Management Plan

for Antarctic Specially Protected Area No. 126 BYERS PENINSULA, LIVINGSTON ISLAND, SOUTH SHETLAND ISLANDS

Introduction

The primary reason for the designation of Byers Peninsula (latitude 62°34′35″ S, longitude 61°13′07″ W), Livingston Island, South Shetland Islands, as an Antarctic Specially Protected Area (ASPA) is to protect the terrestrial and lacustrine habitats within the Area.

Byers Peninsula was originally designated as Specially Protected Area (SPA) No. 10 through Recommendation IV-10 in 1966. This area included the ice-free ground west of the western margin of the permanent ice sheet on Livingston Island, below Rotch Dome, as well as Window Island about 500 m off the northwest coast and five small ice-free areas on the south coast immediately to the east of Byers Peninsula. Values protected under the original designation included the diversity of plant and animal life, many invertebrates, a substantial population of southern elephant seals (*Mirounga leonina*), small colonies of Antarctic fur seals (*Arctocephalus gazella*), and the outstanding scientific values associated with such a large variety of plants and animals within a relatively small area.

Designation as an SPA was terminated through Recommendation VIII-2 and redesignation as a Site of Special Scientific Interest (SSSI) was made through Recommendation VIII-4 (1975, SSSI No. 6). The new designation as an SSSI more specifically sought to protect four smaller ice-free sites on the peninsula of Jurassic and Cretaceous sedimentary and fossiliferous strata, considered of outstanding scientific value for study of the former link between Antarctica and other southern continents. Following a proposal by Chile and the United Kingdom, the SSSI was subsequently extended through Recommendation XVI-5 (1991) to include boundaries similar to those of the original SPA: i.e., the entire ice-free ground of Byers Peninsula west of the margin of the permanent Livingston Island ice sheet, including the littoral zone, but excluding Window Island and the five southern coastal sites originally included, as well as excluding all offshore islets and rocks. Recommendation XVI-5 noted that in addition to the special geological value, the Area was also of considerable biological and archaeological importance.

While the particular status of designation and boundaries have changed from time to time, Byers Peninsula has in effect been under special protection for most of the modern era of scientific activity in the region. Recent activities within the Area have been almost exclusively for scientific research (Benayas et al. (2013) provide a review of all science conducted in the area that was published between 1957 and 2012). Most visits and sampling within the Area, since original designation in 1966, have been subject to Permit conditions, and some areas (e.g., Ray Promontory) have been rarely visited. During the International Polar Year, Byers Peninsula was established as an 'International Antarctic Reference Site for Terrestrial, Freshwater and Coastal Ecosystems' (Quesada et al., 2009, 2013). During this period baseline data relating to terrestrial, limnetic and coastal ecosystems were established, including permafrost characteristics, geomorphology, vegetation extent, limnetic diversity and functioning, marine mammal and bird diversity, microbiology, and coastal marine invertebrate diversity (López-Bueno et al., 2009; Moura et al., 2012; Barbosa et al., 2013; De Pablos et al., 2013; Emslie et al., 2013; Gil-Delgado et al., 2013; Kopalova and van de Vijvier, 2013; Lyons et al., 2013; Nakai et al., 2013; Pla-Rabes et al., 2013; Rico et al., 2013; Rochera et al., 2013a; Rochera et al., 2013b; Toro et al., 2013; Velazquez et al., 2013; Velazquez et al., 2016; Vera et al., 2013; Villaescusa et al., 2013). The archaeological values of Byers Peninsula have been described as unique in possessing the greatest concentration of historical sites in Antarctica, namely the remains of refuges, together with contemporary artefacts and shipwrecks of early nineteenth century sealing expeditions (see Map 2).

Byers Peninsula makes a substantial contribution to the Antarctic protected areas system as it (a) contains a particularly wide diversity of species, (b) is distinct from other areas due to its numerous and diverse lakes, freshwater ponds and streams, (c) is of great ecological importance and represents the most significant limnological site in the region, (d) contains one of the highest concentrations of historical remains associated with 19th Century sealers' activities in Antarctica, (e) is vulnerable to human interference, in particular, due to the oligotrophic nature of the lakes which are highly sensitive to pollution and (f) is of great scientific interest across a range of disciplines. While some of these quality criteria are represented in other ASPAs in the region, Byers Peninsula is unique in possessing a high number of different criteria within one area. While Byers Peninsula is protected primarily for its outstanding environmental values (specifically its biological diversity and terrestrial and lake ecosystems) the Area contains a combination of other values including scientific (i.e. for terrestrial biology, limnology, ornithology, palaeolimnology, geomorphology and geology), historic (artefacts and refuge remains of early sealers), wilderness (e.g. Ray Promontory) and on-going scientific values that may benefit from the Area's protection.

The ice-free ground of Byers Peninsula is surrounded on three sides by ocean and the Rotch Dome glacier to the east. The Area has been designated to protect values found within the ice-free ground on Byers Peninsula. To fulfil this objective a portion of Rotch Dome has been included within the ASPA to ensure newly exposed ice-free ground, (resulting from any retreat of Rotch Dome), will be within the boundaries of the ASPA. In addition, the northwestern Rotch Dome including adjacent de-glaciated ground and Ray Promontory have been designated as restricted zones to allow microbiological studies that required higher quarantine standards than considered necessary within the rest of the Area. The Area (84.7 km2) is considered to be of sufficient size to provide adequate protection of the values described below.

Resolution 3 (2008) recommended that the "Environmental Domains Analysis for the Antarctic Continent", be used as a dynamic model for the identification of Antarctic Specially Protected Areas within the systematic environmental-geographical framework referred to in Article 3(2) of Annex V of the Protocol. Using this model, Byers Peninsula is predominantly Environment Domain G (Antarctic Peninsula off-shore islands geologic). The scarcity of Environment G, relative to the other environmental domain areas, means that substantial efforts have been made to conserve the values found within this environment type elsewhere: other protected areas containing Domain G include ASPAs 109, 111, 112, 114, 125, 128, 140, 145, 149, 150, and 152 and ASMAs 1 and 4. The permanent ice of Rotch Dome comes under Environment Domain E. Other protected areas containing Domain E include ASPAs 113, 114, 117, 126, 128, 129, 133, 134, 139, 147, 149, 152 and ASMAs 1 and 4. Resolution 3 (2017) recommended that the Antarctic Conservation Biogeographic Regions (ACBRs) be used for the 'identification of areas that could be designated as Antarctic Specially Protected Areas within the systematic environmental-geographic framework referred to in paragraph 2 of Article 3 of Annex V to the Environmental Protocol'. ASPA 126 sits within Antarctic Conservation Biogeographic Region (ACBR) 3 Northwest Antarctic Peninsula. In Resolution 5 (2015) the ATCM recognised the significance of the Important Bird Areas (IBAs) of Antarctica. The boundary of ASPA 126 also marks the extent of Important Bird Area ANT054 Byers Peninsula, Livingston Island. The IBA qualifies on the basis of the Antarctic tern (*Sterna vittate*) and kelp gull (*Larus dominicanus*) colonies although may other bird species, including southern giant petrels (*Macronectes giganteus*) are present.

1. Description of values to be protected

The Management Plan attached to Measure 1 (2002) noted values considered important as reasons for special protection of the Area. The values recorded in the original Management Plans are reaffirmed. These values are set out as follows:

- With over 60 lakes, numerous freshwater pools and a great variety of often extensive streams, it is the most significant limnological site in the South Shetland Islands – and perhaps the Antarctica Peninsula region – and also one which has not been subjected to significant levels of human disturbance.
- The described terrestrial flora and fauna is of exceptional diversity, with one of the broadest representations of species known in the maritime Antarctic. For example, sparse but diverse flora of calcicolous and calcifuge plants and cyanobacteria are associated with the lavas and basalts, respectively, and several rare cryptogams and the two native vascular plants (*Deschampsia antarctica* and *Colobanthus quitensis*) occur at several sites. The abundance of vegetation is also exceptional with c. 8.1 km^2 of green vegetation contained within the Area, representing over half of the green vegetation protected with all terrestrial ASPAs.
- *Parochlus steinenii* (the only native winged insect in Antarctica) is of limited distribution in the South Shetland Islands. The only other native dipteral, the wingless midge *Belgica antarctica*, has a widespread but sporadic distribution on the Antarctic Peninsula. Both species are abundant at several of the lakes, streams and pools on Byers Peninsula.
- Unusually extensive cyanobacterial mats dominated by *Leptolyngbya* spp., *Phormidium* spp., and other species, particularly on the upper levels of the central Byers Peninsula plateau, are the best examples so far described in the maritime Antarctic.
- The breeding avifauna within the Area is diverse, including two species of penguin [chinstrap (*Pygoscelis antarctica*) and gentoo (*P. papua*)], Antarctic tern (*Sterna vittate*), Wilson's storm petrels (*Oceanites oceanicus*), cape petrels (*Daption capense*), kelp gulls (*Larus dominicanus*), southern giant petrels (*Macronectes giganteus*), black-bellied storm petrels (*Fregetta tropica*), blue eyed cormorants (*Phalacrocorax atriceps*), brown skuas (*Catharacta loennbergi*), and sheathbills (*Chionis alba*).
- The lakes and their sediments constitute one of the most important archives for study of the Holocene palaeoenvironment in the Antarctic Peninsula region, as well as for establishing a regional Holocene tephrachronology.
- Well-preserved sub-fossil whale bones are present in raised beaches, which are important for radiocarbon and other heavy isotope dating of beach deposits.
- The ice-free sites on the peninsula with exposed Jurassic and Cretaceous sedimentary and fossiliferous strata, are considered of outstanding scientific value for study of the former link between Antarctica and other southern continents.

- The area contains one of the highest concentrations of historic sites and artifacts associated with the activities of sealers in the early 19th Century, and is of outstanding value with regard to our knowledge of the earliest activities of humans in Antarctica.
- The area has remained largely unaffected by human disturbance, compared to other extensive ice-free areas in the local vicinity, and is thought to be free of non-native plants.

2. Aims and objectives

Management at Byers Peninsula aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance;
- allow scientific research on the terrestrial and lacustrine ecosystems, marine mammals, avifauna, coastal ecosystems and geology;
- allow other scientific research within the Area provided it is for compelling reasons which cannot be served elsewhere;
- allow archaeological research and measures for artefact protection, while protecting historic artefacts present within the Area from unnecessary destruction, disturbance, or removal;
- prevent or minimise the introduction to the Area of non-native plants, animals and microbes;
- minimise the possibility of the introduction of pathogens which may cause disease in fauna within the Area; and
- allow visits for management purposes in support of the aims of the management plan.

3. Management activities

The following management activities shall be undertaken to protect the values of the Area:

- A map showing the location of the Area and stating the special restrictions that apply, shall be displayed prominently at Base Juan Carlos I (Spain) and St. Kliment Ohridski Station (Bulgaria) on Hurd Peninsula, where copies of this management plan shall be made available.
- Markers, signs, fences or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition.
- Visits shall be made as necessary to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.

Byers Peninsula has been described as extremely sensitive to trampling impact (Tejedo et al., 2009; Pertierra et al., 2013a). The Area was designated as an ASPA to protect a diverse range of values present within the Area. As a result, it attracts scientists (representing a diverse range of disciplines) and archaeologists from a number of Treaty nations. The high number of people present in the Area at peak times (mid-summer) means there is potential for the environmental values of the area to be negatively impacted upon by human activities, for example by potentially increasing (i) the size and number of camping location, (ii) the trampling of vegetation, (iii) the disturbance of native wildlife (iv) the generation of waste and (v) the need for fuel storage. **Consequently, when making plans for field work within the Area, Parties are strongly encouraged to liaise with other nations likely to be operating in the Area that season and co-ordinate activities to keep environmental impacts, including cumulative impacts, to an absolute minimum** (e.g., fewer than c. 12 people in the International Field Camp at any one time).

