The spatial distribution of Antarctica's protected areas: a product of pragmatism, geopolitics or conservation need?

Kevin A. Hughes[1*] and Susie M. Grant[1]

[1] British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge, CB30ET, United Kingdom

* corresponding author. E-mail: kehu@bas.ac.uk, Tel: +44(0)1223 221616

Abstract

Globally, few protected areas exist in areas beyond the jurisdiction of a single state. However, for over 50 years the Antarctic protected areas system has operated in a region governed through multi-national agreement by consensus. We examined the Antarctic Treaty System to determine how protected area designation under a multi-party framework may evolve. The protected areas system, now legislated through the Protocol on Environmental Protection to the Antarctic Treaty and the Convention on the Conservation of Marine Living Resources, remains largely unsystematic and underdeveloped. Since the Antarctic Treaty entered into force in 1961, the original signatory Parties – and Parties with territorial claims in particular – have dominated work towards the designation of protected areas in the region. The distribution of protected areas proposed by individual Parties has largely reflected the location of Parties' research stations which, in turn, is influenced by national geopolitical factors. Recently non-claimant Parties have become more involved in area protection, with a concurrent increase in areas proposed by two or more Parties. However, overall, the rate of protected area designation has almost halved in the past 10 years. We explore scenarios for the future development of Antarctic protected areas and suggest that the early engagement of Parties in collaborative area protection may strengthen the protected areas system and help safeguard the continent's values for the future. Furthermore, we suggest that the development of Antarctica's protected areas system may hold valuable insights for area protection in other regions under multi-Party governance, or areas beyond national jurisdiction such as the high seas or outer space.

Keywords: Territorial claim, Marine Protected Area, Antarctic Specially Protected Area, Antarctic Specially Managed Area, Environmental Protocol

Highlights

- The Antarctic protected area system (APAS) operates under multi-Party governance
- However, the effectiveness and representativeness of the APAS is in question
- Non-claimant Antarctic Treaty Parties are becoming more engaged in the APAS
- Terrestrial and marine protected areas are being proposed more by multiple Parties
- We examine scenarios for the future development of the APAS

Vitae

Dr. Kevin A. Hughes is the Environmental Research and Monitoring Manager at the British Antarctic Survey (BAS). He is a member of the UK Delegation to the Antarctic Treaty Consultative Meeting (ATCM) Committee for Environmental Protection (CEP) and also Deputy Chief Officer of the Scientific Committee on Antarctic Research (SCAR) Standing Committee on the Antarctic Treaty System (SC-ATS). Within the context of the Antarctic, he has broad science and policy interests including conservation, area protection, non-native species, environmental impact assessment, environmental monitoring and the expansion of human footprint. He has visited Antarctica ten times, including one Antarctic winter.

Dr Susie M. Grant is a marine biogeographer at the British Antarctic Survey (BAS). She is a member of the UK delegation to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), and has served as the Vice-Chair of the CCAMLR Scientific Committee. Her work is focused at the interface between conservation science and policy, particularly on Antarctic marine spatial management and protected areas. This work has included the development of the world's first high seas marine protected area, established around the South Orkney Islands in the Southern Ocean. She has visited Antarctica eight times.

1. Introduction

Designation of most protected areas occurs within sovereign territory and under the jurisdiction of a single state (UNEP-WCMC, 2016). However, Antarctica is globally unique in that the region is governed through consensus under the Antarctic Treaty (to which currently 53 states are party and which applies to the area south of latitude 60°S), and protected area designation must take into consideration the views of the 29 Consultative Parties to the Treaty (see: http://www.ats.aq/index_e.htm). The Antarctic protected areas system represents one of the few long standing conservation systems in an area where decisions are made by consensus by multiple states (Bastmeijer and van Hengel, 2009), with 2016 marking the 50th anniversary of the designation of Antarctica's first protected area (1966) and the 25th anniversary of the agreement of the Protocol on Environmental Protection to the Antarctic Treaty (1991). The pattern of the system's evolution and the degree of involvement by states may hold valuable insights for area protection in other regions under multi-party governance, or areas beyond national jurisdiction, such as the high seas (Grant, 2005) or outer space (Al-Rodhan, 2012).

1.1 Threats and protection

Of Antarctica's 14,000,000 km^2 area, only 0.18% (c. 25,200 km^2) is ice-free and available for colonisation by terrestrial life. Much of this ground is at high latitude or high altitude and in these locations microorganisms dominate (bacteria, fungi, algae and lichens). At coastal locations, ice-free ground may support visible population of cryptogams and micro-invertebrates, but Antarctica's native insects and vascular plant species are restricted to the climatically less extreme northern Antarctic Peninsula region (Smith, 1984). Recent research has revealed substantial biodiversity (particularly in microbial groups) and distinct biogeographic regions (Terauds et al., 2012; Terauds and Lee, 2016; Chown et al., 2015;

87 Hughes et al., 2016a). The coastal areas also support breeding population of seals, penguins
88 and flying birds, which rely upon the biologically rich and more productive marine
89 environment for food. High levels of primary production in the Southern Ocean support a
90 very large biomass of krill, which is a major food source for land-breeding marine predators
91 as well as cetaceans, fish and squid. There is also a high diversity of life on the Antarctic
92 seafloor (Clarke & Johnston, 2003), including slow growing, habitat-forming taxa such as
93 sponges and corals.

94 Antarctica is under increasing threat from global environmental impacts, such as
95 atmospheric pollution and climate change (Bargagli, 2008; Turner et al., 2009, 2014), and
96 local impacts associated with a growing and expanding tourist and national science operator
97 presence in the region, such as habitat destruction, pollution, wildlife disturbance and non-
98 native species introductions (Tin et al., 2009; Bender et al. 2016). The footprint of the
99 tourism industry and scientific activity by some Parties continues to expand (Hughes et al.,
100 2011; Convey et al. 2012; Tin et al., 2014), while cumulative impacts may have a negative
101 effect on scientific and conservation values (Hughes et al., 2013, 2015, 2016b). Antarctic
102 marine living resources have been exploited for over 200 years, beginning with sealing in the
103 early 19th century (Tin et al., 2009; Grant et al., 2012). The whaling industry peaked in the
104 1930s, and unregulated fishing for species such as rock cod in the 1960s and 70s resulted in
105 heavily depleted stocks. Fishing for krill began in the 1970s, and concerns from the Antarctic
106 Treaty Parties about the potential over-exploitation of this key species resulted in the
107 establishment of the Commission for the Conservation of Antarctic Marine Living Resources
108 (CCAMLR) by international convention in 1982. CCAMLR currently regulates legal
109 fisheries for krill, toothfish and mackerel icefish. However, illegal, unregulated and
110 unreported (IUU) fishing also continues to occur in the Southern Ocean, particularly for the
111 valuable Antarctic and Patagonian toothfish (Österblom et al., 2015). Environmental impacts

from fishing (and particularly by IUU vessels which do not adhere to CCAMLR regulations) include by-catch of non-target species, incidental mortality of seabirds and marine mammals, and damage to benthic habitats from longline fishing gear. In addition to the risk of depleting harvested stocks themselves, there may be associated impacts on predators that are dependent on the same stocks.

Some commentators have suggested that the Antarctic Treaty system may not be dynamic enough to respond adequately to emerging conservation issues (Chown et al., 2012; Convey et al., 2012; Tin et al., 2014) and the Antarctic protected areas system has not escaped criticism (Shaw et al., 2014). Although the whole of Antarctica is protected, recent research has shown that large areas of Antarctica remain devoid of specially protected areas and the system remains under-developed, unsystematic and inconsistently applied by Parties (Shaw et al., 2014; Hughes et al., 2013, 2015, 2016a; Pertierra and Hughes, 2013). Shaw et al. (2014) showed that only c. 1.5% of Antarctica's ice-free ground is within a designated specially protected area and many of these sites are located closer to sites of high human activity than would be expected by chance, leaving them vulnerable to impacts. Furthermore, almost all of the Southern Ocean beyond national jurisdiction is devoid of any protected areas (Grant et al., 2012; Hughes et al., 2016a; Brooks, 2013).

1.2 Governance of Antarctica

The arrival of the first sealers in 1819/20 brought a recognition of the potential of Antarctica for commercial exploitation of marine species and, in turn, this led to territorial ambitions by nations over much of the continent (see Table 1) (Headland, 2009). By 1942, only a sector of continent in the region of Marie Byrd Land (90^{o}W to 150^{o}W) remained unclaimed, with the territories claimed by the United Kingdom, Chile and Argentina in the Peninsula region overlapping and leading to international dispute (Saul and Stephens, 2013). Other undisputed

sectors were claimed by Norway, France, Australia and New Zealand. When the Antarctic Treaty was signed in 1959, the seven claimant Parties represented a majority within the original group of 12 signatory Parties (Jacobsson, 2011). Of the remaining five Parties, the United States and Russia maintain that their earlier activities within the Treaty area gave them a basis for making territorial claims in the future, should they deem this appropriate (Scully, 2011). Nevertheless, Article IV of the Treaty put all existing territorial claims in abeyance and put a halt to new territorial claims. During the early years of the Treaty, the original 12 signatory Parties, and the claimant states in particular, dominated the governance of Antarctica including the development of the Antarctic protected areas system. This pattern and level of engagement has largely persisted despite a further 17 states becoming Consultative Parties to the Antarctic Treaty, many of whom play only a minor role in the continent's governance compared with the original signatories (Dudeney and Walton 2012).

