this feedback.

Stage 10: Final options for consideration

The final options for consideration were presented in the second consultation (Supplementary information 2) and are presented in more detail in Section 6.

5 Results and feedback

The information below relates to key aspects of the project's approach and development of initial options. For a full description of the initial options for consideration for the territory's spatial protection measures, please see the first consultation materials in supplementary information 1. For a full description of the feedback on those options and please see supplementary information 2.

Three of the stages discussed in the previous section particularly influenced the development of the final options for consideration. Each of these stages received some degree of feedback in the first consultation, though the most focus was directed towards the identification of priority features (stage 6).

Stage 4: Scientific literature

Part of reviewing the scientific literature meant comparing the territory to what analogous islands and protected area networks have done. The two most relevant comparisons for the territory are the Antarctic framework and systems used by other Sub-Antarctic islands sharing a similar latitude.

Case study 1: Antarctic system

The Antarctic system utilises two designations as the main form of terrestrial protection: Antarctic Specially Managed Areas (ASMAs) and Antarctic Specially Protected Areas (ASPAs). Both are designated under Annex V of the Environment Protocol, adopted by state parties in 1991. ASMAs represent areas aimed at assisting in the planning and coordination of activities so as to minimise environmental impacts, improve cooperation and avoid possible conflicts. ASPAs are areas designated to protect outstanding environmental, scientific, historic, aesthetic or wilderness values and are analogous to IUCN management category Ia sites. The vast majority of ASPAs are designated to protect biodiversity values (Coetzee et al. 2017). Although a permit is required for entry into any ASPA, beyond that the management becomes site-specific. There is some debate over the efficacy of ASPA management plans and measures which can vary significantly between sites (Tin et al. 2009; Pertierra et al. 2017). The SPAs on South Georgia most represent ASPAs which aim to protect these values by keeping the ASPA as an 'inviolate area', for example, they only permit entry for compelling scientific purposes.

How this case study influenced the final options:

- Emphasised the viability of keeping some areas as 'inviolate' areas, with the primary objective of keeping them in as natural a state as possible.
- Highlighted the potential to split SPAs into two classes; inviolate areas (class 1) and areas of particular scientific interest (class 2).
- Suggested that class 2 SPAs should not be considered indefinite, and should only exist so long as research occurs that is susceptible to anthropogenic disturbance.
- Demonstrated that existing measures of protection for SPAs already aligns well with mechanisms used in other similar protected areas.
- Acted as the template for the SPA form used in this project (Annex 1).

Case study 2: Sub-Antarctic systems

Three Sub-Antarctic islands were chosen as a mechanism with which to assess how far the status quo on South Georgia differs from other islands with similar natural heritage values and similar threats. These islands were: Prince Edward, Heard and MacDonal and Macquarie. The most evident difference between these three island groups and South Georgia is the lack of a territory-wide terrestrial protected area. If the whole of the territory were to be protected it would most likely be under international designations such as a Ramsar wetland of international importance or a World Heritage Site. Of the three case studies chosen, all are either World Heritage Sites or Ramsar sites.

Both South Georgia and the South Sandwich Islands were proposed by others as Ramsar sites in 2004 under several criteria (Pienkowski 2005). Although there are many benefits from designating an area as a Ramsar site, for example, acting as a catalyst for greater research (The Ramsar Convention on Wetlands 2009; Ramsar Convention Secretariat 2016), there are also associated costs, predominantly in gathering the material and data necessary for a site to be designated.

World Heritage Sites are sites considered to have outstanding universal cultural and/or natural values. Both South Georgia and the South Sandwich Islands have also been considered by others for proposal on several occasions, even ranking highly under some criteria (IUCN 1992, 1995). South Georgia would suit biodiversity criteria in particular, the same criteria used by other Sub-Antarctic world heritage sites, such as Macquarie and Gough and Inaccessible (Chown et al. 2001; UNESCO World Heritage Centre 2018). The territory's iconic cultural history means that there is also scope for it to be a site with both natural and cultural values. The benefits of inscription as a World Heritage Site can be significant, including increasing funding, increased promotional advantage, increased tourism as well as enhanced collaborations (PricewaterhouseCoopers 2007). The associated costs of proposing a site for World Heritage status can be equally great, costing around £0.5 million on average in the UK to create the bid as well as an additional £200,000 to create the management plan (PricewaterhouseCoopers 2007). Furthermore, the time to create such as bid is significant, often over five years and does not always result in inscription (Stoltz 2015).

How this case study influenced the final options:

- Re-emphasised that the zoning framework on these islands is similar to the existing framework on South Georgia.
- Furthermore, the management within these zones focusses on the same threats and attempts to address them in the same ways (Annex 1: Supplementary Information 1).
- The cost of proposing the territory for international designations needs to be considered against the opportunity to spend those funds on practical management such as biosecurity measures or investing in further research on the territory's natural heritage (Pienkowski 2005).

First consultation feedback:

- Several stakeholders suggested that the ASPA network could work well as a framework with which to influence options for consideration.
- The SPA criteria, which reflect ASPA criteria were met favourably with ~60% of stakeholders being either satisfied or very satisfied with the criteria. However, there were suggestions that nowhere on the territory is entirely pristine due to historic impacts.
- A couple of stakeholders suggested that the entire terrestrial area be protected as a multi-use zone but no respondents suggested the territory should become a Ramsar or a World Heritage Site.

Stage 5: Identifying priority features

The aim of reviewing the literature was also to identify the features which most needed protection. In the initial options nine priority species, four priority habitats, two priority cultural sites and one form of priority research area were considered for additional protection in the first consultation (Table 4). The priority features represented those species considered most susceptible to the territory’s threats. Of these priority features, only seven of the species have accurate data representing their location. Features were considered in the analysis regardless of their current geospatial accuracy. Furthermore, priority cultural sites have not yet been graded so are theoretical only at present. These four categories collectively represented ‘Environmentally Sensitive Areas’ (ESAs), a ‘soft touch’ form of protection intended to be spatially and temporally dynamic and are discussed more in supplementary information 1.

Table 4: 15 priority features spanning four categories were considered in the first consultation.

Category	Feature	IUCN category	Status	Main threat	Secondary threats	% at visitor sites	Terrestrial threat level
Species	Northern giant petrel	LC				<5%	Low
	Southern giant petrel	LC				<5%	Low
	Light mantled albatross	LC				<5%	Low
	Wandering albatross	NT				<5%	Low
	Black-browed albatross	VU				<5%	Low
	Grey-headed albatross	EN				<10%	Low
	Antarctic tern	LC		?		?	?
	Gentoo Penguin	LC				<15%*	Low
	Chinstrap Penguin	LC				<5%*	Low
Habitats	Moss Banks	--					
	Bogs	--				?	?
	Mires	--					
	Tussac w. burrowing petrel	--					
Cultural	Grade I/Grade II	--	?			?	?
Scientific	Long-term monitoring sites	--				?	?

Key	
-- Not applicable	Unknown
LC Least concern	Increasing
NT Near threatened	Stable
VU Vulnerable	Decreasing
EN Endangered	Quickly decreasing
Fishing	Humans
Animals	Climate change
Pollution	Invasive species
	Diseases
	Weathering

* = colony count not by individual count.
 ** = Classification used by SGHT in rat eradication
 Low <20% population**

How this influenced the final options:

- Listing the understudied species potentially benefiting from further protection would be a useful (albeit difficult) exercise but incorporating it into a spatial management framework would require mapping their distribution and therefore large amounts of resources, a central criticism of the concept.
- Therefore, the concept of ESAs and priority features was removed from the project options as overall both their feasibility and conservation value could not be sufficiently proven. They have been incorporated into this report so as to inform future work of potential pitfalls in this approach.