All Parties are strongly encouraged to use the established International Field Camp (located on South Beaches, 62°39′49.7′′ S, 61°05′59.8′ W), to reduce the creation of new camping sites that would increase levels of human impacts within the Area. Two melon huts are found within the camp (one set up for scientific research, the other for domestic activities; both huts are managed by Spain). The melon huts are available to all Treaty Parties, should they wish to use them. Parties should liaise with Spain to co-ordinate access to the melon huts. Pertierra et al. (2013b) provides information concerning the challenges and environmental impacts resulting from the running of the camp.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

Map 1: Byers Peninsula ASPA No. 126 in relation to the South Shetland Islands, showing the location of Base Juan Carlos I (Spain) and St. Kliment Ohridski Station (Bulgaria), and showing the location of protected areas within 75 km of the Area. Inset: the location of Livingston Island along the Antarctica Peninsula.

Map 2: Byers Peninsula ASPA No. 126 topographic map. Map specifications: Projection UTM Zone 20S; Spheroid: WGS 1984; Datum: Mean Sea Level. Horizontal accuracy of control: ±0.05 m. Vertical contour interval 50 m.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

BOUNDARIES

The Area encompasses:

- Byers Peninsula and all ice-free ground and ice sheet west of longitude 60o53′45′′ W, including Clark Nunatak and Rowe Point;
- the near-shore marine environment extending 10 m offshore from the low tide water line; and
- Demon Island and Sprite Island, adjacent to the southern shoreline of Devils Point, but excluding all other offshore islets, including Rugged Island, and rocks (Map 2).

The linear eastern boundary follows longitude 60°53′45′′ W to ensure newly exposed ice-free ground resulting from the retreat of Rotch Dome, which may contain scientifically useful opportunities and new habitats for colonization studies, will be within the boundaries of the ASPA.

No boundary markers are in place.

GENERAL DESCRIPTION

Byers Peninsula (between latitudes 62°34′35″ and 62°40′35″ S and longitudes 60o53′45′′ and 61°13′07″ W, 84.7 km^2) is situated at the west end of Livingston Island, the second-largest of the South Shetland Islands (Map 1). The ice-free area on the peninsula has a central west-east extent of about 9 km and a NW-SE extent of 18.2 km, and is the largest ice-free area in the South Shetland Islands. The peninsula is generally of low, gently rolling relief, although there are a number of prominent hills ranging in altitude between 80 – 265 m (Map 2). The interior is dominated by a series of extensive platforms at altitudes of up to 105 m, interrupted by isolated volcanic plugs such as Chester Cone (188 m) and Negro Hill (143 m) (Thomson and López-Martínez 1996). There is an abundance of rounded, flat landforms resulting from marine, glacial and periglacial erosional processes. The most rugged terrain occurs on Ray Promontory, a ridge forming the northwest-trending axis of the roughly ‘Y’-shaped peninsula. Precipitous cliffs surround the coastline at the northern end of Ray Promontory with Start Hill (265 m) at the NW extremity being the highest point on the peninsula.

The coast of Byers Peninsula has a total length of 71 km (Map 2). Although of generally low relief, the coast is irregular and often rugged, with numerous headlands, cliffs, offshore islets, rocks and shoals. Byers Peninsula is also notable for its broad beaches, prominent features on all three coasts (Robbery Beaches in the north, President Beaches in the west, and South Beaches). The South Beaches are the most extensive; extending 12 km along the coast and up to almost 0.9 km in width, these are the largest in the South Shetland Islands (Thomson and López-Martínez 1996). For a detailed description of the geology and biology of the Area see Annex 1.

6(ii) Access to the Area

- Access shall be by helicopter or small boat.
- There are no special restrictions on boat landings from the sea, or that apply to the sea routes used to move to and from the Area. Due to the large extent of accessible beach around the Area, landing is possible at many locations. Nevertheless, if possible, landing of cargo and scientific equipment should be close to the International Field Camp located at Southern Beaches (62°39′49.7′′ S, 61°05′59.8′ W; see 6(*iii*) for further details). Personnel operating vessels to deliver cargo and/or personnel to the ASPA must not leave the landing area unless in accordance with a permit issued by an appropriate national authority.
- A designated helicopter landing site is located at 62°39′36.4′′ S, 61°05′48.5′ W, to the east of the International Field Camp.
- Under exceptional circumstances necessary for purposes consistent with the objectives of the Management Plan, helicopters may land elsewhere within the Area, although landings should, where practicable, be made on ridge and raised beach crests.
- No helicopter lands shall be made within the restricted zones [see section 6(*v*)].
- Helicopters should avoid sites where there are concentrations of birds (e.g., Devils Point, Lair Point and Robbery Beaches) or well-developed vegetation (e.g., large stands of mosses near President and South Beaches).
- To avoid disturbance of wildlife, aircraft should avoid landing within an over-flight restriction zone extending ¼ nautical mile (c. 460 m) inland from the coast during the period 1 October – 30 April inclusive (see Map 2). The only exception to this is the designated helicopter landing site at 62°39′36.4′′ S, 61°05′48.5′W.
- Within the over-flight restriction zone the operation of aircraft should be carried out, as a minimum requirement, in compliance with the ‘Guidelines for the Operation of Aircraft near Concentrations of Birds’ contained in Resolution 2 (2004). In particular, aircraft should maintain a vertical height of 2000 ft (~ 610 m) AGL and cross the coastline at right angles where possible. When conditions require aircraft to fly at lower elevations than recommended in the guidelines, aircraft should maintain the maximum elevation possible and minimise the time taken to transit the coastal zone.
- Use of helicopter smoke grenades is prohibited within the Area unless absolutely necessary for safety. If used all smoke grenades should be retrieved.

6(iii) Location of structures within and adjacent to the Area

An International Field Camp is located at South Beaches, at 62°39′49.7″ S, 61°05′59.8′ W. It is comprised of two fibreglass 'melon huts'. It is maintained by Spain and is available for use by all Parties. Parties aiming to use the melon huts should communicate their intentions to the Spanish Polar Committee well in advance. The locations of 19th Century sealers remains, including refuges and caves used for shelter are given in Smith and Simpson (1987) (see Map 2). Several cairns marking sites used for topographical survey are also present within the Area, predominantly on high points.

The nearest scientific research stations are 30 km east at Hurd Peninsula, Livingston Island [Base Juan Carlos I (Spain) and St Kliment Ohridski (Bulgaria)].

6(iv) Location of other protected areas within close proximity of the Area

The nearest protected areas to Byers Peninsula are: Cape Shirreff (ASPA No. 149) which lies about 20 km to the northeast, Deception Island (ASMA No. 4), Port Foster and other parts of Deception Island (ASPAs No. 140, 145) which are approximately 40 km SSE, and 'Chile Bay' (Discovery Bay) (ASPA No. 144), which is about 70 km to the east at Greenwich Island (Map 1).

6(v) Restricted and managed zones within the Area

Some zones on Byers Peninsula are thought to have been visited only very rarely, or never. New metagenomic techniques are predicted to allow future identification of microbial biodiversity (bacteria, fungi and viruses) to an unprecedented level, allowing many fundamental questions regarding microbial dispersal and distribution to be answered. Restricted zones have been designated that are of scientific importance to Antarctic microbiology and greater restriction is placed on access with the aim of preventing microbial or other contamination by human activity:

- In keeping with this aim, within the restricted zones sterile protective over-clothing shall be worn. The protective clothing shall be put on immediately prior to entering the restricted zones. Spare boots, previously cleaned using a biocide then sealed in plastic bags, shall be unwrapped and put on just before entering the restricted zones. If accessing the restricted zones by boat, protective clothing shall be put on immediately upon landing.
- To the greatest extent possible, all sampling equipment, scientific apparatus and markers brought into the restricted zones shall have been sterilized, and maintained in a sterile condition, before being used within the Area. Sterilization should be by an accepted method, including UV radiation, autoclaving or by surface sterilisation using 70% ethanol or a commercially available biocide (e.g. Virkon®).
- General equipment includes harnesses, crampons, climbing equipment, ice axes, walking poles, ski equipment, temporary route markers, pulks, sledges, camera and video equipment, rucksacks, sledge boxes and all other personal equipment. To the maximum extent practicable, all equipment used or brought into the restricted zones shall have been thoroughly cleaned and sterilized at the originating Antarctic station or ship. Equipment shall have been maintained in this condition before entering the restricted zones, preferably by sealing in sterile plastic bags or other clean containers.
- Scientists from disciplines other than microbiology are permitted to enter the restricted areas, but shall adhere to the quarantine measures detailed above.
- Camping within the restricted zones is not permitted.
- Helicopter landings within the restricted zones are not permitted.
- If access to the restricted zones is required for research or for emergency reasons, a detailed record of where visitation occurred (preferably using GPS technology) and the specific activities, should be submitted to the appropriate national authority and included in the Exchange of Information Annual Report, preferably through the Electronic Information Exchange System (EIES).

The restricted zones are:

1. North-western Rotch Dome and adjacent deglaciated ground. The restricted zone includes all land and ice sheet within an area bordered to the east by longitude 60°53′45″W, to the west by longitude 60o58′48″ W, to the south by latitude 62o38′30″S, and the northern boundary follows the coastline (see Map 2).
2. Ray Promontory. The restricted zone includes all land and permanent ice northwest of a straight line crossing the Promontory from 62°37′S, 61°08′W (marked by a small coastal lake) to 62°36′S, 61°06′W. Within the Ray Promontory restricted zone, access to archaeological remains located on the coast is permitted without the need for quarantine precautions required elsewhere within the restricted zone. Access to inland areas beyond the coastal archaeological remains is not permitted without quarantine measures, detailed in this section, in place. Preferably, access to the archaeological remains shall be from the sea using small boats. Access to the archaeological remains on foot is also permitted without the need for the additional quarantine measures, by following the coastline from the unrestricted area of the Byers Peninsula ASPA to the southeast. Access to the archaeological remains shall be solely for archaeological investigations, authorised by the appropriate national authority.

7. Terms and conditions for entry permits

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority.

7(i) General permit conditions

Conditions for issuing a Permit to enter the Area are that:

- it is issued only for scientific study of the ecosystem, geology, palaeontology or archaeology of the Area, or for compelling scientific reasons that cannot be served elsewhere; or
- it is issued for essential management purposes consistent with management plan objectives such as inspection, maintenance or review;
- the actions permitted will not jeopardise the ecological, geological, historical or scientific values of the Area;
- the sampling proposed will not take, remove or damage such quantities of soil, rock, native flora or fauna that their distribution or abundance on Byers Peninsula would be significantly affected;
- cumulative impacts of geological sampling are taken into consideration in any EIA, as substantial collections have been made at some palaeontological sites with significant negative impacts upon the Area's scientific values.
- any management activities are in support of the objectives of the management plan;
- the actions permitted are in accordance with the management plan;
- the Permit, or an authorised copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- permits shall be issued for a stated period; and
- the appropriate authority should be notified of any activities/measures undertaken that were not included in the authorised Permit.