1.3 The development of the protected areas system in Antarctica

The development of area protection within Antarctica started when the '*Agreed Measures for the Conservation of Antarctic Fauna and Flora*' were agreed in 1964. Measures were set out for the designation of Specially Protected Areas (SPAs) to preserve the area's '*unique natural ecological system*' and, later, Sites of Special Scientific Interest (SSSI) were established to protect areas where scientific investigations were undertaken (or planned to be undertaken in the future) including sites of non-biological interest.

A major revision of the Antarctic protected areas system came about with the entry into force of the Protocol on Environmental Protection to the Antarctic Treaty in 1998 (see: http://www.ats.aq/e/ep.htm), which also established the Committee for Environmental Protection (CEP) as an expert advisory body to provide advice and formulate recommendations to the Antarctic Treaty Consultative Meeting (ATCM) in connection with

the implementation of the Protocol. The Protocol addressed in one piece of legislation a wide range of topics including environmental impact assessment, conservation of fauna and flora, waste disposal and management, prevention of marine pollution, area protection and management and, more recently, liability arising from environmental emergencies. However, since the Protocol was agreed in 1991, Antarctica has been subject to new environmental pressures including regional climate change and increasing tourism industry activity. A combination of a wide remit and on-going environmental change and has resulted in the CEP's time and resources being spread across many issues and, consequently, progress on some environmental matters has been slow (Orheim et al., 2011).

In Article 2 of the Protocol, Parties committed themselves to the comprehensive protection of the Antarctic environment, designating Antarctica as a '*natural reserve, devoted to peace and science*'. Annex V to the Protocol, on 'Area Protection and Management', came into force in 2002 and set out the system for area protection in Antarctica with SPAs and SSSIs reclassified under the single format of Antarctic Specially Protected Area (ASPA). ASPAs are designed to protect '*outstanding environmental, scientific, historic, aesthetic or wilderness values, any combination of those values, or on-going or planned scientific research'*. ASPAs must have a management plan and entry is not permitted without a permit from a designated national authority. Currently, 72 ASPAs are designated (see Figures 1 and 3) that have a combined area of c. 2,000 km^2 and encompass marine and ice-free areas as well as areas of permanent ice. Under the Protocol, a new management classification tool called an Antarctic Specially Managed Area (ASMA) was also created to '*assist in the planning and co-ordination of activities, avoid possible conflicts, improve co-ordination between Parties or minimise environmental impacts*'. ASMAs are required to have a management plan, but permits are not required for entry and regulations applicable within the ASMA are not mandatory. Six ASMAs are currently designated. Once an ASPA or ASMA is adopted by

187 the ATCM, it is the joint responsibility of all signatories to the Protocol to ensure the values
188 within the area continue to be protected. In practice, any environmental management
189 activities and associated management plan revisions have been undertaken by the Party (or
190 Parties) which proposed a given protected area. However, the Protocol does not in fact give
191 sole responsibility to the proponent(s) to undertake these tasks, but rather encourages
192 exchange of information so that Parties can work together to manage protected areas.
193 Conservation measures implemented by CCAMLR for the protection of marine
194 resources include regulations on catch limits, environmental protection, by-catch, open and
195 closed seasons, and closed areas including special areas for protection and scientific study.
196 The first Marine Protected Area (MPA) designated by CCAMLR was established south of the
197 South Orkney Islands in 2009. Following work by the United Kingdom, this 94,000 km^2
198 MPA was proposed by the European Union, and became the world's first MPA to be
199 designated entirely within the high seas. CCAMLR subsequently developed a general
200 framework for the implementation of further MPAs, and designation of the Ross Sea region
201 Marine Protected Area was agreed by all Members in 2016. Additional areas in East
202 Antarctica and the Weddell Sea have been proposed for protection but are yet to be agreed,
203 and work is ongoing to develop MPA proposals for the Western Antarctic Peninsula region.
204 A joint meeting of the CEP and the CCAMLR Scientific Committee in 2009 concluded that
205 CCAMLR should be the 'lead body' on the development of marine spatial protection in the
206 Southern Ocean, although this does not preclude the development of marine ASPAs and
207 ASMAs by the CEP (France et al., 2009). However, there has to date been little interaction
208 between the two bodies on the designation of MPAs or marine ASPAs and ASMAs.
209 In this paper we examine the development of the Antarctic protected areas system,
210 investigate the influence of territorial claims and research station location on protected area
211 distribution, and look for evidence that a more collective responsibility for Antarctica's

212 protected areas may be starting to develop. Our analysis is focused on the designation of
213 ASPAs, although ASMAs and MPAs are also considered in the context of the wider
214 Antarctic protected areas system.
215
216 ## 2. Methods
217 Data concerning ASMAs and ASPAs were obtained from management plans that are
218 available from the Antarctic Treaty Secretariat website
219 (http://www.ats.aq/e/ep_protected.htm).
220 Information on the position and operating status of Antarctic research stations was obtained
221 from Antarctic national operator websites or from the Council of Managers of National
222 Antarctic Programs (COMNAP) (https://www.comnap.aq/SitePages/Home.aspx).
223 Information on designated and proposed Marine Protected Areas (MPAs) was obtained from
224 CCAMLR (https://www.ccamlr.org/).
225 Russia and the United States are classified as non-claimant Parties within this
226 analysis, as the extent of any potential future claims have not been declared (see Hemmings
227 et al., 2017).
228 A Mann-Whitney U test was used to compare the distance between each ASPA and
229 its proponent's nearest research station for single claimant (n=43) and non-claimant (n=23)
230 proponents.
231
232 ## 3. Results
233 *3.1 Distribution of research stations within Antarctic territorial claims*
234 Almost all research stations of claimant Parties are located within the claimed territory,
235 including those claimant Parties with several stations (i.e. the United Kingdom, Australia,
236 Argentina and Chile) (Figure 2a and 2b; Table S1). The only exception is the joint French-

Italian Concordia Station, situated at Dome C on the ice sheet within Australian Antarctic Territory. In contrast, non-claimant Parties with more than one year-round research station (Russian Federation, United States, China, Korea and India) all have their stations dispersed across more than one of the claimed territories. By virtue of the position of the United States Amundsen-Scott South Pole Station, all claimed Antarctic territorial are occupied.

3.2 Distribution of ASPAs within Antarctic territorial claims

Antarctica has 72 ASPA and 6 ASMAs of which two thirds have a claimant Party acting as at least one of their proponents. The distribution of ASPAs, ASMAs and MPAs within the Treaty Area and claimed Antarctic territories are shown in Figure 3. More detail on ASPA distribution is provided in Table S2, which shows the proportion of ASPAs, for which a Party is the proponent, that are located within the claimed territory of that Party. All ASPAs proposed by claimant states are contained within the respective claimed territory. The United States is the sole proponent for 14 ASPAs, which are located across the Ross Sea Region, Transantarctic Mountains and Antarctic Peninsula, while Russia is the proponent for only one ASPA near its Mirny research station. As observed with ASPAs, all ASMAs proposed by claimant states are contained within the territory they claim, the only exception being Norway's participation as one of six proponent Parties in ASMA No. 4 Deception Island, where they have a historical interest concerned with the Norwegian Hektor Whaling Station in Whalers Bay (Table S3).