First consultation feedback: The concept of ESAs and the selection of priority features represented a significant proportion of the feedback in the first consultation (Supplementary Information 2). In summary:

- The approach was not clear enough and there were misconceptions on how these priority features were identified;
- Experts suggested that the evidence was insufficient to guide changing the existing management and not necessarily directly relevant to the territory as it largely related to other Antarctic/sub-Antarctic research sites;
- In retrospect, the mechanism of identifying priority species was clearly flawed as it exacerbated the research bias in the literature towards charismatic avifauna and thus underrepresented the understudied taxa, such as lower plants;
- Some stakeholders did suggest an alternative list of priority features (Figure 8).

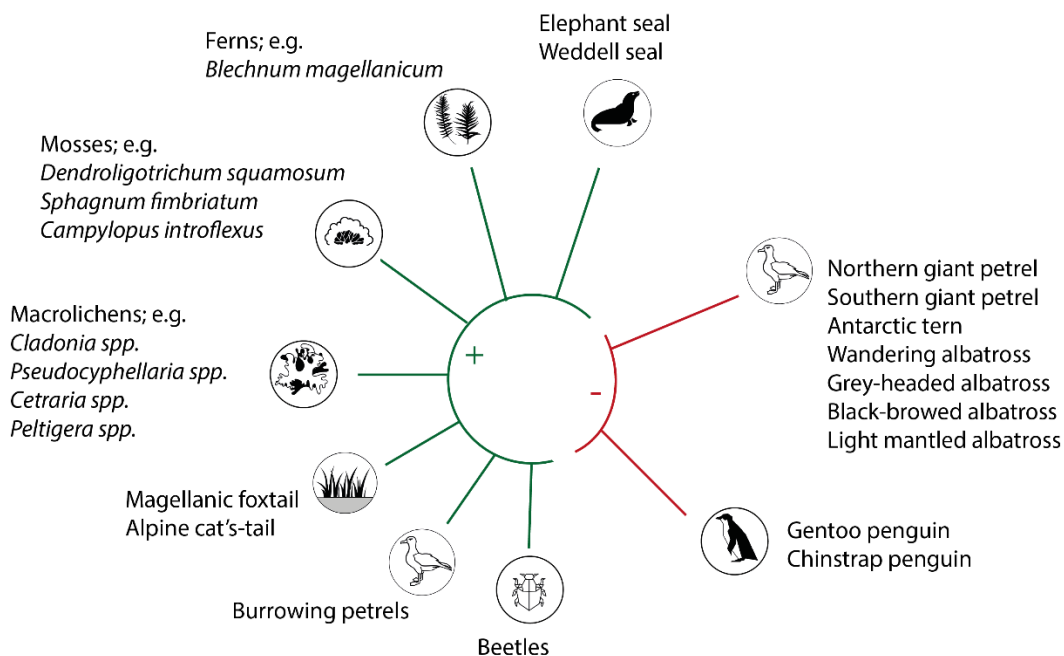


Figure 8: The territory's stakeholder community proposed replacing charismatic avifauna with 'true' terrestrial species.

Stage 6: First analysis

The third key stage which influenced the final options was the analysis using Marxan. The software identifies areas based on two key inputs: the distribution of features and the distribution of threats.

Distribution of features of interest

The refined South Georgia Atlas data demonstrates that the territory's north-east coast contains more habitable area as well as considerably higher species richness (Figure 9).

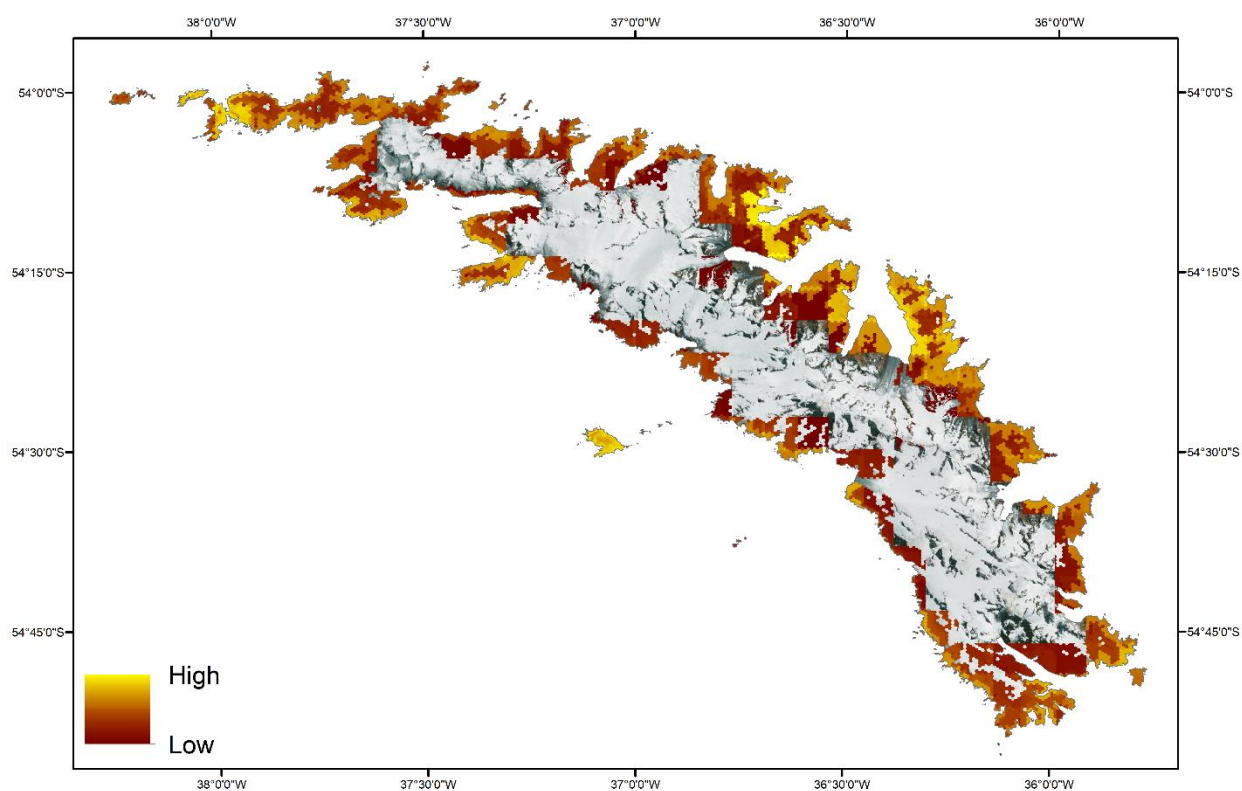


Figure 9: Species richness using the refined South Georgia Atlas layers reported by 0.25km² hexagonal planning units.

For 85% of the territory's species the majority of their distribution remains in the natural zone, 13% are mostly in SPAs and only 2% occur mostly in the visitor zone (Figure 10). The refined data suggest that only one species (small fern; *Blechnum penna-marina*) has the majority of its range in the visitor zone. All species classed as threatened have less than 20% of their distributions in the visitor zone, and several are thought to mostly occur in SPAs.