7(ii) Access to and movement within or over the Area

- Land vehicles are prohibited within the Area.
- Movement within the Area shall be on foot unless under exceptional circumstances when helicopter may be used.
- All movement shall be undertaken carefully so as to minimise disturbance to archaeological remains, animals, soils, geomorphological features and vegetated surfaces, walking on rocky terrain or ridges if practical to avoid damage to sensitive plants, patterned ground and waterlogged soils.
- Pedestrian traffic should be kept to the minimum consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise trampling effects. Where possible, existing tracks should be used to transit the area (Map 2). If no track exists, care should be taken to avoid creation of new tracks. Research has shown that vegetation on Byers Peninsula can recover if fewer than 200 transits are made over it in a single season (Tejedo et al., 2009). Pedestrian routes over vegetated ground should therefore be chosen depending on the forecasted number of transits (i.e., number of people x transits per day x number of days). When the number of transits on the same track is expected to be less than 200 in the same season, the track should be clearly identified and transits always made along the track. When the number is expected to be larger than 200 in a season, then the route should not be fixed along a single track, but transits should be done across a wide belt (i.e. multiple tracks, each with fewer than 200 transits), to diffuse the impact and allow quicker recovery of trampled vegetation.
- Conditions for use of helicopters within the Area are described in section 6(*ii*)
- Overflight of bird colonies within the Area by Remotely Piloted Aircraft Systems (RPAS) shall not be permitted unless for compelling scientific or operational purposes, and in accordance with a permit issued by an appropriate national authority. Furthermore, operation of RPAS within or over the Area shall be in accordance with the 'Environmental guidelines for operation of Remotely Piloted Aircraft Systems (RPAS) in Antarctica' (Resolution 4 (2018)) (available at: *https://documents.ats.aq/recatt/att645_e.pdf*).
- Pilots, air and boat crew, or other people on aircraft or boats, are prohibited from moving on foot beyond the immediate vicinity of their landing site unless specifically authorised by Permit.
- Restrictions on access and movement within the restricted zones are described in section 6(*v*).

7(iii) Activities which may be conducted in the Area

- Compelling scientific research which cannot be undertaken elsewhere and that will not jeopardise the ecosystem or values of the Area or interfere with existing scientific studies.
- Archaeological research.
- Essential management activities, including monitoring.

7(iv) Installation, modification or removal of structures

No new structures are to be erected within the Area, or scientific equipment installed, except for compelling scientific or management reasons and for a pre-established period, as specified in a permit. Installation (including site selection), maintenance, modification or removal of structures and equipment shall be undertaken in a manner that minimises disturbance to the values of the Area. All structures or scientific equipment installed in the Area shall be clearly identified by country, name of the principal investigator and year of installation. All such items should be free of organisms, propagules (e.g., seeds, eggs) and non-sterile soil, and be made of materials that can withstand the environmental conditions and pose minimal risk of contamination of the Area. Removal of specific structures or equipment for which the Permit has expired shall be a condition of the Permit. Permanent structures or installations are prohibited.

7(v) Location of field camps

In order to minimise the area of ground within the ASPA impacted by camping activities, camps should be within the immediate vicinity of the International Field Camp (62°39'49.7'' S, 61°05'59.8'' W). When necessary for purposes specified in the Permit, temporary camping beyond the International Field Camp is allowed within the Area. Camps should be located on non-vegetated sites, such as on the drier parts of the raised beaches, or on thick (> 0.5 m) snow-cover when practicable, and should avoid concentrations of breeding birds or mammals. Camping within 50 m of any sealers' refuge or shelter is prohibited. Previously used campsites should be re-used where practical, unless the guidance above suggests that they were inappropriately located. Camping within the restricted zones is not permitted. Due to the high winds often experienced in the area, great care should be taken to ensure all camping and scientific equipment is adequately secured.

7(vi) Restrictions on materials and organisms which can be brought into the Area

The deliberate introduction of animals, plant material, microorganisms and non-sterile soil into the Area shall not be permitted. Precautions shall be taken to prevent the accidental introduction of animals, plant material, micro-organisms and non-sterile soil from other biologically distinct regions (within or beyond the Antarctic Treaty area). Visitors should also consult and follow, as appropriate, recommendations contained in the *CEP Non-native Species Manual* (Resolution 4 (2016)), and in the *Environmental code of conduct for terrestrial scientific field research in Antarctica* (Resolution 5 (2018)). In view of the presence of breeding bird colonies on Byers Peninsula, no poultry products, including wastes from such products and products containing uncooked dried eggs, shall be released into the Area or into the adjacent sea.

No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted. Release of radio-nuclides or stable isotopes directly into the environment in a way that renders them unrecoverable should be avoided. Fuel or other chemicals shall not be stored in the Area unless specifically authorised by Permit condition. They shall be stored and handled in a way that minimises the risk of their accidental introduction into the environment. Materials introduced into the Area shall be for a stated period only and shall be removed by the end of that stated period. If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*. The appropriate authority should be notified of anything released and not removed that was not included in the authorised Permit.

7(vii) Taking of, or harmful interference with, native flora or fauna

Taking of or harmful interference with native flora or fauna is prohibited, except by Permit issued in accordance with Annex II to the Protocol on Environmental Protection to the Antarctic Treaty. Where taking of or harmful interference with animals is involved, the SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica (Resolution 4 (2019)) should be used as a minimum standard.

7(viii) The collection or removal of materials not brought into the Area by the Permit holder

Collection or removal of anything not brought into the Area by the permit holder shall only be in accordance with a Permit and should be limited to the minimum necessary to meet scientific, archaeological or management needs.

Unless specifically authorized by permit, visitors to the Area are prohibited from interfering with or from handling, taking or damaging any historic anthropogenic material meeting the criteria in Resolution 5 (2001). Similarly, relocation or removal of artefacts for the purposes of preservation, protection or to re-establish historical accuracy is allowable only by permit. The appropriate national authority shall be informed of the location and nature of any newly identified anthropogenic materials.

Other material of human origin likely to compromise the values of the Area which was not brought into the Area by the permit holder or otherwise authorised, may be removed from the Area unless the environmental impact of the removal is likely to be greater than leaving the material in situ; if this is the case the appropriate Authority must be notified and approval obtained.

7(ix) Disposal of waste

As a minimum standard all waste shall be disposed of in accordance with Annex III to the Protocol on Environmental Protection to the Antarctic Treaty. In addition, all wastes, including all solid human waste, shall be removed from the Area. Liquid human wastes may be disposed of into the sea. Solid human waste should not be disposed of to the sea as the near-shore reefs will prevent dispersal, but shall be removed from the Area. No human waste shall be disposed of inland as the oligotrophic characteristics of the lakes and other water-bodies on the plateau can be compromised by even a small quantity of human waste, including urine.

7(x) Measures that are necessary to ensure that the aims and objectives of the management plan can continue to be met

Permits may be granted to enter the Area to:

- carry out monitoring and site inspection activities, which may involve the collection of data and/or a small number of samples for analysis or review;
- erect or maintain signposts, structures or scientific equipment; or
- carry out protective measures.

Scientific activities shall be performed in accordance with the SCAR *Environmental Code of Conduct for Terrestrial Scientific Field Research in Antarctica* (Resolution 5 (2018)). Geological research shall be undertaken in accordance with the SCAR *Environmental Code of Conduct for Geosciences Field Research Activities in Antarctica* (Resolution 1 (2021)).

Any specific sites of long-term monitoring shall be appropriately marked on site and on maps of the Area. A GPS position should be obtained for lodgement with the Antarctic Data Directory System through the appropriate national authority.

To help maintain the ecological and scientific values of the Area, visitors shall take special precautions against introductions. Of particular concern are microbial, animal or vegetation introductions sourced from soils from other Antarctic sites, including stations, or from regions outside Antarctica. To the maximum extent practicable, visitors shall ensure that footwear, clothing and any equipment – particularly camping and sampling equipment – is thoroughly cleaned before entering the Area. Poultry products and other introduced avian products, which may be a vector of avian diseases, shall not be released into the Area. Visitors accessing the ASPA by helicopter should ensure it is free of seeds, soil and propagules before entering the area. The transfer of species between lakes from outside and within the ASPA presents a substantial threat to these chemically and biologically unique waterbodies. Therefore, every precaution shall be taken to prevent cross-contamination of lakes including the cleaning of sampling equipment between use in different waterbodies.

7(xi) Requirements for reports

The principal permit holder for each visit to the Area shall submit a report to the appropriate national authority as soon as practicable, and no later than six months after the visit has been completed. Such visit reports should include, as applicable, the information identified in the recommended visit report form [contained as an Appendix in the Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas available from the website of the Secretariat of the Antarctic Treaty (*www.ats.aq*)]. If appropriate, the national authority should also forward a copy of the visit report to the Party that proposed the Management Plan, to assist in managing the Area and reviewing the Management Plan. Wherever possible, Parties should deposit the original or copies of the original visit reports, in a publicly accessible archive to maintain a record of usage, for the purpose of any review of the Management Plan and in organising the scientific use of the Area.

8. Supporting documentation

For a list of publication resulting from scientific investigations on Byers Peninsula, see Benayas et al. (2013).

Antarctic Treaty Parties. Guidelines for handling of pre-1958 historic remains whose existence or present location is not known. Resolution 5 (2001).

Antarctic Treaty Parties. Guidelines for the assessment and management of heritage in Antarctica. Resolution 2 (2018).

Almela, P., Gonzalez, S. 2020. Are Antarctic Specially Protected Areas safe from plastic pollution? a survey of plastic litter at Byers Peninsula, Livingston Island, Antarctica. *Advances in Polar Science* **31**: 284–290.

Bañón, M., Justel M. A., Quesada, A. 2006. Análisis del microclima de la península Byers, isla Livingston, Antártida, en el marco del proyecto LIMNOPOLAR. In: *Aplicaciones meteorológicas*. Asociación Meteorológica Española.

Bañón, M., Justel, M. A., Velazquez, D., Quesada, A. 2013. Regional weather survey on Byers Peninsula, Livingston Island, South Shetland Islands, Antarctica. *Antarctic Science* **25**: 146-156.

Barbosa, A., de Mas, E., Benzal, J., Diaz, J. I., Motas, M., Jerez, S., Pertierra, L., Benayas, J., Justel, A., Lauzurica, P., Garcia-Peña, F. J., and Serrano, T. 2013. Pollution and physiological variability in gentoo penguins at two rookeries with different levels of human visitation. *Antarctic Science* **25**: 329-338.

Benayas, J., Pertierra, L., Tejedo, P., Lara, F., Bermudez, O., Hughes, K.A., and Quesada, A. 2013. A review of scientific research trends within ASPA 126 Byers Peninsula, South Shetland Islands, Antarctica. *Antarctic Science* **25**: 128-145.

Birnie, R.V., Gordon, J.E. 1980. Drainage systems associated with snow melt, South Shetland Islands, Antarctica. *Geografiska Annaler* **62A**: 57-62.

Björck, S., Hakansson, H, Zale, R., Karlén, W., Jönsson, B.L. 1991. A late Holocene lake sediment sequence from Livingston Island, South Shetland Islands, with palaeoclimatic implications. *Antarctic Science* **3**: 61-72.

Björck, S., Sandgren, P., Zale, R. 1991. Late Holocene tephrochronology of the Northern Antarctic Peninsula. *Quaternary Research* **36**: 322-28.

Björck, S., Hjort, C, Ingólfsson, O., Skog, G. 1991. Radiocarbon dates from the Antarctic Peninsula - problems and potential. In: Lowe, J.J. (ed.), *Radiocarbon dating: recent applications and future potential. Quaternary Proceedings* 1, Quaternary Research Association, Cambridge. pp 55-65.

Björck, S., Håkansson, H., Olsson, S., Barnekow, L., Janssens, J. 1993. Palaeoclimatic studies in South Shetland Islands, Antarctica, based on numerous stratigraphic variables in lake sediments. *Journal of Paleolimnology* **8**: 233-72.

Björck, S., Zale, R. 1996. Late Holocene tephrochronology and palaeoclimate, based on lake sediment studies. In: López-Martínez, J., Thomson, M. R. A., Thomson, J.W. (eds.) *Geomorphological map of Byers Peninsula, Livingston Island*. BAS GEOMAP Series Sheet 5-A, 43-48. British Antarctic Survey, Cambridge.