3.3 Trends in distance of ASPAs from the proponents nearest research station

Figure 4 also shows the change in the distances of protected areas from the proponent's nearest research station with time. In 1966 and during the period 1967-86, more areas close to the proponent's research stations were designated (i.e. within 50 km) compared to areas

262 further away. By 1967-2006, increasing numbers of areas at greater distances from stations
263 were designated for protection (i.e. > 100 km away), with this trend continuing more strongly
264 since 2006, possibly as a result of increasing operational capacity.
265 Due to their long duration of involvement in the Treaty system, some original
266 signatory Parties to the Treaty (i.e. Australia, New Zealand, United Kingdom and the United
267 States) have acted as the proponents for more ASPAs, and at greater distance from their
268 nearest research station, than other original signatory Parties and those that acceded to the
269 Treaty in later years (Figure 5). However, when we considered the median distances between
270 ASPAs and the proponent's nearest research station, there was no statistically significantly
271 difference between ASPAs proposed solely by claimant Parties (n = 43; 36.5 km) and non-
272 claimant Parties (n = 23; 35.8 km) (P = 0.628).
273
274 *3.4 Trends in single, multiple, claimant and non-claimant proponents of ASPAs*
275 Figure 6 shows the proponents of ASPA (or their earlier equivalents, SPA or SSSI)
276 designation during different time periods since the start of the Antarctic protected areas
277 system in 1966. Proponents were either claimant Parties, non-claimant Parties, two Parties or
278 multiple Parties. Fifteen protected areas were designated in 1966, 22 during the period 1967-
279 86, 30 during the period 1987-2006 and eight during the period 2007-2016. During the
280 period between 1966 and 2006 claimant Parties were the sole proponents for at least 55% of
281 designated ASPAs (or their earlier equivalent) and all areas with more than one proponent
282 involved only claimant Parties. In contrast, during the period 2007-2016, only 12.5% of
283 ASPAs were designated by a sole claimant Party, and 50% of designated ASPAs had more
284 than one proponent, at least one of which was a non-claimant Party. Compared to the periods
285 1967-86 and 1987-2006, the average annual rate of ASPA designation during 2007-2016 has
286 decreased by 37.5% and 87.5%, respectively.

4. **Discussion**

The designation of protected areas can benefit Antarctic terrestrial and freshwater ecosystem by reducing (i) transfer of non-native species, (ii) pollution from local sources, (iii) disturbance of wildlife, (iii) habitat alteration and (iv) trampling of vegetation, including by prohibiting construction of large scale national operator facilities and recreational visits by national operator staff and tourists within the area (Tin et al., 2009; Hughes and Convey, 2010). Protected areas may also benefit marine ecosystems by reducing fishing pressure and any associated damage to benthic habitats (Brooks et al., 2016). However, protected area designation may have little conservation benefit without proactive management and relevant monitoring by the proponent(s) and also adherence to the associated area management plan by all the Parties operating in the vicinity. While many Parties make substantial efforts to conform with their area protection responsibilities, this is not universally the case, and education of visiting personnel and enforcement of area management plan requirements may be lacking (Pertierra and Hughes, 2013). Examples exist of ignorance or a disregard of the mandatory ASPA management plan requirements, including (a) trampling of protected vegetation, (b) abandonment of dilapidated refuges that present a potential threat to wildlife, (c) leaving litter/waste and disturbed ground at field camps, (d) abandonment of redundant scientific equipment, (e) unpermitted collection of fossils, (f) handling and interference with wildlife, (g) breaching agreed minimum flight heights and distances over bird colonies, (h) unpermitted visits for recreational purposes and (i) illegal driving of vehicles within the area (see Hughes et al., 2013 for specific examples). To counter this, engagement by more Parties in the development of the protected areas system may increase understanding of their obligations under the ATS and encourage development of national systems to more effectively educate national operator staff and regulate ASPA entry and activities therein.

312 Encouraging ASPA designation with multiple proponent Parties may help share the resource
313 burden of protected area management and enhance regulatory and, where relevant, scientific
314 communication and co-operation between Parties.
315
316 *4.1 Protected areas and territorial claims*
317 In 2009, Elzinga wrote '*the siting of new research stations is based on expediency and the*
318 *political need to demonstrate a presence*' and it is clear that the choice of location of Parties'
319 research stations is a product of historical, geopolitical, logistical and scientific criteria
320 (Elzinga, 2009; Hemmings and Gilbert, 2015). This is demonstrated by the focused
321 distribution of almost all claimant Parties' stations within the claimed territories, compared to
322 the often broader Antarctic distribution of stations founded by non-claimant Parties with
323 more than one station (Figure 2a and 2b; Table S1). However, does this pattern extend to
324 protected areas that have claimant Parties as their proponents? Of the currently designated
325 ASMAs and ASPAs with claimant proponents, almost all are located within the claimed
326 territory (Figure 3, Table S2). However, this pattern may largely be a consequence of history
327 and logistical capacity. An analysis of changes in the distance of ASPAs from proponents'
328 nearest research stations over the past 50 years suggests that Parties initially proposed ASPAs
329 close to their research stations (Figures 4 and 5) and may only subsequently propose
330 designation of areas further away. For logistical reasons, Parties may be reluctant to engage
331 with protected area designation much beyond their area of normal operation or influence, as
332 visitation and management of these areas comes at a cost. Hemmings and Gilbert (2015)
333 suggested that since the establishment of the Antarctic protected areas system the practice of
334 Parties has been to propose areas for protection only in the area where the national
335 programme operated, which in turn explained the lack of ASPAs within the unclaimed sector
336 of Antarctica. However, Parties able to demonstrate substantial logistical capability may be

337 able to propose and fulfil their ASPA management responsibilities at a location hundreds of
338 kilometres from their nearest stations (e.g. ASPA 119 Davis Valley and Forlidas Pond, Dufek
339 Massif, Pensacola Mountains (US) or ASPA 168 Mount Harding, Grove Mountains, East
340 Antarctica (China)). An examination of the mean distance between ASPAs and the
341 proponent's nearest research station showed there was no significant difference between
342 areas proposed solely by claimant Parties compared with those proposed by non-claimant
343 Parties. This finding suggests that claimant Parties are likely to be making no greater efforts
344 to act as proponents for ASPAs across their claimed territories, than non-claimant Parties
345 within the areas around their research stations.

346 How would acting as the proponent for a protected area strengthen any territorial
347 claim? For ASPAs, their conservation or scientific emphasis may make their management of
348 little political value other than to demonstrate activity in the regions and participation in the
349 wider Treaty Area governance systems. Furthermore, once agreed by consensus, the
350 protected area becomes the responsibility of all Treaty Parties, albeit, in practice the
351 proponents take on the majority of management responsibility. Additional factors may be
352 relevant for designation of ASMAs, which are generally larger in scale (ranging from c. 40 to
353 26,400 km^2) and require the proponent(s) to draft non-mandatory, but generally widely
354 respected, guidelines concerning activities undertaken in the area. Therefore, while ASPAs
355 are restricted in their application to scientific and conservation issues, ASMAs may be
356 considered to be of more political value due to their scale and capacity to influence broader
357 issues, e.g., tourism activities, regional presence, building construction, management of
358 transport hubs, safety issues, international scientific collaboration, as well as conservation
359 through the incorporation of ASPAs and restricted zones within ASMAs (Brazil et al., 2006,
360 Braun et al., 2012, China, 2015).

The designation of CCAMLR MPAs is not considered in detail here; however, the establishment of such areas has faced significant political difficulties in recent years (Cordonnery et al., 2015; Brooks, 2016), possibly due in part to perceptions that there may be underlying territorial reasons behind their proposal (Lukin, 2014). All four of the currently designated or formally proposed CCAMLR MPAs have proponents who claim the sector in which they are located (Table 2). However, all four also have joint, non-claimant proponents. Germany has led the development of a proposal for a Weddell Sea MPA, and several other CCAMLR Members have also had significant involvement in this process since its earliest stages (CCAMLR, 2013 (paragraph 5.78)). The European Union (as a CCAMLR Member in its own right) is now the formal proponent of the Weddell Sea MPA (proposal submitted to the CCAMLR Commission in 2016), thus including all EU Member States. The other MPA proposal currently in development has multiple proponents, and most proposals have had a larger group of Members who have contributed significantly to research and planning activities related to the MPA (Table 2). The CCAMLR Scientific Committee has agreed on the importance of consolidating scientific views to maintain a common basis for the development of MPAs (SC-CAMLR, 2010 (paragraph 5.20)). Although still in the early stages of development, CCAMLR has also started to address the question of research and monitoring within MPAs, agreeing that this should be a community effort undertaken by any interested Members (CCAMLR, 2014 (paragraph 5.73)).

4.2 Enhanced collaboration

Our analysis shows that the earliest ASPA designations were mostly located close to research stations, and proposed by single, claimant Parties. Now, in the early 21st century, there has been a shift towards joint and multiple proponent ASPAs (Figure 6), as well as early efforts towards the collaborative proposal of MPAs (as described above) and an increasing use of

multi-party ASMAs. Recent discussion at CEP resisting the proposed single-Party ASMA around Dome A demonstrated a move away from a single-Party model towards a multi-Party management structure. There may be several reasons for the broader multi-Party engagement and collaboration with the protected areas system that has begun to develop in recent years, including:

- Antarctic investment by some Parties has recently increased (e.g. India, Republic of Korea and China) and there may be a desire to demonstrate greater involvement in Antarctic affairs (Brady, 2012).
- More recent signatories to the Treaty may prefer to act collaboratively with other Parties that are more experienced in the proposal of protected areas, possibly as a means to build relations between Parties active in the same region of the continent (e.g. Australia and China; US and Italy).
- Parties with management responsibilities for several ASPAs may not have the capacity to propose further protected areas independently, and may choose to work with other Parties.
- Changes in operational footprint may make it more efficient to share environmental management responsibilities with Parties operating close to an existing protected areas. For example, the UK recently asked Argentina to co-manage ASPA No. 148, specifically because it has a research station nearby.
- Effective designation of protected areas by multiple Parties may generate a desire for further collective area designation. For example, the four co-proponent Parties for ASMA No. 6 Larsemann Hills were also co-proponents for ASPA No. 174 Stornes, Larsemann Hills.