Figure 10: The relative proportion of each species' range in SPAs (green), visitor sites (orange) and the natural zone (blue) using the refined South Georgia Atlas data.

Distribution of threats

Of the five threats identified in Figure 2, fishing originates in the marine realm and thus cannot help identify terrestrial protected areas and climate change is so multidimensional that its effects, especially at a species level, cannot yet be mapped at resolutions helpful for this study (Morley et al. 2010; Tancell et al. 2016). This leaves three terrestrial threats: pollution, invasive species and human/animal disturbance.

Terrestrial pollution is limited to the whaling stations which are already prohibited areas. Beyond the occurrence of a couple of invasive beetles at whaling stations, the only invasive species with spatial data are invasive plant records from the Busen, Barff and Thatcher Peninsulas, even though invasive species are known to occur throughout the territory. This forms little help in acting as a threat for identifying priority areas beyond these peninsulas.

Human disturbance is therefore the only spatially defined threat which spans the entirety of the South Georgia. Data exists recording where visitors go, what activities they do and in what numbers. It is important to note that this is a proxy for disturbance however, as simply because a site is visited or even significantly visited does not necessitate damage to the environment. Numbers of tourists have quadrupled since 2000, with the vast majority going to eight main visitor sites (Figure 11; (Government of South Georgia & the South Sandwich Islands 2017)). Stakeholder feedback repeatedly suggested that early discussions were exaggerating the extent and severity of human disturbance, suggesting that current levels of visitation are sustainable. These visitor sites represent only ~4% of the territory's terrestrial area however and beyond these sites there is almost nothing with which to act as a threat in spatial planning.

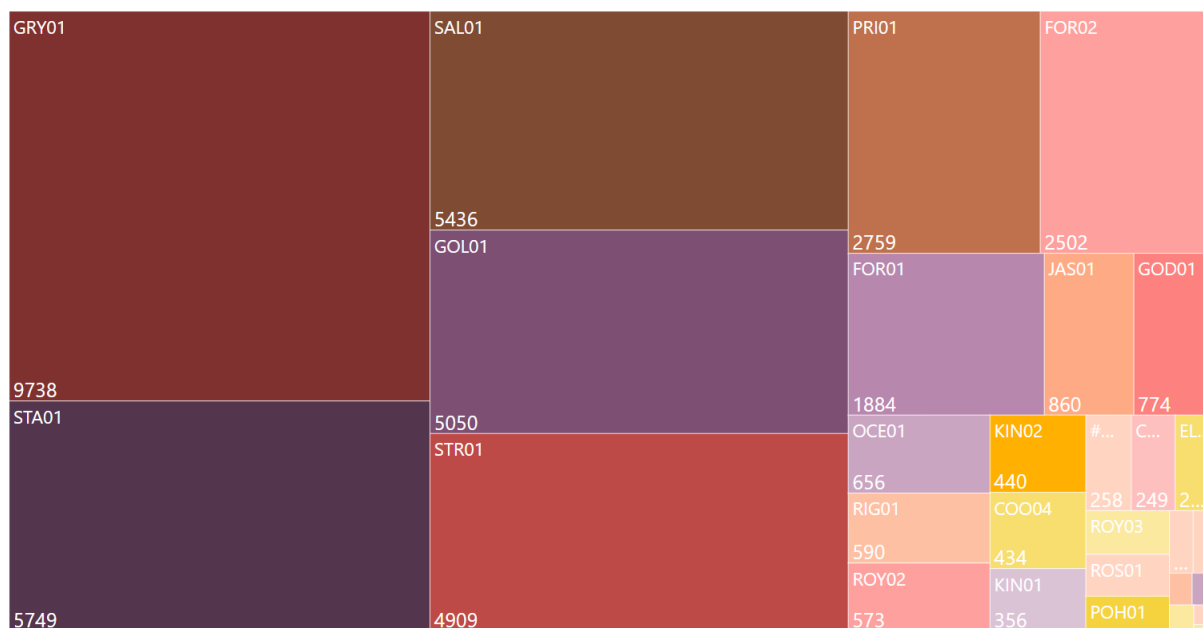
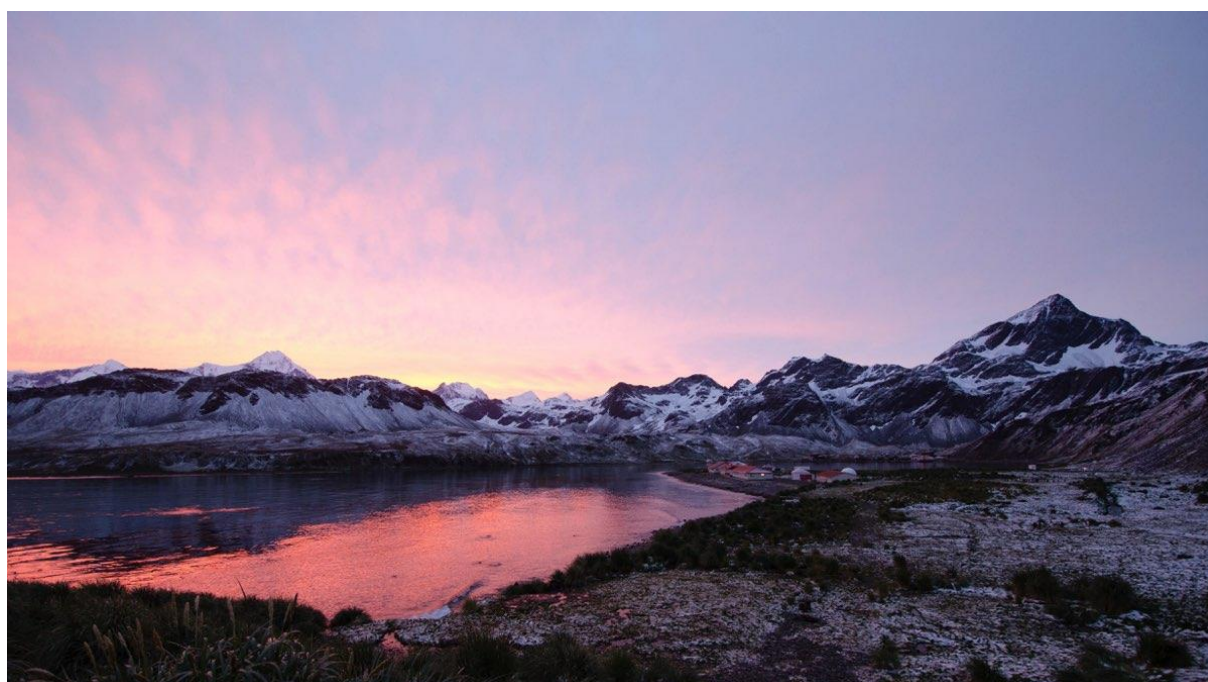


Figure 11: There is huge variation in how much individual visitor sites are used. Top left is site code and bottom left is the number of visitors in the 2016-2017 season.

Combining features and threats

The ubiquity of features of interest (species and habitats) over most of South Georgia and the absence of threats beyond visitor sites meant that Marxan identified many peninsulas as being appropriate for incorporation into a SPA network (Figure 12). Scenarios were run with various targets, but the outputs invariably created highly fragmented networks that included many small SPAs. A large part of this is the lack of a terrestrial threat with which to spatially refine the location of the potential networks.