Björck, S., Hjort, C., Ingólfsson, O., Zale, R., Ising, J. 1996. Holocene deglaciation chronology from lake sediments. In: López-Martínez, J., Thomson, M. R. A., Thomson, J.W. (eds.) *Geomorphological map of Byers Peninsula, Livingston Island*. BAS GEOMAP Series Sheet 5-A, 49-51. British Antarctic Survey, Cambridge.

Block, W., Starý, J. 1996. Oribatid mites (Acari: Oribatida) of the maritime Antarctic and Antarctic Peninsula. *Journal of Natural History* **30**: 1059-67.

Bonner, W.N., Smith, R.I.L. (Eds) 1985. *Conservation areas in the Antarctic.* SCAR, Cambridge: 147-56.

Booth, R.G., Edwards, M., Usher, M.B. 1985. Mites of the genus Eupodes (Acari, Prostigmata) from maritime Antarctica: a biometrical and taxonomic study. *Journal of the Zoological Society of London (A)* **207**: 381-406.

Carlini, A.R., Coria, N.R., Santos, M.M., Negrete, J., Juares, M.A., Daneri, G.A. 2009. Responses of *Pygoscelis adeliae* and *P. papua* populations to environmental changes at Isla 25 de Mayo (King George Island). *Polar Biology* **32**: 1427-1433.

Convey, P., Greenslade, P. Richard, K.J., Block, W. 1996. The terrestrial arthropod fauna of the Byers Peninsula, Livingston Island, South Shetland Islands - Collembola. *Polar Biology* **16**: 257-59.

Covacevich, V.C. 1976. Fauna valanginiana de Peninsula Byers, Isla Livingston, Antartica. *Revista Geologica de Chile 3*: 25-56.

Crame, J.A. 1984. Preliminary bivalve zonation of the Jurassic-Cretaceous boundary in Antarctica. In: Perrilliat, M. de C. (Ed.) *Memoria, III Congreso Latinamerico de Paleontologia, Mexico, 1984. Mexico City*, Universidad Nacional Autonoma de Mexico, Instituto de Geologia. pp 242-54.

Crame, J.A. 1985. New Late Jurassic Oxytomid bivalves from the Antarctic Peninsula region. *British Antarctic Survey Bulletin* **69**: 35-55.

Crame, J.A. 1995. Occurrence of the bivalve genus Manticula in the Early Cretaceous of Antarctica. *Palaeontology* **38** Pt. 2: 299-312.

Crame, J.A. 1995. A new Oxytomid bivalve from the Upper Jurassic–Lower Cretaceous of Antarctica. *Palaeontology* **39** Pt. 3: 615-28.

Crame, J.A. 1996. Early Cretaceous bivalves from the South Shetland Islands, Antarctica. *Mitt. Geol-Palaont. Inst. Univ. Hamburg* **77**: 125-127.

Crame, J.A., Kelly, S.R.A. 1995. Composition and distribution of the Inoceramid bivalve genus *Anopaea. Palaeontology* **38** Pt. 1: 87-103.

Crame, J.A., Pirrie, D., Crampton, J.S., Duane, A.M. 1993. Stratigraphy and regional significance of the Upper Jurassic - Lower Cretaceous Byers Group, Livingston Island, Antarctica. *Journal of the Geological Society* **150** Pt. 6: 1075-87.

Croxall, J.P., Kirkwood, E.D. 1979. *The distribution of penguins on the Antarctic Peninsula and the islands of the Scotia Sea*. British Antarctic Survey, Cambridge.

Cruz, M.J. 2016. Incorporando comiidas e contextos: a alimentação dos grupos foqueiros nas Setland do Sul (Antártica, século XIX). In Soares, F.C. 2016. (ed) Comida, cultura e sociedade – Arqueologias da alimentação no Mundo Moderno, Estudos Contemporâneos na Arqueologis 2, Editora Universirtaria UFPE, Recife: 169-190.

Cruz, M.J. 2018. Food and feeding of sealers on Livingston Island, South Shetland Islands. In Headland, R. K. (editor) 2018. Historical Antarctic Sealing Industry. Proceedings of an International Conference in Cambridge 16-21 September 2016. Scott Polar Research Institute, Occasional Publication Series, Cambridge: 101-106.

Davey, M.C. 1993. Carbon and nitrogen dynamics in a maritime Antarctic stream. *Freshwater Biology* **30**: 319-30.

Davey, M.C. 1993. Carbon and nitrogen dynamics in a small pond in the maritime *Antarctic. Hydrobiologia* **257**: 165-75.

De Pablo, M.A., Blanco, J.J., Molina, A., Ramos, M. Quesada, A., and Vieira G. 2013. Interannual active layer variability at the Limnopolar Lake CALM site on Byers Peninsula, Livingston Island, Antarctica. *Antarctic Science* 25: 167-180.

Duane, A.M. 1994. Preliminary palynological investigation of the Byers Group (Late Jurassic-Early Cretaceous), Livingston Island, Antarctic Peninsula. *Review of Palaeobotany and Palynology* **84**: 113-120.

Duane, A.M. 1996. Palynology of the Byers Group (Late Jurassic-Early Cretaceous) Livingston and Snow Islands, Antarctic Peninsula: its biostratigraphical and palaeoenvironmental significance. *Review of Palaeobotany and Palynology* **91**: 241-81.

Duane, A.M. 1997. Taxonomic investigations of Palynomorphs from the Byers Group (Upper Jurassic-Lower Cretaceous), Livingston and Snow Islands, Antarctic Peninsula. *Palynology* **21**: 123-144.

Ellis-Evans, J.C. 1996. Biological and chemical features of lakes and streams. In: López-Martínez, J., Thomson, M. R. A., Thomson, J.W. (eds.) *Geomorphological map of Byers Peninsula, Livingston Island*. BAS GEOMAP Series Sheet 5-A, 20-22. British Antarctic Survey, Cambridge.

Emslie, S. D., Polito, M. J., and Patterson, W. P. 2013. Stable isotope analysis of ancient and modern gentoo penguin egg membrane and the krill surplus hypothesis in Antarctica. *Antarctic Science* **25**: 213-218.

Fernández-Valiente, E., Camacho, A., Rochera, C., Rico, E., Vincent, W. F., Quesada, A. 2007 Community structure and physiological characterization of microbial mats in Byers Peninsula, Livingston Island (South Shetland islands, Antarctica). *FEMS Microbiology Ecology* **59**: 377- 385

Gil-Delgado, J.A., Villaescusa, J.A., Diazmacip, M.E., Velazquez, D., Rico, E., Toro, M., Quesada, A., Camacho, A. 2013. Minimum population size estimates demonstrate an increase in southern elephant seals (Mirounga leonina) on Livingston Island, maritime Antarctica *Polar Biology* **36**: 607-610

Gil-Delgado, J.A., González-Solis, J., Barbosa, A. 2010. Breeding birds populations in Byers Peninsula (Livingston Is., South Shetlands Islands. 18th International Conference of the European Bird Census Council. 22-26 March. Caceres. Spain).

González-Ferrán, O., Katsui, Y., Tavera, J. 1970. Contribución al conocimiento geológico de la Península Byers, Isla Livingston, Islas Shetland del Sur, Antártica. *Publ. INACH Serie. Cientifica* **1**: 41-54.

González-Pleiter, M., Edo, C., Velázquez, D., Casero-Chamorro, M. C., Leganés, F., Quesada, A., Fernández-Piñas, F., Rosal, R. (2020). First detection of microplastics in the freshwater of an Antarctic Specially Protected Area, Marine Pollution Bulletin 161, Part B, 111811.

Gray, N.F., Smith, R.I. L. 1984. The distribution of nematophagous fungi in the maritime Antarctic. *Mycopathologia* **85**: 81-92.

Harris, C.M. 2001. *Revision of management plans for Antarctic protected areas originally proposed by the United States of America and the United Kingdom: Field visit report*. Internal report for the National Science Foundation, US, and the Foreign and Commonwealth Office, UK. Environmental Research and Assessment, Cambridge.

Hansom, J.D. 1979. Radiocarbon dating of a raised beach at 10 m in the South Shetland Islands. B*ritish Antarctic Survey Bulletin* **49**: 287-288.

Hathway, B. 1997. Non-marine sedimentation in an Early Cretaceous extensional continental-margin arc, Byers Peninsula, Livingston Island, South Shetland Islands. *Journal of Sedimentary Research* **67**: 686-697.

Hathway, B., Lomas, S.A. 1998. The Upper Jurassic-Lower cretaceous Byers Group, South Shetland Islands, Antarctica: revised stratigraphy and regional correlations. *Cretaceous Research* **19**: 43-67.

Hernandez, P.J., Azcarate, V. 1971. Estudio paleobotanico preliminar sobre restos de una tafoflora de la Peninsula Byers (Cerro Negro), Isla Livingston, Islas Shetland del Sur, Antartica. *Publ. INACH Serie. Cientifica* **2**: 15-50.

Hjort, C., Ingólfsson, O., Björck, S. 1992. The last major deglaciation in the Antarctic Peninsula region - a review of recent Swedish Quaternary research. In: Y. Yoshida et al. (eds.) *Recent Progress in Antarctic Science*. Terra Scientific Publishing Company (TERRAPUB), Tokyo: 741-743.

Hjort, C., Björck, S., Ingólfsson, Ó., Möller, P. 1998. Holocene deglaciation and climate history of the northern Antarctic Peninsula region: a discussion of correlations between the Southern and Northern Hemispheres. *Annals of Glaciology* **27**: 110-112.

Hodgson, D.A., Dyson, C.L., Jones, V.J., Smellie, J.L. 1998. Tephra analysis of sediments from Midge Lake (South Shetland Islands) and Sombre Lake (South Orkney Islands), Antarctica. *Antarctic Science* **10**: 13-20.

Hughes, K. A., Ireland, L. C, Convey, P., Fleming, A. 2015. Assessing the effectiveness of specially protected areas for conservation of Antarctica's botanical diversity. *Conservation Biology* **30**: 113-120.

John, B.S., Sugden, D.E. 1971. Raised marine features and phases of glaciation in the South Shetland Islands. B*ritish Antarctic Survey Bulletin* **24**: 45-111.

Jones, V.J., Juggins, S., Ellis-Evans, J.C. 1993. The relationship between water chemistry and surface sediment diatom assemblages in maritime Antarctic lakes. *Antarctic Science* **5**: 339-48.

Kelly, S.R.A. 1995. New Trigonioid bivalves from the Early Jurassic to Earliest Cretaceous of the Antarctic Peninsula region: systematics and austral paleobiogeography. *Journal of Paleontology* **69**: 66-84.

Kopalova, K., van de Vijver, B. 2013. Structure and ecology of freshwater benthic diatom communities from Byers Peninsula, Livingston Island, South Shetland Islands. *Antarctic Science* **25**: 239-253.

Lewis-Smith. R.I., Simpson, H.W. 1987. Early nineteenth century sealers' refuges on Livingston Island, South Shetland Islands. *British Antarctic Survey Bulletin* **74**: 48-72.

Lindsay, D.C. 1971. Vegetation of the South Shetland Islands. *British Antarctic Survey Bulletin* **25**: 59-83.

López-Bueno, A., Tamames, J. Velazquez, D., Moya, A., Quesada, A., Alcami, A. 2009. Viral Metagenome of an Antarctic lake: high diversity and seasonal variations. *Science* **326**: 858-861.

Lopez-Martinez, J., Serrano, E., Martinez de Pison, E. 1996. Geomorphological features of the drainage system. In: López-Martínez, J., Thomson, M. R. A., Thomson, J.W. (eds.) *Geomorphological map of Byers Peninsula, Livingston Island*. BAS GEOMAP Series Sheet 5-A, 15-19. British Antarctic Survey, Cambridge.