4.3 Possible future scenarios for the Antarctic protected area system

411 What will the Antarctic protected areas system look like in 30 years' time when potentially a
412 greater number of Parties have acceded to the Treaty and station numbers have increased
413 (although not necessarily their spatial distribution across the continent)? Under a '*business*
414 *as usual*' scenario, the rate of designation of ASPAs will continued to decline, and protected
415 area locations will remain largely dictated by their proximity to the proponent's stations,
416 resulting in little improvement in the representativeness of the continent's protected area
417 network. Alternatively, in a '*different Parties, same behaviour*' scenario, Parties who, up to
418 now, have shown little engagement with the protected area system (predominantly non-
419 claimant Parties), now show more involvement, but follow earlier patterns of proposing areas
420 near their stations and infrastructure, at least initially. Such activity may increase ASPA
421 numbers but, given the long-standing trend of Parties' clustering their station together in
422 accessible locations (see Figures 2a, b and 3) these designations do not provide a
423 representative ASPA network across the continent as a whole. Under a '*good planning, poor*
424 *delivery'* scenario, considerable scientific and policy effort is employed to identify a
425 representative network of potential protected areas. However, little conservation benefit
426 results due to inadequate levels of Party engagement in subsequent designation and
427 management of the proposed protected areas. Finally, a '*planned and integrated*' future
428 scenario envisions a protected areas system which works across both the CEP and CCAMLR,
429 and involves consortium groups of proponents across regional planning areas, covering the
430 full range of marine and terrestrial areas. Figure 7 illustrates the development of the
431 Antarctic protected areas system over time, from the designation of the first areas in 1966 to a
432 point in the future when this model might be realised. To remove any suggestions of areas
433 being protected for political reasons, the trend towards ASPAs, ASMAs and MPAs being
434 proposed by more than one proponent should be encouraged, to achieve the goal of a fully
435 collaborative system.

436

437 *4.4 Next steps*

438 What could be done to reverse the recent decline in the rate of ASPA designation and help
439 deliver a representative system of protected areas of suitable scale, as envisioned in the
440 Protocol? SCAR, with its status as an 'apolitical' organisation, could be encouraged to
441 produce a list of areas and features worthy of designation as ASPAs, based upon scientific
442 and conservation needs (Hughes et al., 2013; 2016a,b; Coetzee et al., 2017). Systematic
443 conservation planning may be an appropriate methodology to determine representative areas
444 in Antarctica for subsequent protection, but this has yet to be applied to the continent as a
445 whole (Margules and Pressey, 2000; Coetzee et al., 2017). There must be a greater
446 recognition within the Parties that protected areas, once designated, are the joint
447 responsibility of all signatories to the Protocol so that management burdens could be shared.
448 Therefore, the Parties that have not, to date, acted as proponents for ASPAs may have
449 capacity to drive the next phase of ASPA management. In addition to increased collaboration
450 between Parties, mechanisms for co-operation between the CEP and CCAMLR on protection
451 for marine areas of mutual interest should also be considered as a future priority, as
452 highlighted during their first joint workshop (France et al., 2009).

453

454 **5. Conclusions**

455 Over more than 50 years the Parties have engaged with the Antarctic protected areas system
456 to protect a diverse range of important values present within the Treaty Area. This study
457 aimed to establish the relative importance of pragmatism, geopolitics and conservation need
458 as drivers for the spatial distribution of Antarctica's protected areas. While conservation is
459 the overarching aim of the protected area system, a systematic evaluation of environmental
460 values worthy of protection and their distribution across Antarctica's different eco-regions

has not yet been delivered, and represents a major gap which has hindered the ATCM's delivery of an effective protected areas system (Coetzee et al., 2017). Geopolitical factors have strongly influenced the distribution of Parties' logistical facilities within the continent, which, in turn, has dictated the operational footprint in which they have the capacity to manage protected areas - resulting in the patchy distribution of protected areas we see today. Nevertheless, the perception of geopolitical interests influencing the proposal of protected areas is likely be dispelled through greater multi-Party engagement in area designation (Figure 7). Hopefully, any initiative to designate protected areas in other areas under multi-Party governance or beyond national jurisdiction may learn from the experiences within the Antarctic Treaty area, and make systematic conservation planning and broad engagement and consultation a component of any protected area proposal and designation process.

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672

673

674 **Figure captions**

675 Figure 1. Designation of ASPAs (or the earlier equivalents) between 1966 and 2015 and
676 number of ASPAs proposed by each proponent Consultative Party.

677

678 Figure 2. Map of Antarctica showing the distribution of Antarctic research facilities. A:
679 research facilities operated by claimant states (Argentina, Australia, Chiles, France, New
680 Zealand, Norway, United Kingdom). B: research facilities operated by non-claimant Parties
681 that operate more than one year-round station (India, Korea, China, US, and Russia).

682

683 Figure 3. Map of Antarctica showing the distribution of protected areas designated currently
684 (72 ASPA, six ASMAs and the South Orkney and Ross Sea MPA) within the seven claimed
685 Antarctic territories. ASPAs are colour coded with different colours for each claimant
686 proponent Party (see legend). ASPAs with more than one proponent Party are indicated in
687 'dark blue'. ASPAs proposed by non-claimant Parties are indicated in 'grey'.

688

689 Figure 4. Percentage of ASPAs designated during each time period at different distances
690 from their proponent Party's nearest research station

691

692 Figure 5. Mean distance between the ASPA for which the Party is the sole proponent and
693 that Party's nearest research station (± SE). Claimant Parties are shown in black (and
694 denoted with an asterisk) and non-claimant Parties in white. For ASPAs with two or more
695 proponents (shown in yellow) the distance was taken between the ASPA and the research
696 station of the nearest proponent Party.

697

Figure 6. Percentage of ASPA designated during each time period that were proposed by single claimant proponents, single non-claimant proponents, two proponents or multiple proponents. In 2014, one ASPAs was de-designated (ASPA 114), and two ASPAs were combined with a new area into a single ASPA (ASPA 175). In 2015, it was agreed that ASPA 148, originally designated in 1989 by a single proponent (UK), was to be managed jointly by two Parties (UK and Argentina; both claimant Parties).

Figure 7. Schematic showing the development of the Antarctic protected areas system over time, from designation of the first areas in 1966 to a target scenario for the future. Although a transition towards more multiple-proponent areas has been evident in recent years, there is still some way to go to achieve a fully collaborative protected areas system.

Table 1. Territorial claims within the Antarctic Treaty area

Treaty Party	Territory name	Boundaries	Claim date
United Kingdom*	British Antarctic Territory (Overseas Territory of the United Kingdom	20ºW to 80ºW; 60ºS	1908
New Zealand	Ross Dependency (Dependency of New Zealand)	150ºW to 160ºE; 60ºS	1923
France	Adélie Land (District of French Southern and Antarctic Lands)	142º2'E to 136º11'E; 60ºS	1924
Norway	Peter I Island Dronning Maud Land (Dependency of Norway)	Peter I Island: 68°50′S 90°35′W Dronning Maud Land: 20ºW to 45ºE (latitudinal limits not defined)	Peter I Island: 1929 Dronning Maud Land: 1939
Australia	Australian Antarctic Territory (External Territory of Australia)	165ºE to 45ºE; 60ºS (excluding Adélie Land: 142º2'E to 136º11'E)	1933
Chile*	Chilean Antarctic Territory (Commune of Antártica Chilena Province)	53ºW to 90ºW; 60ºS	1940
Argentina*	Argentine Antarctica (Argentine Antarctic Sector)	25ºW to 74ºW; 60ºS	1942
Unclaimed Sector	-	90ºW to 150ºW	-

* overlapping territorial claims

Table 2. Current and proposed Marine Protected Areas under CCAMLR.

Area	Status	Claimant proponent(s)	Non-claimant proponent(s)	Claimed sector (or sectors) in which MPA is located	Major contributors to MPA-relevant research and planning[a]
South Orkney Islands Southern Shelf	Designated (2009)	(UK & France, as part of EU)	European Union	Argentina, Chile, UK	Argentina, Norway, UK, US
Ross Sea	Designated (2016)	New Zealand	United States	New Zealand	Italy, NZ, US
East Antarctica	Proposed	Australia, France (& UK as part of EU)	European Union	Australia, France	Australia, France
Weddell Sea	Proposed	(UK & France, as part of EU)	European Union	Argentina, Chile, UK, Norway	Argentina, Belgium, Chile, Germany, Japan, Norway, Russia, South Africa, UK
Western Antarctic Peninsula	Proposal in development	Argentina, Chile, UK	(may include others, to be determined)	Argentina, Chile, UK	Argentina, Chile, Germany, Norway, UK, US

[a] This is not an exhaustive list of nations who undertake research in these regions or who have contributed to discussions on development of the relevant MPA, however it represents those who have contributed data and expertise to recent MPA planning workshops.