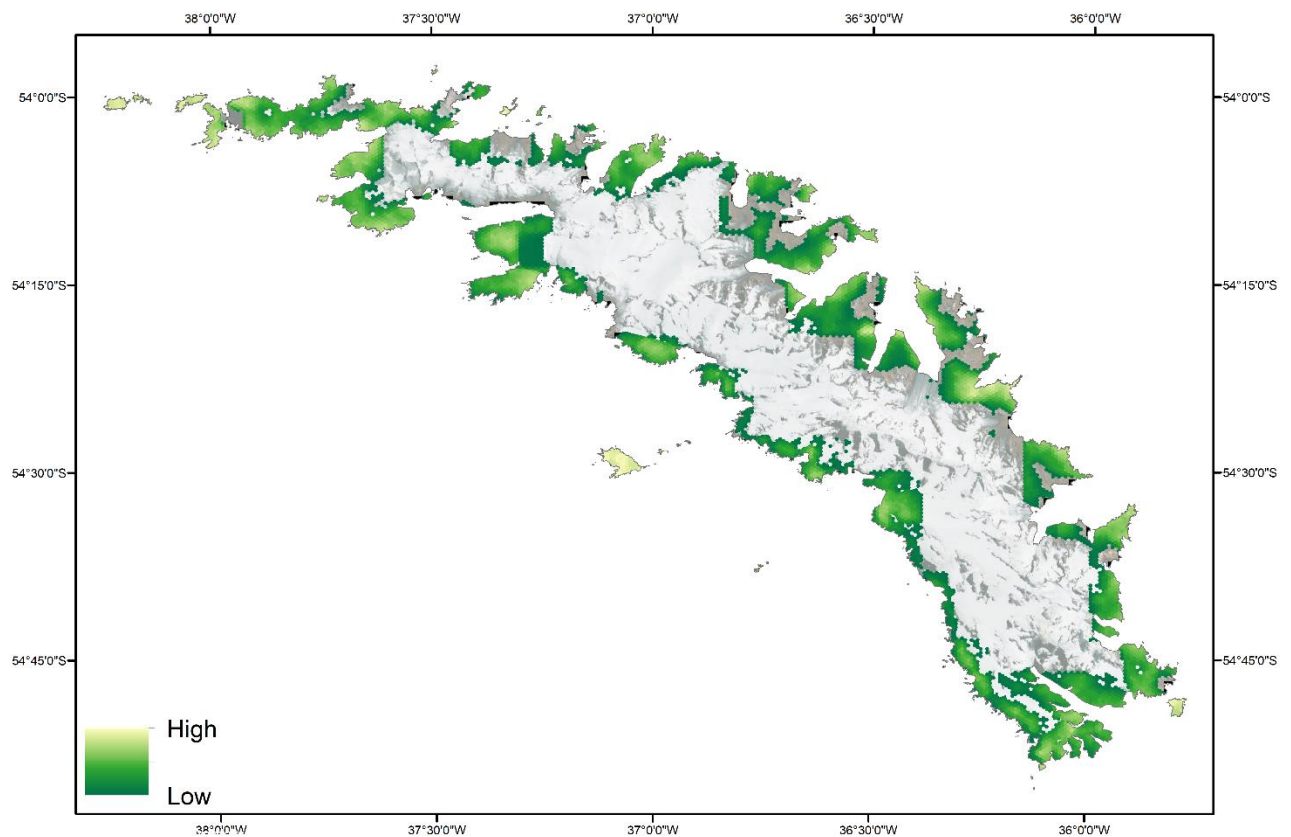


Figure 12: The selection frequency of each planning unit to be considered for incorporation into a terrestrial protected area network.

How this influenced the final options:

- The ubiquity of features and absence of terrestrial threats beyond visitor sites not only questioned the accuracy of Marxan’s outputs but also the necessity of its use.
- Marxan was considered to create a third class of SPA, which could incorporate representative assemblages of each bioregion’s flora and fauna, but the realisation that the natural zone already provides a very high level of protection questioned how this new class would differ in terms of management to the status quo.

First consultation feedback: Marxan was originally intended to feature much more centrally in the project’s approach. Due to the reasons discussed above the suitability of Marxan became questionable, especially in the context of the currently available data.

- Only 35% of respondents had confidence in the data to make management-based decisions.
- Stakeholders acknowledged the state of the data limited what was possible with Marxan and at what resolution it could be reported on.
- When asked whether they considered further refining of the data a worthwhile endeavour only 25% responded favourably, suggesting little support for the underlying datasets.

- The main data gaps identified by stakeholders, to be addressed should future work build on the project, are shown in Figure 13. The majority of respondents agreed with the approach to omit ecosystem services (90%) and wilderness (85%).

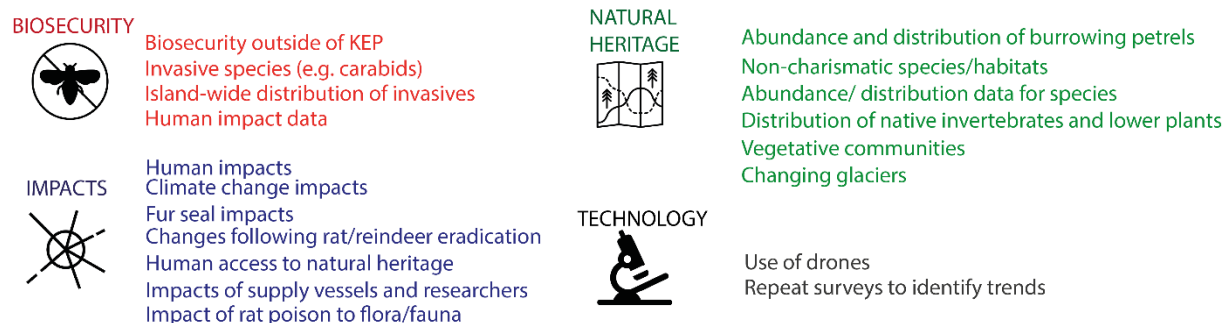


Figure 13: The main data gaps identified by stakeholders focussed on the territory’s natural heritage and the threats it faces.

Stage 8: Second analysis

Lessons learned from stage 4 had indicated that the latent terrestrial protection was high throughout the territory and matched that in place in other high-profile protected areas. Lessons learned from stage 5 had shown that the approach to identify priority species has been unsuccessful and that if such a list were to be created significant research taking years would have to be undertaken. Lastly, lessons from stage 6 had demonstrated that even if there wasn’t a high level of protection in place that existing limitations in the data and the absence of threats means identifying further protected areas highlights vast swathes of the coastline as being equally suitable. For these reasons there was little the second analysis could provide to help the final options.

Conditional sites

A degree of uncertainty should be added to the options relative to the rationale and certainty with which the sites can be defined spatially. Sites which still had an imprecise boundary were classed as ‘conditional’, i.e. they are options for consideration once a suitable boundary can be defined. Both classes of SPA have conditional sites.

The south coast SPA, introduced in the first consultation, is the only conditional class I SPA presented here. The original boundary was refined through a Marxan scenario which required 20% of the south coast bioregion to be protected, as well as 20% of the species ranges and habitat classes to be protected. This results in a conditional SPA that represents the region’s flora and fauna but is 55% smaller than the boundary presented in the first consultation (Figure 14).