Lopez-Martínez, J., Martínez de Pisón, E., Serrano, E., Arche, A. 1996 *Geomorphological map of Byers Peninsula, Livingston Island*. BAS GEOMAP Series, Sheet 5-A, Scale 1:25 000. Cambridge, British Antarctic Survey.

Lyons, W. B., Welch, K. A., Welch, S. A., Camacho, A. Rochera, C., Michaud, L., deWit, R., Carey, A.E. 2013. Geochemistry of streams from Byers Peninsula, Livingston Island. *Antarctic Science* 25: 181-190.

Martínez De Pisón, E., Serrano, E., Arche, A., Lopez-Martínez, J. 1996. Glacial geomorphology. In: López-Martínez, J., Thomson, M. R. A., Thomson, J.W. (eds.) *Geomorphological map of Byers Peninsula, Livingston Island*. BAS GEOMAP Series Sheet 5-A, 23-27. British Antarctic Survey, Cambridge.

Morgan, F., Barker, G., Briggs, C., Price, R. and Keys, H. 2007. Environmental Domains of Antarctica Version 2.0 Final Report, Manaaki Whenua Landcare Research New Zealand Ltd. 89 pp.

Moura, P.A., Francelino, M.R., Schaefer, C.E.G.R., Simas, F.N.B., de Mendonca, B.A.F. 2012. Distribution and characterization of soils and landform relationships in Byers Peninsula, Livingston Island, Maritime Antarctica. *Geomorphology* **155**: 45-54.

Muñoz, S. 2000. Zooarqueología de la Isla Livingston, Shetland del Sur. *Archaeofauna* **9**: 39- 57.

Nakai, R., Shibuya, E., Justel, A., Rico, E., Quesada, A., Kobayashi, F., Iwasaka, Y., Shi, G.-Y., Amano, Y., Iwatsuki, T., Naganuma, T. 2013. Phylogeographic analysis of filterable bacteria with special reference to *Rhizobiales* strains that occur in cryospheric habitats. *Antarctic Science* **25**: 219-228.

Nielsen, U. N., Wall, D. H. W., Li, G., Toro, M., Adams, B. J., Virginia, R. A. 2011. Nematode communities of Byers Peninsula, Livingston Island, maritime Antarctica. *Antarctic Science* **23**: 349-357.

Otero, X.L., Fernández, S., De Pablo-Hernández, M.A., Nizoli, E.C., Quesada, A. 2013. Plant communities as a key factor in biogeochemical processes involving micronutrients (Fe, Mn, Co, and Cu) in Antarctic soils (Byers Peninsula, maritime Antarctica). *Geoderma* 195-196: 145-154.

Olivia, M., Antoniades, D., Giralt, S., Granados, I., Pla-Rabes, S., Toro, M., Liu, E.J., Sanjurjo, J., Vieira, G. 2016. The Holocene deglaciation of the Byers Peninsula (Livingston Island, Antarctica) based on the dating of lake sedimentary records. *Geomorphology* **261**: 89-102.

Pankhurst, R.J., Weaver, S.D., Brook, M., Saunders, A.D. 1979. K-Ar chronology of Byers Peninsula, Livingston Island, South Shetland Islands. *British Antarctic Survey Bulletin* **49**: 277-282.

Pearson, M. 2018. Living under their boats: a strategy for southern sealing in the nineteenth century — its history and archaeological potential. *The Polar Journal* **8**: 68-83.

Pearson, M., Stehberg, R., Zarankin, A., Senatore, M.X., Gatica, C. 2008. Sealer's sledge excavated on Livingston Island, South Shetland Islands. *Polar Record* **44**: 362- 364.

Pertierra, L.R., Lara, F., Tejedo, P., Quesada, A., Benayas, J. 2013a. Rapid denudation processes in cryptogamic communities from Maritime Antarctica subjected to human trampling. *Antarctic Science* **25**: 318-328.

Pertierra, L.R., Hughes, K.A., Benayas, J., Justel, A., and Quesada, A. 2013b. Environmental management of a scientific field camp in Maritime Antarctica: reconciling research impacts with conservation goals in remote ice-free areas. *Antarctic Science* **25**: 307-317.

Pla-Rabes, S., Toro, M., Van De Vijver, B., Rochera, C., Villaescusa, J. A., Camacho, A., and Quesada, A. 2013. Stability and endemicity of benthic diatom assemblages from different substrates in a maritime stream on Byers Peninsula, Livingston Island, Antarctica: the role of climate variability. *Antarctic Science* **25**: 254-269.

Petz, W., Valbonesi, A., Schiftner, U., Quesada, A., Ellis-Evans, C.J. 2007. Ciliate biogeography in Antarctic and Arctic freshwater ecosystems: endemism or global distribution of species? *FEMS Microbiology Ecology* **59**: 396-408.

Quesada, A., Fernández Valiente, E., Hawes, I., Howard. Williams, C. 2008. Benthic primary production in polar lakes and rivers. In: Vincent, W., Leybourn-Parry J. (eds). *Polar Lakes and Rivers – Arctic and Antarctic Aquatic Ecosystems*. Springer. pp 179-196.

Quesada, A., Camacho, A. Rochera, C., Velazquez, D. 2009. Byers Peninsula: a reference site for coastal, terrestrial and limnetic ecosystems studies in maritime Antarctica. *Polar Science* **3**: 181-187.

Quesada, A., Camacho, A., Lyons, W.B. 2013. Multidisciplinary research on Byers Peninsula, Livingston Island: a future benchmark for change in Maritime Antarctica. *Antarctic Science* **25**: 123-127.

Radicchi. G de A. (2015). Os sapatos dos lobeiros-baleeiros [manuscrito]: práticas de calçar do século XIX nas Ilhas Shetland do Sul (Antártica). Unpublished dissertation. Federal University of Minas Gerais.

Richard, K.J., Convey, P., Block, W. 1994. The terrestrial arthropod fauna of the Byers Peninsula, Livingston Island, South Shetland Islands. *Polar Biology* **14**: 371-79.

Rico, E., Quesada, A. 2013. Distribution and ecology of chironomids (Diptera, Chironomidae) on Byers Peninsula, Maritime Antarctica. *Antarctic Science* **25**: 288-291.

Rochera, C., Justel, A., Fernandez-Valiente, E., Bañón, M., Rico, E., Toro, M., Camacho, A., Quesada, A. 2010. Interannual meteorological variability and its effects on a lake from maritime Antarctica. *Polar Biology* **33**: 1615-1628.

Rochera, C., Villaescusa, J. A., Velázquez, D., Fernández-Valiente, E., Quesada, A., Camacho, A. 2013a. Vertical structure of bi-layered microbial mats from Byers Peninsula, Maritime Antarctica. *Antarctic Science* **25**: 270-276.

Rochera, C., Toro, M., Rico, E., Fernández-Valiente, E., Villaescusa, J. A., Picazo, A., Quesada, A., Camacho, A. 2013b. Structure of planktonic microbial communities along a trophic gradient in lakes of Byers Peninsula, South Shetland Islands. *Antarctic Science* **25**: 277-287.

Rodríguez, P., Rico, E. 2008. A new freshwater oligochaete species (Clitellata: Enchytraeidae) from Livingston Island, Antarctica. *Polar Biology* **31**: 1267-1279.

SGE, WAM and BAS. 1993. *Byers Peninsula, Livingston Island*. Topographic map, Scale 1:25 000. Cartografia Antartica. Madrid, Servicio Geografia del Ejercito.

Salerno, M. 2007. Identidades extremas: moda, vestido e identidad en los confines de la sociedad moderna (Antártida, siglo XIX). *Arqueología* **13**: 185–211.

Salerno, M. 2011. Persona y cuerpo-vestido en la modernidad: un enfoque arqueológico. PhD dissertation (archaeology). Facultad de Filosofía y Letras, Universidad de Buenos Aires.

Serrano, E., Martínez De Pisón, E., Lopez-Martínez, J. 1996. Periglacial and nival landforms and deposits. In: López-Martínez, J., Thomson, M. R. A., Thomson, J.W. (eds.) *Geomorphological map of Byers Peninsula, Livingston Island*. BAS GEOMAP Series Sheet 5-A, 28-34. British Antarctic Survey, Cambridge.

Smellie J.L., Davies, R.E.S., Thomson, M.R.A. 1980. Geology of a Mesozoic intra-arc sequence on Byers Peninsula, Livingston Island, South Shetland Islands. *British Antarctic Survey Bulletin* **50**: 55-76.

Starý, J., Block, W. 1998. Distribution and biogeography of oribatid mites (Acari: Oribatida) in Antarctica, the sub-Antarctic and nearby land areas. *Journal of Natural History* **32**: 861-94.

Stehberg, R. 2003. Arqueología histórica antártica: Aborígenes sudamericanos en los mares subantárticos en el siglo XIX, Centro de Investigaciones Diego Barros Arana, Santiago.

Stehberg, R., Pearson, M., Blanchette, R., Jurgens, J.A. 2009. A further note on a sealer's sledge, discovered on Livingston Island, South Shetland Islands. *Polar Record* **45**: 275

Sugden, D.E., John, B.S. 1973. The ages of glacier fluctuations in the South Shetland Islands, Antarctica. In: van Zinderen Bakker, E.M. (ed.) *Paleoecology of Africa and of the surrounding islands and Antarctica* . Balkema, Cape Town, pp. 141-159.

Tejedo, P., Justel, A., Benayas, J., Rico, E., Convey, P., Quesada, A. 2009. Soil trampling in an Antarctic Specially Protected Area: tools to assess levels of human impact. *Antarctic Science* **21**: 229-236.

Tejedo, P., Pertierra, L.R., Benayas, J., Convey, P., Justel, A., Quesada, A. 2012. Trampling on maritime Antarctica: can soil ecosystems be effectively protected through existing codes of conduct? *Polar Research* **31**: Art. No. UNSP 100888

Thom, G. 1978. Disruption of bedrock by the growth and collapse of ice lenses. *Journal of Glaciology* **20**: 571-75.

Thomson, M.R.A., López-Martínez, J. 1996. Introduction. In: López-Martínez, J., Thomson, M. R. A., Thomson, J.W. (eds.) *Geomorphological map of Byers Peninsula, Livingston Island*. BAS GEOMAP Series Sheet 5-A, 1-4. British Antarctic Survey, Cambridge.

Toro, M., Camacho, A., Rochera, C., Rico, E., Bañón, M., Fernández, E., Marco, E., Avendaño, C., Ariosa, Y., Quesada, A. 2007. Limnology of freshwater ecosystems of Byers Peninsula (Livingston Island, South Shetland Islands, Antarctica. *Polar Biology* **30**: 635-649.

Toro, M., Granados, I., Pla, S., Giralt, S., Antoniades, D., Galán, L., Cortizas, A. M., Lim, H. S., Appleby, P. G. 2013. Chronostratigraphy of the sedimentary record of Limnopolar Lake, Byers Peninsula, Livingston Island, Antarctica. *Antarctic Science* **25**: 198-212.

Torres, D. 1992, 'Cráneo indígena en cabo Shirreff': Un estudio en desarrollo, *Boletin Antártico Chileno* **11**: 2-6.

Torres, D., Cattan, P., Yanez, J. 1981. Post-breeding preferences of the Southern Elephant seal *Mirounga leonina* in Livingston Island (South Shetlands). P*ubl. INACH Serie. Cientifica* **27**: 13-18.

Torres, D., Jorquera, D. 1994. Marine debris analysis collected at cape Shirreff, Livingston Island, South Shetland, Antarctica. *Ser. Cient. INACH* **44**: 81-86.

Usher, M.B., Edwards, M. 1986. The selection of conservation areas in Antarctica: an example using the arthropod fauna of Antarctic islands. *Environmental Conservation* **13**: 115-22.