Table S1. Research stations within claimed Antarctic territories

	Territory claimant							
	Argentina[1]	Chile[1]	United Kingdom[1]	Australia	France	New Zealand	Norway	Total
Non-claimant Parties with more than one station occupied year-round								
United States[2]	x	x	x	x	x	x	x	7
Russian Federation	x	x	x	x			x	5
China	x	x	x	x		(x)[3]		4 (5[3])
Korea	x	x	x			x		4
India				x			x	2
Claimant Parties								
Argentina	x	x	x					3[1]
Chile	x	x	x					3[1]
United Kingdom	x	x	x					3[1]
Australia				x				1
France[4]					x			1[4]

New Zealand	x		1
Norway		x	1

[1] The claimed territories overlap, meaning the position of a station in one territory may also be with one or both of the other two claimed territories.

[2] The Amundsen-Scott South Pole Station, by virtue of its location, lies within the territories of all the claimant Parties.

[3] China has submitted a Comprehensive Environmental Evaluation for construction of a research station within the Ross Dependency (Dependency of New Zealand) to the Antarctic Treaty Consultative Meeting, but construction work has not commenced.

[4] As well as the French station within Adélie Land (District of French Southern and Antarctic Lands), France operates the Concordia Station in collaboration with Italy. Concordia is situated on the ice sheet within Australian Antarctic Territory and represent the only stations operated by a claimant nation outside the claimed territory.

Table S2. Antarctic Specially Protected Areas within the claimed territories of the Antarctic Treaty area[a]

Proponent/managing Party	No. of ASPAs for which the Party is the proponent[b]	Percentage of ASPAs, for which the Party is the proponent, that lie within the claimed territory of that Party	ASPAs for which the Party is the proponent
Claimant Parties			
Australia	10	100%	101, 102, 103, 135, 136, 143, 160, 162, 164, 167
Argentina[c]	2	100%	132, 134
Chile[c]	6	100%	112, 125, 144, 145, 146, 150
France	2	100%	120, 166
New Zealand	10	100%	104, 105, 116, 131, 154, 155, 156, 157, 158, 159
Norway	1	100%	142
United Kingdom[c]	12	100%	107, 108, 109, 110, 111, 115, 117, 129, 140, 147, 170
Non-claimant Parties			
United States	14	-	106, 113, 119, 121, 122, 123, 124, 137, 138, 139, 149, 152, 153, 172
Russian Federation	1	-	127
China	1	-	168
Italy	2	-	161, 165
India	1	-	163
Japan	1	-	141
Korea	1	-	171
Poland	2	-	128, 151
Multiple Parties			
United Kingdom & Chile	1	100% [d]	126
Argentina & Chile	1	100% [d]	133
United Kingdom & Argentina	1	100% [d]	148
Australia & China	1	100% [e]	169

United States & Italy	1	-	173
Australia, China, India & Russian Federation	1	100% [e]	174
United States & New Zealand	1	100% [f]	175

[a] No ASPAs have been designated within the unclaimed sector of Antarctica
[b] Number of ASPAs for which the Party is the sole proponent are shown for *Claimant Parties* and *Non-claimant Parties*
[c] Parties with overlapping territorial claims
[d] ASPA lies within the claimed territory of both proponent/managing Parties
[e] ASPA lies within the claimed territory of Australia
[f] ASPA lies within the claimed territory of New Zealand

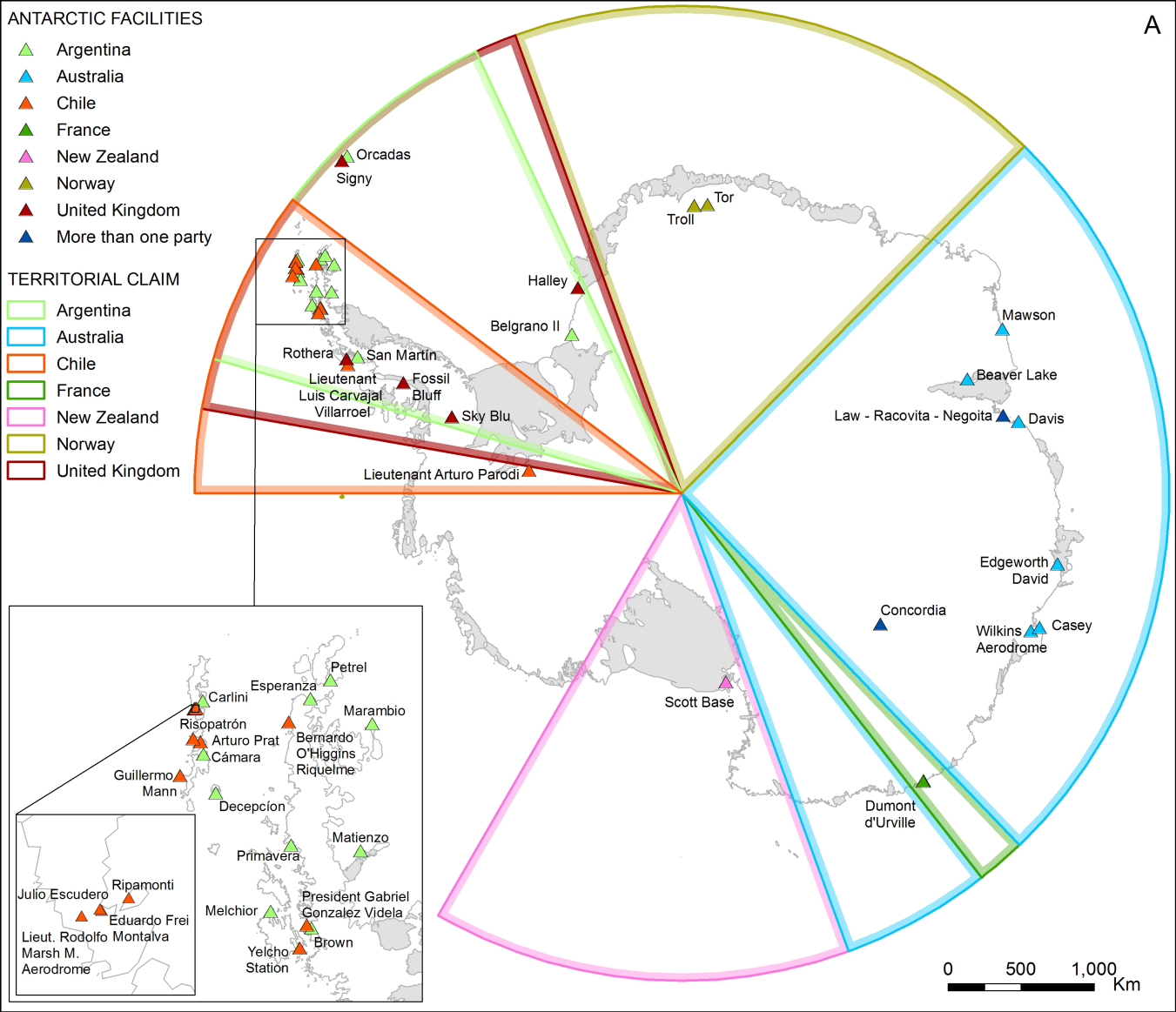
Table S3. Antarctic Specially Managed Areas