Conditional class II SPAs are potential glacial retreat study sites. Several stakeholders suggested locations for monitoring the long-term impacts of glacial retreat, but only as crude point locations. These areas could be applicable under areas of scientific interest for designation as SPAs as they would need controlled management to ensure anthropogenic influence did not affect the research methodology.

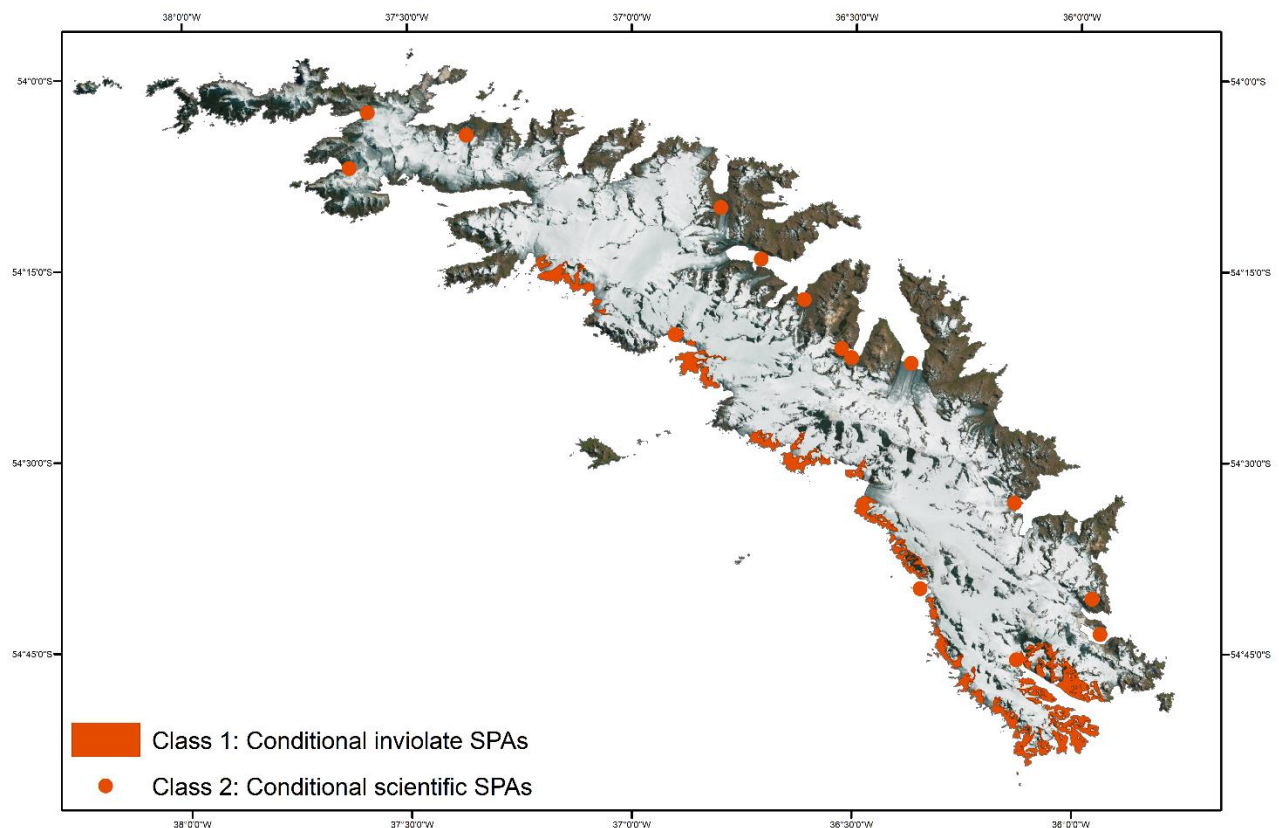


Figure 14: The conditional sites represent a balance between sites identified by stakeholders and those identified by Marxan.

How this influenced the final options:

- Uncertainty around how best to define the boundary of the South Coast, and a range of opinion amongst stakeholder replies resulted in the 'conditional' status for some of the options.
- The sites proposed for protection by stakeholders were also considered for categorisation as possible sites for a third class of SPA. As with the Marxan analyses, this concept was dropped because the underlying objective of this third class was unclear and there seemed limited rationale for what it might protect or how.
- Because the exact transects would require substantially more consideration before designation the proposed study sites for retreating glaciers put forward by stakeholders were also kept as conditional.

Second consultation feedback:

Those stakeholders who replied in the second consultation gave very favourable responses to this approach (Annex II) and endorsed designating the nine SPAs identified as options for consideration in this study.

6 Final options for consideration

Through an iterative process of presentation, receiving feedback and review the following options are presented to GSGSSI:

6.1 Visitor sites

Creating management plans for all open visitor sites is a large undertaking, but is likely to be a worthwhile endeavour as it will standardise and clarify operating procedures and act as a cornerstone for the continued harmonisation of different activities. Some of the early findings are already beginning to be acted upon, for example in the categorisation of visitor sites (Government of South Georgia and South Sandwich Islands 2018).

Option 1: Consider creating management plans for all visitor sites as a matter of priority. Review these management plans regularly, e.g. every five years, ideally in parallel to the review of the Biodiversity Action Plan.

A cheap, simple and effective way of getting more accurate data on where visitors go at visitor sites would be to provide GPS trackers to any operator who volunteered to trial the approach. The outputs could help showcase how visitor sites are used and could be invaluable for O₃ and O₄.

Option 2: Consider collecting more geospatial data on the location of where visitors go, preferably with the voluntary use of GPS trackers.

The number of visitors to the territory is predicted to increase substantially over the next decade. There is enormous scope to accommodate this, as well as further expeditions into the natural zone, but it needs to be approached ensuring that visits remain safe and environmentally sensitive.

Option 3: In collaboration with stakeholders, consider creating a plan for how South Georgia will sustainably support increasing tourism numbers over the next decade. In this plan consider management options including: extended walks, seasonal rotations, grading of visitor sites, additional protected areas and future modifications to existing SPA boundaries.

Early consideration for visitor site management were critiqued as being too resource intensive. As such, a less intensive management framework could be considered which still enables targeted feedback on the condition and trend of visitor sites. There are several such established frameworks, Table 5 explores the visitor impact management (VIM) framework.

Table 5: The visitor impact management approach is one of many adaptive frameworks that could be used to ensure visitor sites remain in a favourable condition.

1. Conduct pre-assessment database review - the current condition of the visitor sites
2. Review management objectives - what condition should the visitor sites be kept?
3. Select key indicators - e.g. trampled moss beds, unplanned visitor paths, abandoned nests
4. Select standards for key impact indicators - what is an acceptable level of change?
5. Compare standards and existing conditions - is the visitor site still within the acceptable limits?
6. Identify probable causes of impacts - what is causing the change? fur seals or humans?
7. Identify management strategies - how to best address this, if possible?
8. Implement - e.g. guided routes, walkway, or no intervention.

The VIM framework in particular could be well suited for visitor sites as it identifies problem conditions, the potential causal factors and the potential management strategies. It is a framework that uses science

but importantly, also professional judgement. This framework is entirely dependent on the input and collaboration of the wider stakeholder community, especially in the identification of pragmatic key indicators (step 3), standards (step 4) and reporting of these standards, e.g. through the post visit report form. This option would address concerns that threats such as human disturbance were being exaggerated whilst degradation from seals was not mentioned, as the framework tries to identify the causative factors before identifying a solution.