Van der Vijver, J., Agius, T., Gibson, J., Quesada, A. 2009. An unusual spine-bearing Pinnularia species from the Antarctic Livingston Island. *Diatom Research* **24**: 431-441.

Velazquez, D., Lezcano, M.A., Frias, A., Quesada, A. 2013. Ecological relationships and stoichiometry within a Maritime Antarctic watershed. *Antarctic Science* **25**: 191-197.

Vera, M. L., Fernández-Teruel, T., Quesada, A. 2013. Distribution and reproductive capacity of Deschampsia antarctica and Colobanthus quitensis on Byers Peninsula, Livingston Island, South Shetland Islands, Antarctica. *Antarctic Science* **25**: 292-302.

Villaescusa, J.A., Jorgensen, S.E., Rochera, C., Velazquez, D., Quesada, A., Camacho, A. 2013. Carbon dynamics modelization and biological community sensitivity to temperature in an oligotrophic freshwater Antarctic lake. *Ecological Modelling* **319**: 21-30.

Villaescusa, J.A., Casamayor, E.O., Rochera, C., Velazquez, D., Chicote, A., Quesada, A., Camacho, A. 2010. A close link between bacterial community composition and environmental heterogeneity in maritime Antarctic lakes. *International Microbiology* **13**: 67-77.

Villaescusa, J. A., Casamayor, E. O., Rochera, C., Quesada, A., Michaud L., Camacho, A. 2013. Heterogeneous vertical structure of the bacterioplankton community in a non-stratified Antarctic lake. *Antarctic Science* **25**: 229-238.

White, M.G. Preliminary report on field studies in the South Shetland Islands 1965/66. Unpublished field report in BAS Archives AD6/2H1966/N6.

Woehler, E.J. (Ed.) 1993. *The distribution and abundance of Antarctic and sub-Antarctic penguins.* SCAR, Cambridge.

Zarankin, A., Senatore, M.X. 2005. Archaeology in Antarctica: Nineteenth-century capitalism expansion strategies. *International Journal of Historical Archaeology* **9**: 43-56.

Zarankin, A., Senatore. M.X. 2007. Historias de un pasado en blanco: arqueología histórica antártica. Belo Horizonte: Argumentum.

Zidarova, E., Van de Vijver, B., Quesada, A., de Haan, M. 2010. Revision of the genus *Hantzschia* (Bacillariophyceae) on Livingston Island (South Shetland Islands, Southern Atlantic Ocean). *Plant Ecology and Evolution* **143**: 318-333.

Annex 1

Supporting information

Byers Peninsula has supported scientific investigations for many years and many of the resulting publications up until 2013 are listed in Banayas et al. (2013); however, but numerous new articles have been published since then.

CLIMATE

No extended meteorological records are available for Byers Peninsula before 2001, but the climate is expected to be similar to that at Base Juan Carlos I, Hurd Peninsula (recorded since 1988). Conditions there indicate a mean annual temperature of below -2.8 °C, with temperatures less than 0 °C for at least several months each winter and a relatively high precipitation rate estimated at about 800 mm yr^{-1}, much of which falls as rain in summer (Ellis-Evans 1996; Bañón et al., 2013). The peninsula is snow-covered for much of the year, but is usually mostly snow-free by the end of the summer. The peninsula is exposed to weather from the Drake Passage in the north and northwest, the directions from which winds prevail, and Bransfield Strait to the south. The climate is polar maritime, with a permanently high relative humidity (about 90%), cloud covered skies for most of the time, frequent fogs and regular precipitation events. Mean temperature in summer is 1.1 ° C, but occasionally can be higher than 5 °C. Exceptionally summer temperature has reached 9 °C. Minimum average temperature in summer is close to 0 °C. In winter, temperatures can be lower than -26 °C, although the average value is -6 °C and maximum temperatures in winter can be close to 0 °C. Mean radiation in summer is 14,000 KJ m^{-2}, reaching 30,000 KJ m^{-2} on sunny days close to the solstice. Winds are high and average speed is 24 km h^{-1}, with frequent storms with winds over 140 Km h^{-1}. The predominant winds are from SW and NE.

GEOLOGY

The bedrock of Byers Peninsula is composed of Upper Jurassic to Lower Cretaceous marine sedimentary, volcanic and volcaniclastic rocks, intruded by igneous bodies (see Smellie et al., 1980; Crame et al., 1993, Hathway and Lomas 1998). The rocks represent part of a Mesozoic Cenozoic magmatic arc complex which is exposed throughout the whole of the Antarctic Peninsula region, although most extensively on the Byers Peninsula (Hathway and Lomas 1998). The elevated interior region of the eastern half of the peninsula – surrounded to the north and south by Holocene beach deposits – is dominated by Lower Cretaceous non-marine tuffs, volcanic breccias, conglomerates, sandstones and minor mudstones, with intrusions in several places by volcanic plugs and sills. The western half of the peninsula, and extending NW half-way along Ray Promontory, is predominantly Upper Jurassic-Lower Cretaceous marine mudstones, with sandstones and conglomerates, with frequent intrusions of volcanic sills, plugs and other igneous bodies. The NW half of Ray Promontory comprises mainly volcanic breccias of the same age. Mudstones, sandstones, conglomerates and pyroclastic rocks are the most common lithologies found on the peninsula. Expanses of Holocene beach gravels and alluvium are found in coastal areas, particularly on South Beaches and the eastern half of Robbery Beaches, with less-extensive deposits on President Beaches.

The Area is of high geological value because "the sedimentary and igneous rocks exposed at Byers Peninsula constitute the most complete record of the Jurassic-Early Cretaceous period in the northern part of the Pacific flank of the magmatic arc complex, and they have proved a key succession for the study of marine molluscan faunas (e.g. Crame 1984, 1995, Crame and Kelly 1995) and non-marine floras (e.g. Hernandez and Azcárte 1971, Philippe et al., 1995)" (Hathway and Lomas 1998).

GEOMORPHOLOGY AND SOILS

Much of the terrain consists of lithosols, essentially a layer of shattered rock, with permafrost widespread below an active layer of 30-70 cm depth (Thom 1978, Ellis-Evans 1996, Serrano et al., 1996). Stone fields (consisting of silty fines with dispersed boulders and surficial clasts), gelifluction lobes, polygonal ground (both in flooded and dry areas), stone stripes and circles and other periglacial landforms dominate the surface morphology of the upper platforms where bedrock outcrop is absent (Serrano et al., 1996). Debris and mud-flows are observed in several localities. Beneath some of the moss and grass communities there is a 10 20 cm deep layer of organic matter although, because vegetation is sparse over most of Byers Peninsula, there are no deep accumulations of peat (Bonner and Smith 1985; Moura et al., 2012; Otero et al., 2013). Ornithogenic soils are present especially in the Devils Point vicinity and on a number of knolls along President Beaches (Ellis-Evans 1996).

Parts of the interior of the peninsula have been shaped by coastal processes with a series of raised beaches ranging from 3 to 54 m in altitude, some of which are over 1 km wide. A radiocarbon date for the highest beach deposits suggests that Byers Peninsula was largely free of permanent ice by 9700 yr B.P., while the lowest beach deposits are dated at 300 yr B.P. (John and Sugden 1971, Sugden and John 1973). Lake sediment analyses, however, are contradictory; some suggest a recent general deglaciation of central Byers Peninsula of around 4000-5000 yr B.P. (Björck et al., 1991a, b), but others provide a deglaciation age about 8000-9000 yr B.P. (Toro et al., 2013). More recent work has suggested that the onset of the deglaciation started during the Early Holocene in the western fringe of the Byers Peninsula (ca. 8.3 thousand calibrated years before present (cal. ky BP)) (Oliva et al., 2016). Glacial retreat gradually exposed the highest parts of the Cerro Negro nunatak in the SE corner of Byers Peninsula, creating a nunatak (c. 7.5 ky BP). During the Mid-Holocene the retreat of the Rotch Dome glacier cleared the central part of the Byers plateau of ice, with this area being ice-free at least 5.9 cal. ky BP. Deglaciation of the current ice-free easternmost part of the Byers Peninsula occurred before 1.8 cal. ky BP (Oliva et al., 2016). In several places sub-fossil whalebones are embedded in the raised beaches, occasionally as almost entire skeletons. Radiocarbon dates of skeletal material from about 10 m a.s.l. on South Beaches suggest an age of between 2000 and 2400 yr B.P. (Hansom 1979). Pre-Holocene surfaces of Byers Peninsula exhibit clear evidence of a glacial landscape, despite the gentle landforms. Today only three small residual glaciers (comprising less than 0.5 km^2) remain on Ray Promontory. The pre-existing glacially modified landforms, have been subsequently overprinted by fluvial and periglacial processes (Martinez de Pison et al., 1996).

STREAMS AND LAKES

Byers Peninsula is perhaps the most significant limnological site in the South Shetland Islands/Antarctic Peninsula region, with over 60 lakes, numerous freshwater pools (differentiated from lakes in that they freeze to the bottom in winter) and a dense and varied stream network. The gentle terrain favours water retention and waterlogged soils are common in the summer. The water capacity of the thin soils is limited, however, and many of the channels are frequently dry, with flow often intermittent except during periods of substantial snow melt, rain or where they drain glaciers (Lopez-Martinez et al., 1996). Most of the streams drain seasonal snowfields and are often no more than 5-10 cm in depth (Ellis-Evans 1996) although snow accumulation in some narrow gorges can reach over 2 m height, and result in ice dams blocking the lake outlet. The larger streams are up to 4.5 km in length, up to 20 m in width and 30-50 cm in depth in the lower reaches during periods of flow. Streams that drain to the west often have sizeable gorges (Lopez-Martinez et al., 1996) and gullies up to 30 m in depth have been cut into the uppermost, and largest, of the raised marine platforms (Ellis-Evans 1996). Above the Holocene raised beaches the valleys are gentle, with widths of up to several hundred metres.

Lakes are especially abundant on the higher platforms (i.e. at the heads of basins) and on the Holocene raised beaches near the coast. Midge Lake is the largest at 587 x 112 m, and deepest with a maximum depth of 9.0 m. The inland lakes are all nutrient-poor and highly transparent, with extensive sediments in deeper water overlain by a dense aquatic moss carpet [*Drepanocladus longifolius* (=*D. aduncus*)]. In some lakes, such as Chester Cone Lake about 500 m to the south of Midge Lake, or Limnopolar lake, stands of aquatic moss are found growing at one to several metres in depth and cover most of the lake bottom, which is the habitat for *Parochlus* larvae (Bonner and Smith 1985). Large masses of this moss are sometimes washed up along parts of the shoreline. The lakes are generally frozen to a depth of 1.0 - 1.5 m for 9 - 11 months of the year and overlain by snow (Rochera et al., 2010), although surfaces of some of the higher lakes remain frozen year-round (Ellis-Evans 1996, Lopez-Martinez et al., 1996). On the upper levels of the central plateau many small, shallow, slow-flowing streams flow between lakes and drain onto large flat areas of saturated lithosol covered with thick cyanobacterial mats of *Phormidium* spp., *Microcoleus* spp. and *Leptolyngbya* spp. These mats are more extensive than in any other maritime Antarctic site thus far described and reflect the unique geomorphology and relatively high annual precipitation of the Area. With spring melt there is considerable flush through most lakes, but outflow from many lakes may cease late in the season as seasonal snowmelt decreases (Rochera et al., 2010). Most lakes contain some crustaceans such as the copepods *Boeckella poppei* and the fairy shrimp *Branchinecta gainii*. Some of the streams also contain substantial growths of cyanobacterial and green filamentous algae, along with diatoms and copepods (Kopalova and van de Vijver 2013). A number of relatively saline lakes of lagoonal origin occur close to the shore, particularly on President Beaches. Where these are used as southern elephant seal (*Mirounga leonina*) wallows these lakes have been highly organically enriched. Those coastal shallow lakes and pools located behind the first raised beach often have abundant algal mats and crustaceans, including the copepods *B. poppei* and *Parabroteas sorsi*, and occasionally the fairy shrimp *Br. gainii*. Some of these water bodies have high biological diversity, with newly described species of diatoms (van der Vijver et al., 2009), oligochaete (Rodriguez and Rico, 2009) and ciliate protozoa (Petz et al., 2008).