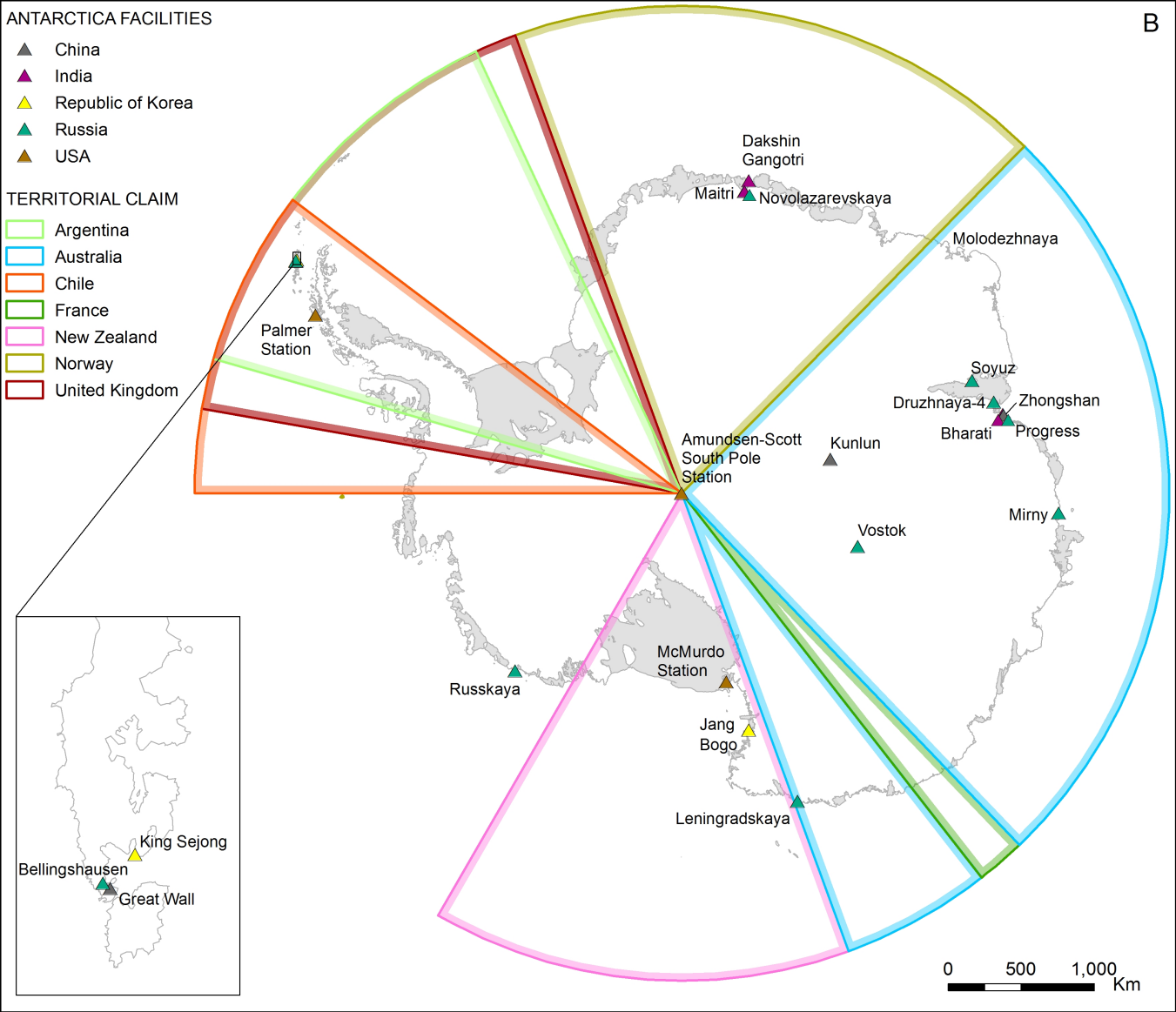
ASMA number and name[a]	Date established	Proponents	No. of proponents which are claimant states	ASMA within claimed territory?
ASMA 1 Admiralty Bay, King George Island	2006	Brazil, Poland, Ecuador, Peru and USA	0	-
ASMA 2 McMurdo Dry Valleys, Southern Victoria Land	2004	New Zealand and USA	1 (New Zealand)	Yes
ASMA 4 Deception Island	2005	Argentina, Chile, Norway, Spain, UK and USA	4 (Argentina, Chile, Norway and UK)	ASMA within claimed territories of Argentina, Chile and the UK. The ASMA is outside the area claimed by Norway[b].
ASMA 5 Amundsen-Scott South Pole Station, South Pole	2007	USA and Norway	1 (Norway)	Yes
ASMA 6 Larsemann Hills, East Antarctica	2007	Australia, China, India, Romania and Russian Federation	1 (Australia)	Yes
ASMA 7 Southwest Anvers Island and Palmer Basin	2008	USA	0	-

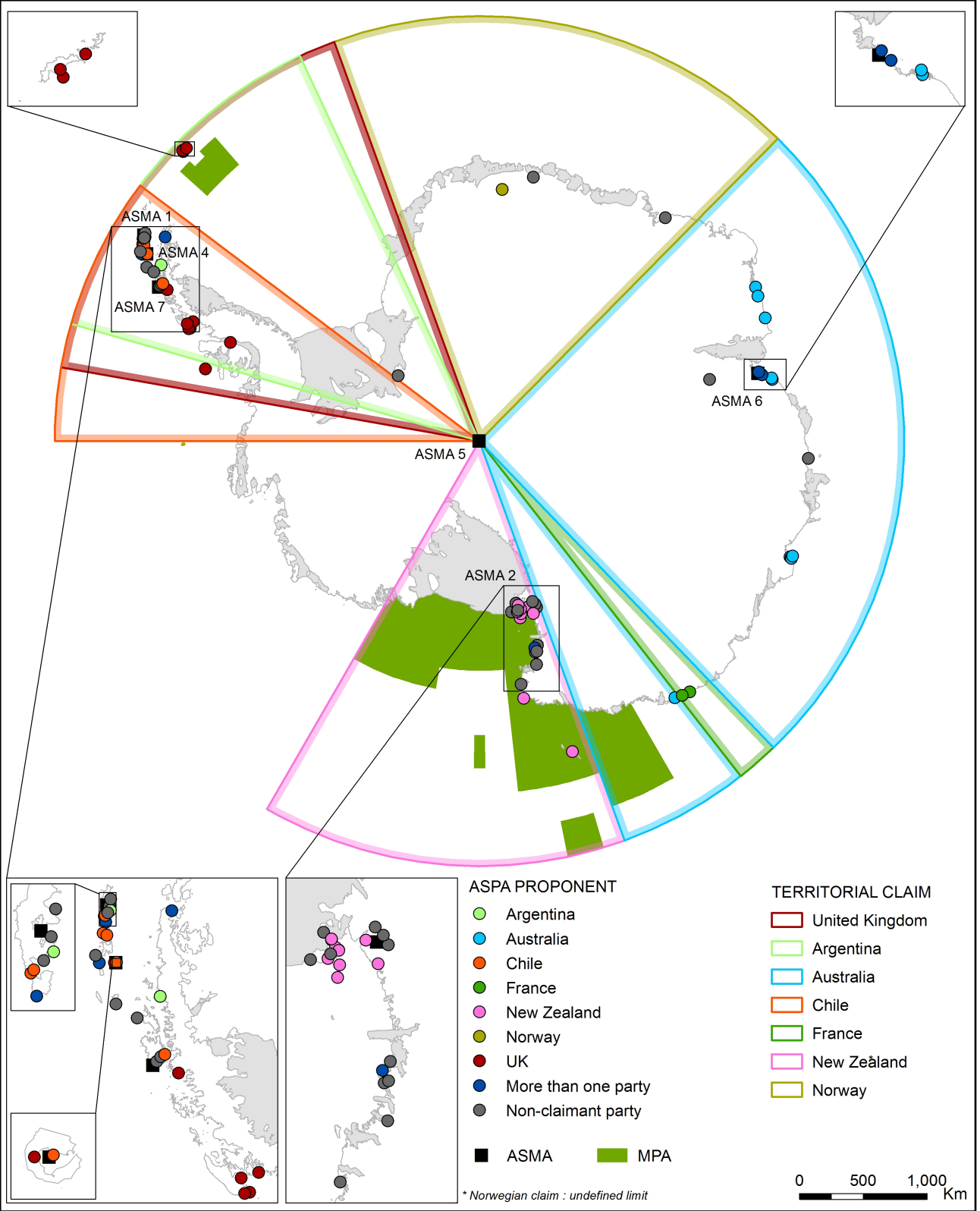
[a] ASMA 3 Cape Denison, Commonwealth Bay, George V Land, East Antarctica (Australia sole proponent) was revoked in 2014