Option 4: In collaboration with stakeholders, discuss feasibility for an adaptive management framework such as VIM for all visitor sites. Input from stakeholders at each stage of the framework will be essential in creating an approach that is practical but which also provides assurance that sites remain in favourable condition.

The territory's approach for collecting data on numbers of visitors and the activities they do is invaluable. To maximise the quality and utility of this data it is important to keep it in a standardised format. The best way of ensuring this is to standardise the use of visitor site names to their site codes.

Option 5: Consider applying site codes in the GSGSSI's visitor statistics database to ensure better standardisation of data and application to geospatial data.

There is a huge resource in the presence of visitors to help with the reporting of species distributions. Citizen science is imperfect, and requires a modicum of quality control, but is already being undertaken in the territory and could become a more robust resource with further support.

Option 6: Continue with ACAP reporting and consider additional reporting mechanisms, such as citizen science with the aim of creating distributional data for all ACAP species.

6.2 Natural zone

The natural zone is incredibly important as it represents ~85% of the territory. The natural zone has not been considered as a SPA because doing so would require defining the boundaries of all visitor sites, something considered highly resource intensive, overly restrictive and of limited conservation benefit at this stage.

Option 7: Consider incorporating the natural zone into the sustainable tourism plan (O₃), specifically assessing the social, ecological and economic costs and benefits of creating new visitor sites, routes and allowing increased expeditions.

There will likely be increasing demand for expeditions in the natural zone over the coming years. However, further consideration could be given for expeditions that move through areas being treated for invasive plants simply as a measure to further reduce the risk of spreading propagules to areas infrequently visited.

Option 8: Consider stricter forms of biosecurity for expeditions which enter management units involved in the removal of invasive species.

6.3 SPAs

This study presents options for two classes of terrestrial protected area: inviolate areas and areas of particular scientific interest (Figure 15). Individual information sheets on each SPA can be found in Annex I.

6: Final options for consideration

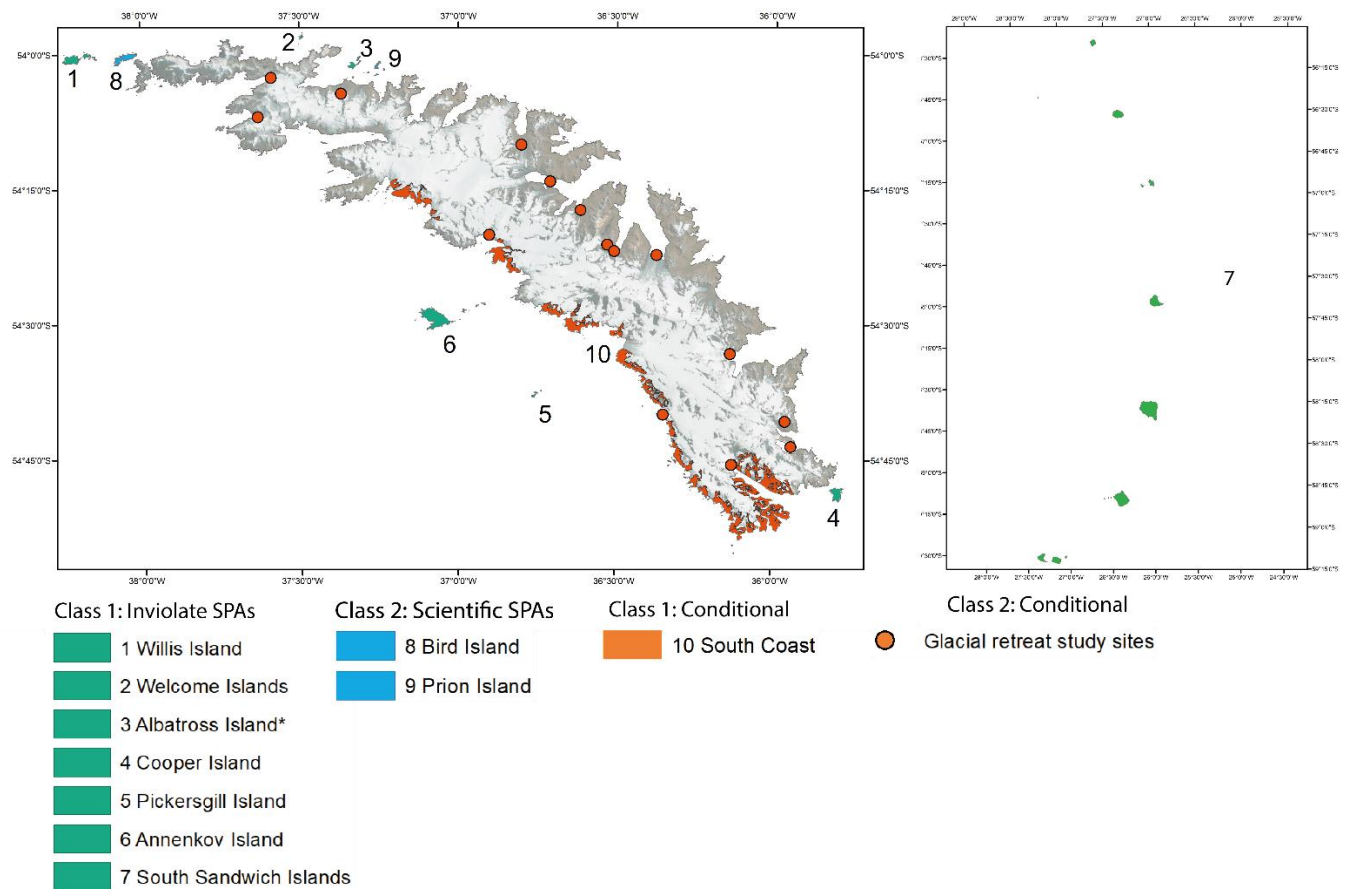


Figure 15: Options for consideration when redesigning the territory's terrestrial protected areas.

Class 1: Inviolable areas

Possible objective: To keep the territory's most pristine areas in as natural condition as possible so as to enable future comparisons with other areas disturbed by anthropogenic threats.

Possible period of designation: Indefinite

Possible period of review: 5 years

Rationale:

1. These sites represent a minority area in the territory, and region more broadly, and have remained free of invasive mammal species;
2. These areas have also been free from the vast majority of human influence in recent decades;
3. These areas contain key populations of the territory's wildlife, including globally threatened species and ACAP species (see individual information sheets);
4. The underlying criteria and objective of these sites was met favourably by most stakeholders;
5. The option to continue a strict level of protection for these sites was approved by most stakeholders.

Management options: Access to the sites could be governed by the use of regulated activity permits (RAPs). The RAP would aim to help determine whether the proposed access by the individual is feasible, and what additional assessments and/or permits will be needed if the access goes ahead. For entry into a class 1 SPA the entrant would need an approved category 3 RAP. GSGSSI could consider waiving the associated costs of category 3 RAPs for non-commercial requests.

Like the visitor sites, the SPAs would be well-suited for a VIM-like monitoring approach, though tailored to the nuances of the SPAs. This could mean a reliance on the use of less-damaging approaches to monitoring the changes in the SPAs, e.g. the use of drones, and by extension, tailored indicators of change, e.g. proportion of the SPA covered by non-native plant species.