VEGETATION

Although much of Byers Peninsula lacks abundant vegetation, especially inland (see Lindsay 1971), the use of satellite technology shows the areas does contain 8.1 km2 of green vegetation (e.g. vascular plants, algae and some moss species), which represents over 50% of the green vegetation protected within all the terrestrial ASPAs (Hughes et al., 2015). The often sparse communities contain a diverse flora, with at least 56 lichen species, 29 mosses, 5 hepatics and 2 phanerogams having been identified as present within the Area (Vera et al., 2013). Numerous unidentified lichens and mosses have also been collected. This suggests the Area contains one of the most diverse representations of terrestrial flora known in the maritime Antarctic. A number of the species are rare in this part of the maritime Antarctic. For example, of the bryophytes, *Anthelia juratzkana, Brachythecium austroglareosum, Chorisodontium aciphyllum, Ditrichum hyalinum, Herzogobryum teres, Hypnum revolutum, Notoligotrichum trichodon, Pachyglossa dissitifolia, Platydictya jungermannioides, Sanionia cf. plicata, Schistidium occultum, Syntrichia filaris and Syntrichia saxicola* are considered rare. For *A. juratzkana, D. hyalinum, N. trichodon* and *S. plicata*, their furthest-south record is on Byers Peninsula. Of the lichen flora, *Himantormia lugubris, Ochrolechia parella, Peltigera didactyla* and *Pleopsidium chlorophanum* are considered rare.

Vegetation development is much greater on the south coast than on the north. Commonly found on the higher, drier raised beaches in the south is an open community dominated by abundant *Polytrichastrum alpinum* (=*Polytrichum alpinum*), *Polytrichum piliferum* (=*Polytrichum antarcticum*), *P. juniperinum, Ceratodon purpureus*, and the moss *Pohlia nutans* and several crustose lichens are frequent. Some large stands of mosses occur near President and South Beaches, where extensive snowdrifts often accumulate at the base of slopes rising behind the raised beaches, providing an ample source of melt water in the summer. These moss stands are dominated mainly by *Sanionia uncinata* (=*Drepanocladus uncinatus*), which locally forms continuous carpets of several hectares. The vegetation composition is more diverse than on the higher, drier areas. Inland, wet valley floors have stands of *Brachythecium austro salebrosum, Campylium polygamum, Sanionia uncinata, Warnstorfia laculosa* (=*Calliergidium austro stramineum*), and *W. sarmentosa* (=*Calliergon sarmentosum*). In contrast, moss carpets are almost non existent within 250 m of the northern coast, replaced by scant growth of *Sanionia* in hollows between raised beaches of up to 12 m in altitude. Lichens, principally of the genera *Acarospora, Buellia, Caloplaca, Verrucaria* and *Xanthoria*, are present on the lower (2-5 m) raised beach crests, with *Sphaerophorus, Stereocaulon* and *Usnea* becoming the more dominant lichens with increasing altitude (Lindsay 1971).

On better drained ash slopes *Bryum* spp., *Dicranoweisia* spp., *Ditrichum* spp., *Pohlia* spp., *Schistidium* spp., and *Tortula* spp. are common as isolated cushions and turves with various liverworts, lichens (notably the pink *Placopsis contortuplicata* and black foliose *Leptogium puberulum*), and the cyanobacterium *Nostoc commune. P. contortuplicata* occurs in inland and upland habitats lacking in nitrogen, and is typical of substrata with some degree of disturbance such as solifluction; it is often the only plant to colonise the small rock fragments of stone stripes and frost-heave polygons (Lindsay 1971). It is usually found growing alone, though rarely with species of *Andreaea* and *Usnea*. *N. commune* covers extensive saturated areas on level or gently sloping, gravelly boulder clay from altitudes of between 60-150 m, forming discrete rosettes of about 5 cm in diameter 10-20 cm apart (Lindsay 1971). Scattered, almost spherical, cushions of *Andreaea, Dicranoweisia*, and *Ditrichum* are found on the driest soils. In wet, bird and seal influenced areas the green foliose alga *Prasiola crispa* is sometimes abundant.

Rock surfaces on Byers Peninsula are mostly friable, but locally colonised by lichens, especially near the coast. Volcanic plugs are composed of harder, more stable rock and are densely covered by lichens and occasional mosses. Usnea Plug is remarkable for its luxuriant growth of *Himantormia lugubris* and *Usnea aurantiaco-atra* (=*U. fasciata*). More generally, *H. lugubris* and *U. aurantiaco-atra* are the dominant lichen species on inland exposed montane surfaces, growing with the moss *Andreaea gainii* over much of the exposed rock with up to 80% cover of the substratum (Lindsay 1971). In sheltered pockets harbouring small accumulations of mineral soil, the liverworts *Barbilophozia hatcheri* and *Cephaloziella varians* (= *C. exiliflora*) are often found, but more frequently intermixed with cushions of *Bryum, Ceratodon, Dicranoweisia, Pohlia, Sanionia, Schistidium*, and *Tortula*. *Sanionia* and *Warnstorfia* form small stands, possibly correlated with the absence of large snow patches and associated melt streams. *Polytrichastrum alpinum* forms small inconspicuous cushions in hollows, but it may merge with *Andreaea gainii* cushions in favourable situations (Lindsay 1971).

Crustose lichens are mainly species of *Buellia, Lecanora, Lecedella*, *Lecidea*, *Placopsis* and *Rhizocarpon* growing on rock, with species of *Cladonia* and *Stereocaulon* growing on mosses, particularly *Andreaea* (Lindsay 1971). On the south coast moss carpets are commonly colonised by epiphytic lichens, such as *Leptogium puberulum, Peltigera rufescens, Psoroma* spp., together with *Coclocaulon aculeata* and *C. epiphorella*. On sea cliffs *Caloplaca* and *Verrucaria* spp. dominate on lower surfaces exposed to salt spray up to about 5 m, with nitrophilous species, such as *Caloplaca regalis, Haematomma erythromma*, and *Xanthoria elegans* often dominant at higher altitudes where seabirds are frequently nesting. Elsewhere on dry cliff surfaces a *Ramalina terebrata* - crustose lichen community is common. A variety of ornithocoprophilous lichens, such as *Catillaria corymbosa, Lecania brialmontii*, and species of *Buellia, Haematomma, Lecanora*, and *Physcia* occur on rocks near concentrations of breeding birds, along with the foliose lichens *Mastodia tessellata, Xanthoria elegans* and *X. candelaria* which are usually dominant on dry boulders.

Antarctic hairgrass (*Deschampsia antarctica*) is common in several localities, mainly on the south coast, and occasionally forms closed swards (e.g. at Sealer Hill); Antarctic pearlwort (*Colobanthus quitensis*) is sometimes associated. Both plants are quite abundant in southern gullies with a steep north-facing slope, forming large, occasionally pure stands with thick carpets of *Brachythecium* and *Sanionia*, although they are rarely found above 50 m in altitude (Lindsay 1971). An open community of predominantly *Deschampsia* and *Polytrichum piliferum* extends for several kilometres on the sandy, dry, flat raised beaches on South Beaches. A unusual growth form of the grass, forming isolated mounds 25 cm high and up to 2 m across, occurs on the beach near Sealer Hill. *Deschampsia* has been reported at only one locality on the north coast (Lair Point), where it forms small stunted tufts (Lindsay 1971).

INVERTEBRATES

The invertebrate fauna on Byers Peninsula thus far described comprises (Usher and Edwards 1986, Richard et al., 1994, Block and Stary 1996, Convey et al., 1996, Rodriguez and Rico, 2008): six Collembola (*Cryptopygus antarcticus, Cryptopygus badasa, Friesea grisea, Friesea woyciechowskii, Isotoma* (*Folsomotoma*) *octooculata* (=*Parisotoma octooculata*) and *Tullbergia mixta*; one mesostigmatid mite (*Gamasellus racovitzai*), five cryptostigmatid mites (*Alaskozetes antarcticus, Edwardzetes dentifer, Globoppia loxolineata* (=*Oppia loxolineata*), *Halozetes belgicae* and *Magellozetes antarcticus*); nine prostigmatid mites (*Bakerdania antarcticus, Ereynetes macquariensis, Eupodes minutus, Eupodes parvus grahamensis, Nanorchestes berryi, Nanorchestes nivalis*, *Pretriophtydeus tilbrooki, Rhagidia gerlachei, Rhagidia leechi*, and *Stereotydeus villosus*); two Dipterans (*Belgica antarctica* and *Parochlus steinenii*), and two oligochaetes (*Lumbricillus healyae* and *Lumbricillus* sp.), one copepod (*Boeckella poppei*), one crustacean (*Branchinecta gainii*) and one cladoceran (*Macrothrix ciliate*).

Larvae of the wingless midge *Belgica antarctica* occur in limited numbers in moist moss, especially carpets of *Sanionia*, although it is of very restricted distribution on Byers Peninsula (found especially near Cerro Negro) and may be near its northern geographical limit. The winged midge *Parochlus steinenii* and its larvae inhabit the margins of inland lakes and pools, notably Midge Lake and another near Usnea Plug, and are also found amongst the stones of many stream beds (Bonner and Smith 1985, Richard et al., 1994, Ellis-Evans pers. comm., 1999, Rico et al., 2013). During warm calm weather, swarms of adults may be seen above lake margins.

The diversity of the arthropod community described at Byers Peninsula is greater than at any other documented Antarctic site (Convey et al., 1996). Various studies (Usher and Edwards 1986, Richard et al., 1994, Convey et al., 1996) have demonstrated that the arthropod population composition on Byers Peninsula varies significantly with habitat over a small area. *Tullbergia mixta* has been observed in relatively large numbers; it appears to be limited in Antarctic distribution to the South Shetland Islands (Usher and Edwards 1986). Locally, the greatest diversity is likely to be observed in communities dominated by moss cushions such as *Andreaea* spp. (Usher and Edwards 1986). Further sampling is required to establish populations and diversities with greater reliability. While further sampling at other sites may yet reveal the communities described at Byers Peninsula to be typical of similar habitats in the region, available data on the microfauna confirm the biological importance of the Area.

MICROORGANISMS

An analysis of soil samples collected from Byers Peninsula yielded several nematophagous fungi: in soil colonised by *Deschampsia* were found *Acrostalagmus goniodes, A. obovatus, Cephalosporium balanoides* and *Dactylaria gracilis*, while in *Colobanthus*-dominated soil was found *Cephalosporium balanoides* and *Dactylella gephyropaga* (Gray and Smith 1984). The basidiomycete *Omphalina antarctica* is often abundant on moist stands of the moss *Sanionia uncinata* (Bonner and Smith 1985). Thirty seven nematode taxa have been recorded, with samples showing great variation in richness and abundance making Byers Peninsula a nematode biodiversity hotspot (Nielsen et al., 2011).

Some of the water bodies have high microbial biodiversity (Velazquez et al., 2010; Villaescusa et al., 2010) including the largest viral genetic diversity found in Antarctic lakes (López-Bueno et al., 2009)

BREEDING BIRDS

The avifauna of Byers Peninsula is diverse, although breeding colonies are generally not large. Two species of penguin, the chinstrap (*Pygoscelis antarctica*) and the gentoo (*P. papua*), breed in the Area.