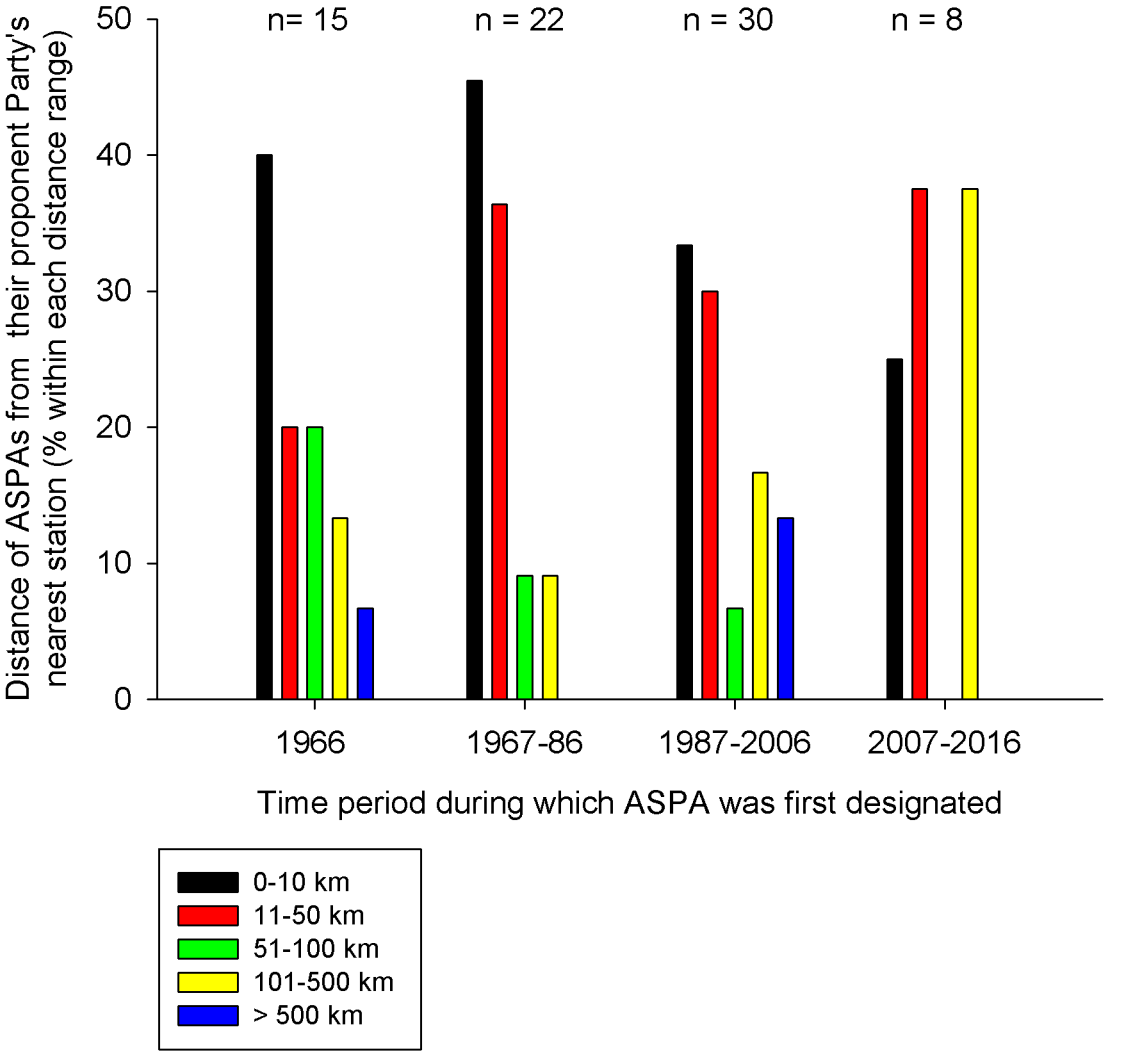
[b] Norway's participation in ASMA 4 management is at least in part due to the presence of the historic Norwegian whaling station on the island at Whalers Bay.

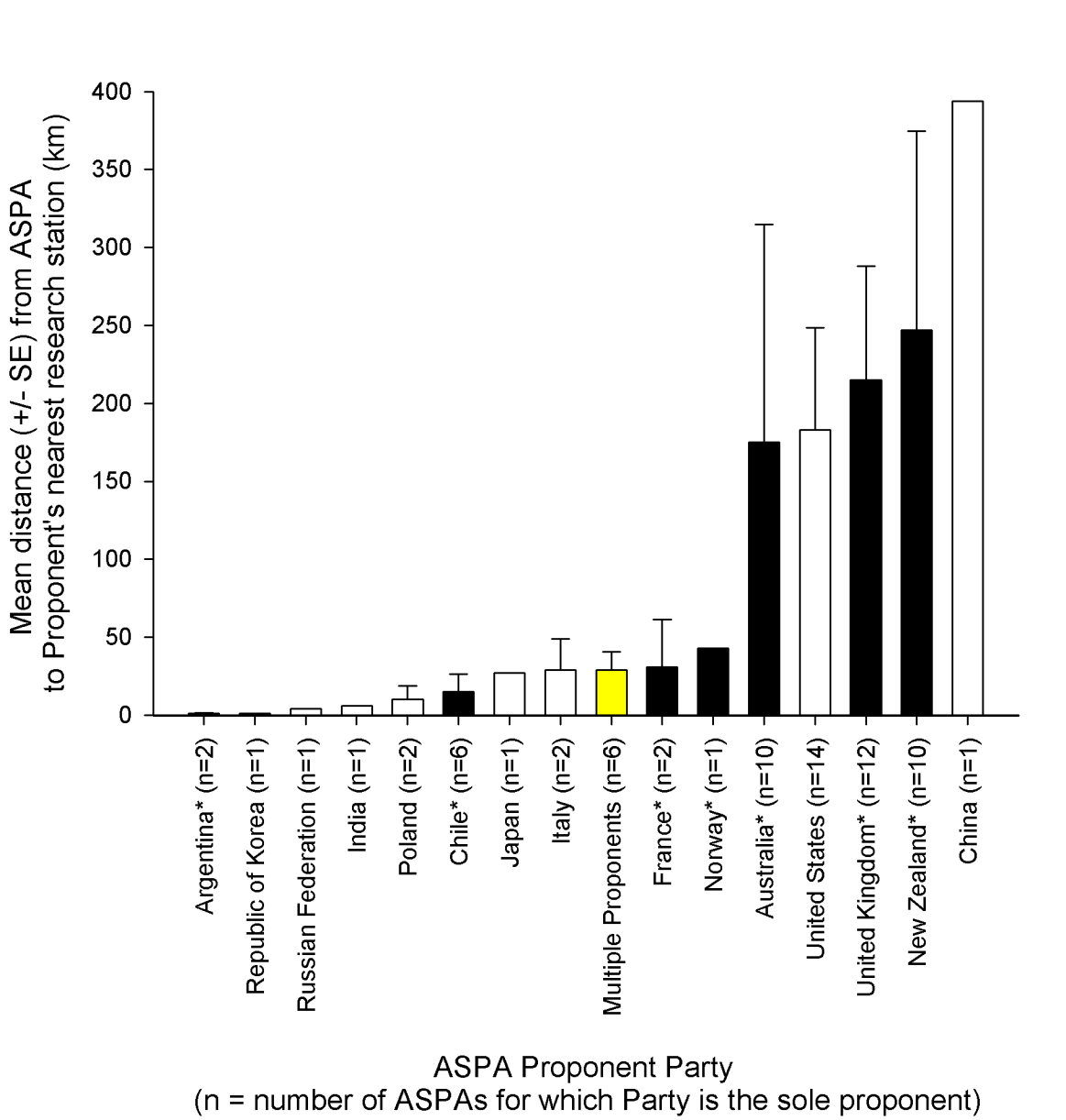
Year
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Number of ASPAs for which the Party is a proponent
0
2
4
6
8
10
12
14
16
Total number of designated ASPAs
10
20
30
40
50
60
70
80
United States
United Kingdom
Australia
New Zealand
Chile
Argentina
Italy
China
Poland
France
Russia
India
Japan
Norway
Rep. of Korea
Treaty Party