Class 2: Areas of high scientific interest

Possible objective: To ensure long-term monitoring sites open to visitors are kept in a condition that does not affect the scientific purposes or the underlying natural heritage.

Possible period of designation: As long as the site warrants specific management to protect research objectives.

Possible period of review: 5 years

Rationale:

1. Locations which have long-term monitoring sites in close proximity to visitor sites are particularly susceptible to disturbance;
2. These sites can be best protected through the creation of a management plan which clarifies permitted activities and best practice;
3. These areas contain key populations of the territory's wildlife, including globally threatened species and ACAP species (see individual information sheets);
4. Of the two class 2 sites presented, 76% of respondents thought Bird Island should keep enhanced levels of protection and 71% of respondents thought Prion Island should keep enhanced levels of protection.

Management options:

Access to these sites could also be governed through the use of regulated activity permits. For Prion Island this could apply to all areas beyond the landing beach and boardwalk (i.e. the visitor site) and for Bird Island this could apply to the agreed travel limits at the BAS station in Jordan Cove. The recently updated RAP system indicates that a category 2 RAP would be required to go beyond these areas. Category 2 RAPs are reviewed internally by GSGSSI and are suggested to take between one and three months. This would seem sufficiently rapid to enable the occasional entry by scientists/media.

Option 9: Consider designating the nine SPAs and create management plans for them all. These management plans could be reviewed regularly, e.g. every five years, ideally in parallel with the review of the Biodiversity Action Plan in 2020 and the visitor sites plans.

Option 10: Consider implementing enhanced biosecurity measures, e.g. adding the requirement for new clothes/shoes, banning of Velcro, biotic materials etc for entry into SPAs designated as pristine areas.

6.4 Significance of the presented options

The presented options are aimed at strengthening the many existing forms of protection that are in place. Many of these measures and activities contribute to more than the territory's biodiversity action plan but also the territory's wider strategy as well as global environmental strategies the territory is a signatory to.

Multilateral Environmental Agreements (MEAs) are legally-binding agreements between nations to enable environmental goals to be reached. All require policy actions and vigilance to ensure that activities are compliant with the agreements. Through the UK's ratifications, a range of MEAs extend to SGSSI, including:

- Convention on Biological Diversity (CBD)
- Convention on the Conservation of Migratory Species of Wild Animals (CMS)
- United Nations Convention on the Law of the Sea
- London Convention
- Convention on Wetlands of International Importance especially as Waterfowl Habitat
- Vienna Convention for the Protection of the Ozone Layer
- Aarhus Convention

Two of these conventions are of particular relevance to the territory and the project's options:

The CBD aims to conserve biodiversity whilst enabling its sustainable use. It also seeks to ensure the fair and equitable sharing of benefits arising from the use of genetic resources. In 2014, the UK's ratification of the Convention was extended to SGSSI at the request of the Government of SGSSI. As such, SGSSI's obligations now include providing the UK with all information necessary to compile its National Report to the Convention and supporting the UK in achieving the Aichi Targets (part of the Convention's Strategic Plan for Biodiversity 2011-2020). The objectives outlined in SGSSI's Biodiversity Action Plan (Government of South Georgia & South Sandwich Islands 2016) all contribute to different Aichi targets (Figure 16).

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated and measures are in place to manage pathways to prevent their introduction and establishment

Due to the huge efforts undertaken over the last decade the territory is now free from invasive mammal species and invasive plant species have a plan for their control. Although the invasive plant population is considered widespread throughout South Georgia and the invasive invertebrates are known to occur on the north-east coast the pathways for additional incursions are now increasingly restricted through a wide range of measures. The possible SPAs are just one part of this multi-faceted approach. SPAs would help prevent the introduction and establishment of invasive species at some of the territories most unspoilt and natural sites, including sites such as the South Sandwich Islands which are a rarity in being invasive species free. By formally designating these sites GSGSSI would be creating an additional layer of protection over these important sites and creating management plans to ensure their continued protection, perhaps including stricter biosecurity measures (O10).

The CMS aims to provide a global platform for the conservation and sustainable use of migratory animals and their habitats. This Convention brings together the States through which migratory animals pass, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range. Obligations under this Convention include providing the UK with all information necessary to compile its national report to the Convention, and undertaking actions described in its ACAP implementation plan.

Goal 2: Reduce the direct pressures on migratory species and their habitats

Target 7: Multiple anthropogenic pressures have been brought to levels that are not detrimental to the conservation of migratory species or to the functioning, integrity, ecological connectivity and resilience of their habitats.

GSGSSI works closely with IAATO and other stakeholders to ensure anthropogenic pressures on South Georgia are kept at sustainable levels. Several of the ACAP species are notably susceptible to disturbance however and some suggest that further protection is required for these species, e.g. increasing the maximum approach distance (Australian Antarctic Division 2004; Holmes Giese and Kriwoken 2005; Young Lee et al 2017). Designating of additional SPAs would ensure many of the territory's most important ACAP colonies are kept with as low a level of anthropogenic disturbance as possible. This may be increasingly important as numbers of visitors to the territory continues to increase.

In 2015, 150 countries adopted the Sustainable Development Goals to end poverty, protect the planet and ensure prosperity for all, with specific targets to be met by 2030. The 17 Sustainable Development Goals came into in 2016 and will run until 2030. Although the goals are not legally binding state parties are expected to take ownership of the goals and establish national frameworks for their achievement.

SDG Target 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Indicator: 15.1.2: Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type.

SDG indicator 15.1.2 is calculated and delivered to the United Nations Statistics Department (UNSD) every January. This indicator uses two databases. The first is the World Database on Protected Areas (WDPA), the world's authoritative database on the world's protected areas. The second is the World Database on Key Biodiversity Areas (WDKBA) maintained by BirdLife International. South Georgia has designated as an Important Bird Area (IBA) and will thus be incorporated into the reporting of SDG Indicator 15.1.2.

Designation of additional protected areas would contribute to national and global efforts to ensure sites important to diversity are well protected with robust management frameworks in place to ensure the natural heritage is maintained for the long-term. Furthermore, it would inform regional and global conservation practitioners that these sites, and this IBA, are now formally protected sites.

The territory's actions to date have already demonstrated considerable commitment to the various MEAs as well as to voluntary goals such as the SDGs. Protected areas are only one part of these commitments, but they underpin the actions directed towards several of the territory's objectives (Figure 17). As such, it is fitting that these sites now are now considered for continued or further protection as GSGSSI and the global conservation community look beyond 2020 and to future priorities for nature.



6: Final options for consideration



Figure 16: Interlinkages between GSGSSI's priorities and CBD targets/SDGs

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Annex I: Guide to supplementary information.

7.1 Supplementary Information 1:

First consultation document: The offline-friendly version of the first consultation document. This is a 25-page document including a description of the initial analyses as well as maps showing the initially presented boundaries.

First consultation document accompanying materials: A collection of nine additional documents created to help inform feedback in the first consultation.