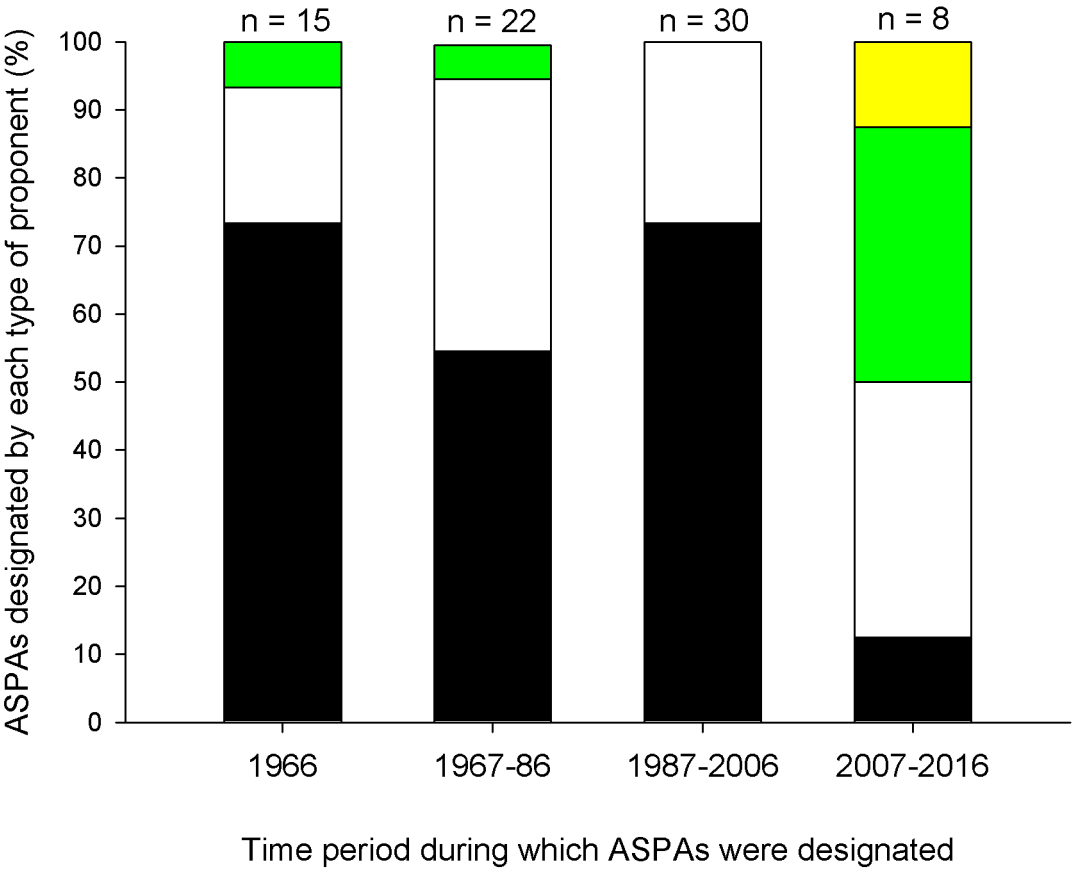

ANTARCTIC FACILITIES
Argentina
Australia
Chile
France
New Zealand
Norway
United Kingdom
More than one party
TERRITORIAL CLAIM
Argentina
Australia
Chile
France
New Zealand
Norway
United Kingdom
A
Orcadas
Signy
Halley
Belgrano II
Rothera
San Martin
Lieutenant Luis Carvajal Villarroel
Fossil Bluff
Sky Blu
Lieutenant Arturo Parodi
Tor
Troll
Mawson
Beaver Lake
Law - Racovita - Negoita
Davis
Edgeworth David
Concordia
Wilkins Aerodrome
Casey
Scott Base
Dumont d'Urville
Petrel
Esperanza
Carlini
Marambio
Risopatrón
Arturo Prat
Bernardo O'Higgins
Cámara
Riquelme
Guillermo Mann
Decepción
Matienzo
Primavera
Julio Escudero
Ripamonti
Eduardo Frei
Lieut. Rodolfo Marsh M. Montalva Aerodrome
Melchior
President Gabriel Gonzalez Videla
Brown
Yelcho Station
0
500
1,000
Km

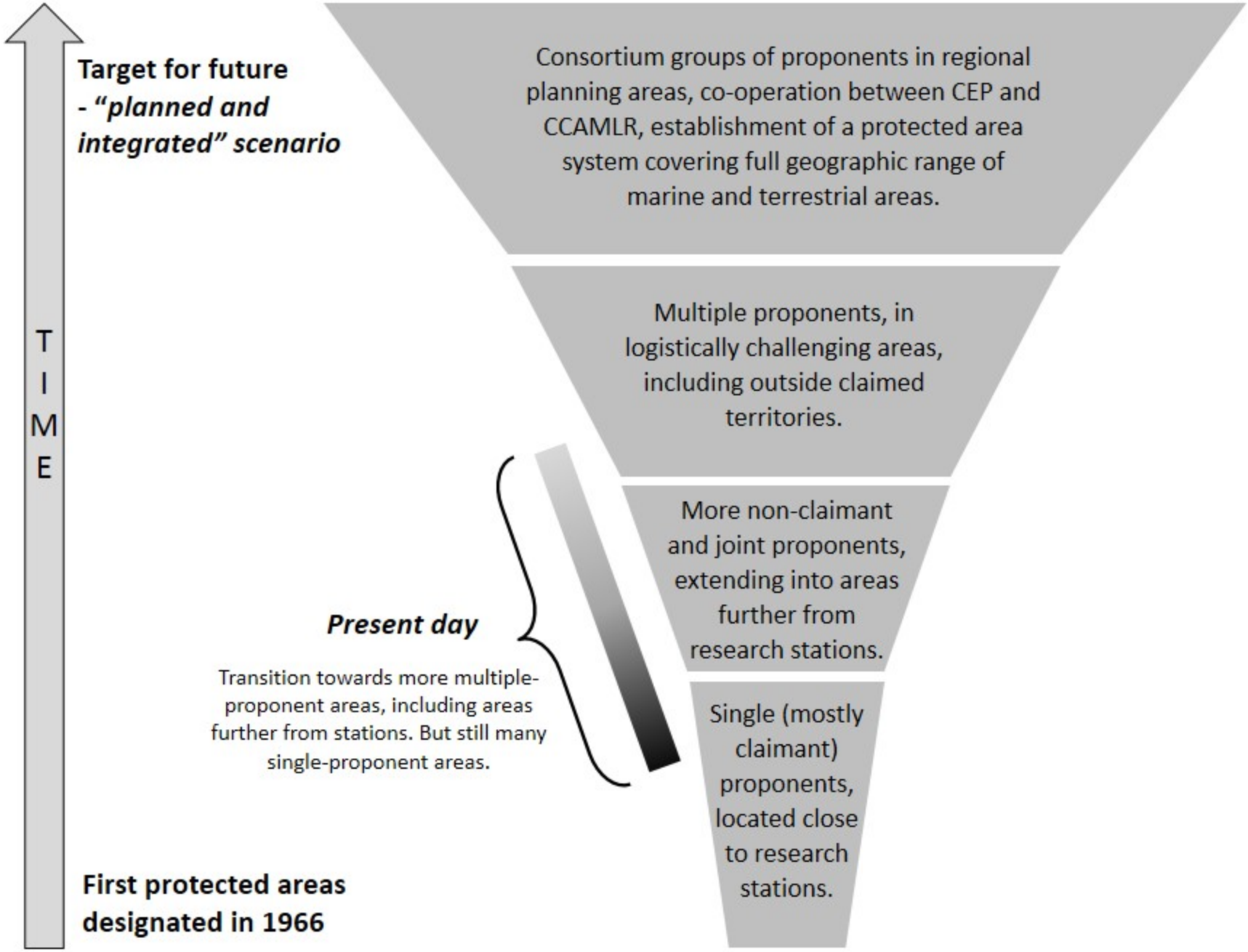

ANTARCTICA FACILITIES
China
India
Republic of Korea
Russia
USA
TERRITORIAL CLAIM
Argentina
Australia
Chile
France
New Zealand
Norway
United Kingdom
B
Dakshin Gangotri
Maitri
Novolazarevskaya
Molodezhnaya
Palmer Station
Soyuz
Druzhnaya-4
Zhongshan
Bharati
Progress
Amundsen-Scott South Pole Station
Kunlun
Mirny
Vostok
McMurdo Station
Russkaya
Jang Bogo
Leningradskaya
King Sejong
Bellingshausen
Great Wall
0
500
1,000
Km


ASMA 1
ASMA 4
ASMA 7
ASMA 5
ASMA 6
ASMA 2
ASPA PROPONENT
Argentina
Australia
Chile
France
New Zealand
Norway
UK
More than one party
Non-claimant party
ASMA
MPA
TERRITORIAL CLAIM
United Kingdom
Argentina
Australia
Chile
France
New Zealand
Norway
* Norwegian claim : undefined limit
0
500
1,000
Km


n= 15
n = 22
n = 30
n = 8
50
40
30
20
10
0
Distance of ASPAs from their proponent Party's nearest station (% within each distance range)
1966
1967-86
1987-2006
2007-2016
Time period during which ASPA was first designated
0-10 km
11-50 km
51-100 km
101-500 km
> 500 km


Mean distance (+/- SE) from ASPA
to Proponent's nearest research station (km)
400
350
300
250
200
150
100
50
0
Argentina* (n=2)
Republic of Korea (n=1)
Russian Federation (n=1)
India (n=1)
Poland (n=2)
Chile* (n=6)
Japan (n=1)
Italy (n=2)
Multiple Proponents (n=6)
France* (n=2)
Norway* (n=1)
Australia* (n=10)
United States (n=14)
United Kingdom* (n=12)
New Zealand* (n=10)
China (n=1)
ASPA Proponent Party
(n = number of ASPAs for which Party is the sole proponent)


n = 15
n = 22
n = 30
n = 8
ASPAs designated by each type of proponent (%)
100
90
80
70
60
50
40
30
20
10
0
1966
1967-86
1987-2006
2007-2016
Time period during which ASPAs were designated
single claimant proponent
single non-claimant proponent
two proponents
multiple proponents


TIME
Target for future
- "planned and integrated" scenario
Consortium groups of proponents in regional planning areas, co-operation between CEP and CCAMLR, establishment of a protected area system covering full geographic range of marine and terrestrial areas.
Multiple proponents, in logistically challenging areas, including outside claimed territories.
More non-claimant and joint proponents, extending into areas further from research stations.
Single (mostly claimant) proponents, located close to research stations.
Present day
Transition towards more multiple-proponent areas, including areas further from stations. But still many single-proponent areas.
First protected areas designated in 1966