1. Three are brief (<5 page) case studies on other Subantarctic islands (French Antarctic Territories, Heard and MacDonal (Australia) and Marion and Prince Edward (South Africa)). One additional word document acts as a synthesis of the management undertaken on these islands, as well as per island zone.
2. Two review the criteria used in this project and compare them to what has been proposed by others in the past for the territory.
3. The Excel sheet includes a brief (~50 word) summary of each native mammal, bird and plant species in the territory and the rationale for further protection. Each species links to references listed in the project's full bibliography (see Supplementary Information 3). The Excel lists the priority species originally listed in the first consultation. A word document accompanies this Excel which lists how these priority species are managed or suggested to be managed elsewhere.
4. The last document is a list of how often the South Sandwich Islands are mentioned in GSGSSI's action plans and strategies over the years.

First consultation questionnaire: A questionnaire for stakeholders aimed at gathering targeted feedback on 40 key areas of interest. Questions spanned quantitative, categorical and free-text formats.

First consultation feedback: A summary Excel of the replies provided by stakeholders per question as well as longer written replies from those respondents who provided them.

7.2 Supplementary Information 2:

Second consultation document: The offline-friendly version of the second consultation document. This is a 16-page document including a description of the updated analyses and options having incorporated input from the first consultation.

Second consultation questionnaire: A questionnaire asking stakeholders their thoughts on the project's final ten options for consideration.

Second consultation feedback: A summary Excel of the replies provided by stakeholders on the second consultation per question. These replies are anonymised.

7.3 Supplementary Information 3:

Full project bibliography: A list of the >300 references consulted throughout the lifespan of the project. The list is predominantly peer-reviewed scientific journal articles but the list also includes, books, websites, management plans as legislation.

Full data inventory: A list of > that have been reviewed for incorporation in the project.

Geospatial database: The geospatial data that was created or updated as part of this project:

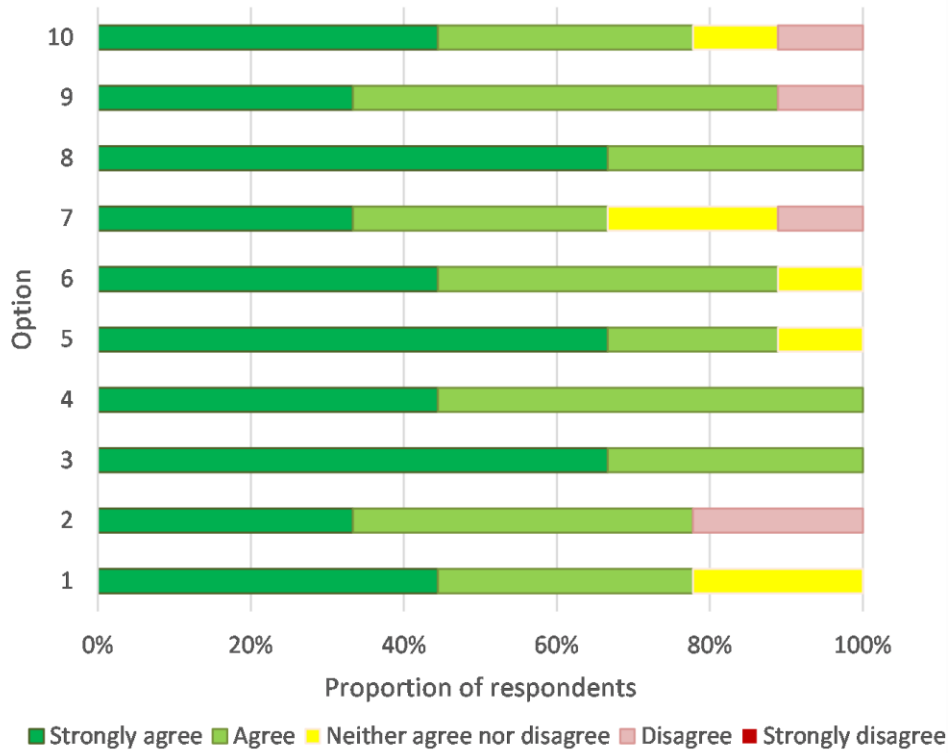
1. Planning units: A geodatabase containing the 250,000m² planning units used in this project.
2. South Georgia Atlas: Updated representations of the territory's species distributions. This work updated and refined the existing South Georgia Atlas (Trathan et al. 1996).
3. Cost Layers: Various geospatial representations considered for inclusion in this analysis representing the level of human activity and the historic presence of invasive species.
4. Stakeholder glacier study sites: Sites proposed by stakeholders as possible locations to study the retreat of glaciers and the impacts this has on terrestrial biodiversity.
5. Stakeholder proposed SPAs: Sites proposed by stakeholders for possible locations of SPAs.
6. Marxan Outputs: The geospatial outputs from the Marxan runs.
7. Possible SPA Boundaries: The potential boundaries for nine SPAs for consideration.

Step-by-step guide: A guide to help GSGSSI re-do any of the Marxan analyses should they wish to once better data becomes available.

7.4 Supplementary Information 4

SPA Information Sheets: Tailored forms based on those used for the Antarctic Specially Protected Areas for each of the possible SPAs. These forms include a description of the possible SPAs location, size, physical aspects, rationale for protection, possible management as well as a map of its possible boundary. These forms are designed to act as standardised repository for information regarding the possible SPA as well as a document that can feed into a site's management plan.

Annex II: Final consultation feedback.



The number of respondents in the second consultation was only nine individuals but the responses for the presented options was incredibly positive. On average, 87% of respondents either strongly agreed or agreed with the options and three options (3, 4 and 8) only met with positive feedback.

Annex III: Key stakeholders

	Name	Organisation
1	Alison Neil	South Georgia Heritage Trust
2	Mike Richardson	South Georgia Heritage Trust
3	Denise Landau	South Georgia Heritage Trust & Friends of South Georgia
4	Damon Stanwell-Smith	International Association of Antarctic Tour Operators*
5	Skip Novak	International Association of Antarctic Tour Operators/ Pelagic Expeditions
6	Lisa Kelley	International Association of Antarctic Tour Operators
7	Johnathan Hall	Royal Society for the Protection of Birds
8	Dieter Hoffmann	Royal Society for the Protection of Birds
9	Helen Peat	British Antarctic Survey
10	Phil Trathan	British Antarctic Survey
11	Peter Convey	British Antarctic Survey
12	Kevin Hughes	British Antarctic Survey
13	Helen Baker	Joint Nature Conservation Committee
14	Claire Hamilton	Department for Environment, Food and Rural Affairs
15	Holly Kelley	Department for Environment, Food and Rural Affairs
16	Anna Fohrbeck	Department for Environment, Food and Rural Affairs
17	Thea Edwards	Department for Environment, Food and Rural Affairs
18	Rod Downie	World Wide Fund for Nature
19	David Drewry	South Georgia Association*
20	Bob Headland	South Georgia Association
21	Bob Burton	HAP/South Georgia Surveys
22	Tom Hart	Oceanites/Oxford University
23	Crag Jones	Expedition panel
24	Sally Poncet	South Georgia Surveys
25	Roisin Hayes	Foreign and Commonwealth Office
26	Birgit Njaastad	Norwegian Polar Institute
27	John Croxall	South Georgia Heritage Trust
28	Tara Pelembe	South Atlantic Environmental Research Institute
29	Ness Smith	South Atlantic Environmental Research Institute
30	Neil Golding	South Atlantic Environmental Research Institute

*Consultation materials were disseminated throughout these organisations which led to feedback from additional individuals, e.g. from individual tour operators.

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