Adélie penguins (*P. adeliae*) have not been observed to breed on Byers Peninsula or its offshore islets. In the South Shetlands Islands, Adélie penguins only breeds on King George Island where the populations are declining (Carlini et al. 2009).

The principal chinstrap penguin colony is at Devils Point, where a rough estimate of about 3000 pairs was made in 1987; a more accurate count made in 1965 indicated about 5300 pairs in four discrete colonies, of which almost 95% were nesting on Demon Island, 100 m to the south of Devils Point (Croxall and Kirkwood 1979; Woehler 1993). Two colonies of about 25 chinstrap penguin pairs surrounded by a colony of gentoo penguins can be found on the President Beaches close to Devils Point (Barbosa et al., 2013). Small chinstrap penguin colonies have been reported on the northern coast, e.g. on Robbery Beaches (50 pairs in 1958; Woehler 1993), but no breeding pairs were reported there in a 1987 survey. In other locations, Lair Point contained 156 pairs in 1966, declining to 25 pairs in 1987 (Woehler 1993). In a recent visit to the area (January 2009) 20 pairs were counted (Barbosa pers.com).

Gentoo penguins breed at several colonies on Devils Point, with approximately 750 pairs recorded in 1965 (Croxall and Kirkwood 1979, Woehler 1993). Currently three colonies of about 3000 pairs in total can be found (Barbosa pers.com). On the northern coast, a rookery of three colonies with 900 pairs in total is located in Robbery Beaches (Woehler 1993). In a visit to Lair Point in January 2009, about 1200 pairs were counted. Woehler (1993) gives no data on gentoo penguins at this location.

Recent estimations of population size for some species of flying birds were obtained from a survey conducted in December 2008 and January 2009 (Gil-Delgado et al., 2010). The Antarctic tern (*Sterna vittata*) population was estimated at 1873 breeding pairs. Two hundred and thirty eight pairs of southern giant petrels (*Macronectes giganticus*) and 15 pairs of brown skua (*Catharacta lonnbergi*) nest locally. A detailed survey of other breeding birds was conducted in 1965 (White 1965). The most populous breeding species recorded then, with approximately 1760 pairs, was the Antarctic tern (*Sterna vittata*), followed by 1315 pairs of Wilson's storm petrels (*Oceanites oceanicus*), approximately 570 pairs of cape petrels (Daption capense), 449 pairs of kelp gulls (*Larus dominicanus*), 216 pairs of southern giant petrels, 95 pairs of black-bellied storm petrels (*Fregetta tropica*), 47 pairs of blue eyed cormorants (*Phalacrocorax atriceps*) (including those on nearshore islets), 39 pairs of brown skuas, and 3 pairs of sheathbills (*Chionis alba*). In addition, prions (*Pachytilla* sp.) and snow petrels (*Pagodroma nivea*) have been seen on the peninsula but their breeding presence has not been confirmed. The census of burrowing and scree-nesting birds is considered an underestimate (White pers. comm. 1999). The majority of the birds nest in close proximity to the coast, principally in the west and south.

Recently some vagrant waders, probably white-rumped sandpipers (*Calidris fuscicollis*) have been seen frequently foraging in some streams in the southern beaches (Quesada pers. comm. 2009).

BREEDING MAMMALS

Large groups of southern elephant seals (*Mirounga leonina*) breed on the Byers Peninsula coast, with a total of over 2500 individuals reported on South Beaches (Torres et al., 1981), which is one of the largest populations of this species recorded in the South Shetland Islands. A estimation made in 2008-2009 showed a population ranging from 4700 to 6300 individuals (Gil-Delgado et al., 2013). Large numbers haul out in wallows and along beaches in summer. Weddell (*Leptonychotes weddellii*), crabeater (*Lobodon carcinophagous*) and leopard (*Hydrurga leptonyx*) seals may be seen around the shorelines. Antarctic fur seals (*Arctocephalus gazella*) were once very abundant on Byers Peninsula (see below), but have not substantially recolonised the Area in high numbers in spite of the recent rapid population expansion in other parts of the maritime Antarctic.

HISTORICAL FEATURES

Following discovery of the South Shetland Islands in 1819, intensive sealing at Byers Peninsula between 1820 and 1824 exterminated almost all local Antarctic fur seals and southern elephant seals, though sealing was revived periodically through the rest of the century. American and British sealers built dry-stone refuges and occupied caves around the shores of the Byers Peninsula, which constitute the greatest concentration of early 19th Century sealers' refuges and associated relics in the Antarctic and these are vulnerable to disturbance and/or removal. Archaeological survey and excavations over the last 30 years have documented these sites and provided a rich history of the lives and activities of the sealers (Stehberg 2003; Zarankin and Senatore 2005, 2007; Lewis-Smith and Simpson 1987).

Sealers' camps consist of stone enclosures shown to have been used for habitation, and other structures of various shapes the functions of which remain unknown. In all cases, structures were built with local stone with whale ribs and jaw bones used as roof supports for canvas or seal skin roofing. The shelters were built against rock outcrops or within caves to provide shelter from the weather. Whale vertebrae commonly served as seating. The use of foreign materials was restricted to old sails (in the case of roofs) and wood (in the case of some roof beams). Some wood pieces show working or copper mails, indicating their being obtained from the remains of wrecked ships or boats. The number, shape, and size of the structures varied. Most sites had only one or two enclosures, but others included multiple structures. Buildings were square, rectangular, or round. In general, none of these structures exceeded 15 square meters; walls were approximately 1.2 meters high. Material remains found in the camps were primarily made of wood and bone, with some textile, metal, ceramic, and glass objects. The distribution of artefacts makes it possible to distinguish cooking, sleeping and work areas within the shelters, and work functions in some of the annexes.

In the shelters lived in by the sealers, material remains include iron pots, stoneware jugs, and wine/spirit bottles, suggesting the shared consumption of food in which the members of a gang ate or drank from the same containers. Faunal assemblages provide information on sealers' diet. In general, food was obtained from local resources—mainly from the seals and elephant seals the men had to kill to get oil and skins. Only a small proportion of the remains corresponded to foreign resources brought from the vessels—for instance, salted meat and pork (Muñoz 2000; Cruz 2016, 2018).

Clothing remains—including textiles and leather shoes—are also found in the shelters. Some of these articles showed signs of intense repair and recycling, such as stitched rips and patches. Sealers' clothes were not fit for the purpose of their work and the life in the severe environment of the South Shetland Islands. However, people did the best they could to retain these articles in use (Salerno 2007, 2011; Radicchi 2015). Evidence of leisure activities, including clay pipes and gaming pieces and boards (made of salvaged wood and leather), and carved whale and seal teeth, suggest pastimes during rest periods, bad weather, and when seals were not available.

Table 1 provides the location and description of the known sealing sites, to enable researchers to identify them and avoid their disturbance.

Table 1. Sealing sites on the Byers Peninsula

Unofficial name	Coordinates	Description
Lima Lima 1 Cave	62° 36′ 55.62″S 61° 02′ 13.08″W	Cave at the base of a small rocky hill, fronting the sea. Northern Beaches. Cave 3.5 m high, 22 m deep, and 6 m wide. Excavated in 1994-95 (Zarankin & Senatore 2007: 90-91, 124-129, 174-175, Muñoz 2000), and again in 2018-19 by Andres Zarankin.
Lair Point 1	62° 36′ 54.78″S 61° 02′ 06.3″W	Stone hut and annex built against a rock stack. Northern Beaches (Zarankin & Senatore, 2007: 93).
Robbery Beach 1	62° 37′ 19.02″S 61° 01′ 56.58″W	Stone structure between rock stacks. Northern Beaches. (Zarankin & Senatore, 2007: 91-92).
Cutler 1	62° 37′ 38.34″S 60° 59′ 54.18″W	Stone shelter against a rock stack, Northern Beaches. Dug by British naturalists in the 1950-80s period (Lewis-Smith & Simpson 1987: 61-65) (Zarankin & Senatore, 2007: 94-94).
Cutler 2	62° 37′ 38.34″S 60° 59′ 54.18″W	Stone structure against a rock stack. Northern Beaches (Zarankin & Senatore, 2007: 96).
Cutler 1 Tryworks	63° 37′ 36.24S, 60° 59′ 56.4″W	Two concreted oil and stone circles c. 43 cm internal, 75 cm external diameter, 1.8m apart, bases for try pots. Flat area 1.3 m sq, 6 m west of pot sites, possible work area. On beach berm at western end of beach 100 m NE of Cutler 1 shelter site. Located 2017.
Negro Hill 1- 4	62° 39′ 43.08″S 61° 00′ 11.82″W	Four stone-walled structures against a rock stack, Southern Beaches. excavated in 1999. It had been occupied at two different times during the 19th century, the only multiple-occupation as yet documented (Zarankin & Senatore, 2007: 68-70).
South Beaches 1	62° 39′ 40.02″S 60° 58′ 34.56″W	Stone wall linking a low rock ridge adjacent to a beach lagoon, Southern Beaches. Excavated between 1995 and 1997 (Zarankin & Senatore, 2007: 66-67)
South Beaches (new)	62° 39′ 41.52″S, 61° 04′ 11.34″W	Rectangular stone structure, 2.3-3 m long and 2 m wide, on the back of the front beach berm, 40 m from shore, half-way between Negro Hill and Sealers Hill. Located 2014.
Stackpole 1	62° 39′ 54.42″S 60° 57′ 10.26″W	A low line of stones on open beach 60m from Stackpole Stack, Eastern end of Southern Beaches (Zarankin & Senatore, 2007: 63-64).
Stackpole 2	62° 39′ 55.86″S 60° 56′ 31.74″W	Stones and whale bones on open beach terrace, Eastern end of Southern Beaches. Interpreted by Pearson (2018) as boat camp site. (Zarankin & Senatore, 2007: 65-66).
Point X-1	62° 40′ 16.62″S 60° 55′ 44.88″W	Three stone walls against a rock stack in beach boulders close to the sea and a lagoon separating it from other Punta X sites. Eastern end of Southern Beaches. Excavated 2012 (Zarankin & Senatore, 2007: 59).
Point X-2	62° 40′ 15.00″S 60° 55′ 27.54″W	Stone walled structure with whale jaw against a big sea stack . Eastern end of Southern Beaches. Excavated 2012 (Zarankin & Senatore, 2007: 60-61).
Point X-3	62° 40′ 16.32″S 60° 55′ 25.02″W	Stone walled structure with whale ribs against a rock stack. Eastern end of Southern beaches. Excavated 2012 (Zarankin & Senatore, 2007: 62-63).
Victor Rocks 1	62° 40′ 29.04″S 61° 05′ 42″W	Three stone walls 2.1 x 1.8 m against a very large rock stack. Whale ribs and vertebra seats. Western end of Southern Beaches (Zarankin & Senatore, 2007: 71- 72). Recorded by biologist Martin White 1965/66.
Victor Rocks 2	62° 40′ 29.46″S 61° 05′ 48.3W	Large stone structure of 5.4 x 2.4 m with an annex of 2.1 x 1.5 m. Walls to 1.3 m high. Among rock stacks. Western end of Southern Beaches (Zarankin & Senatore, 2007: 72-73) Recorded by biologist Martin White 1965/66.
Victor Rocks 3	62° 40′ 29.28″S 61° 06′ 2.58″W	2.5 m long double line of stones with whale skull bone at the end. Western end of Southern beaches (Zarankin & Senatore, 2007: 74). Interpreted by Pearson (2018) as possible boat campsite.
Sealer Cave 1	62° 40′ 26.94″S 61° 06′ 47.58″W	Stone-walled structure and an annex against a rock stack. Western end of Southern beaches. Excavated by Zarankin 2017 (Zarankin & Senatore, 2007: 75-76).

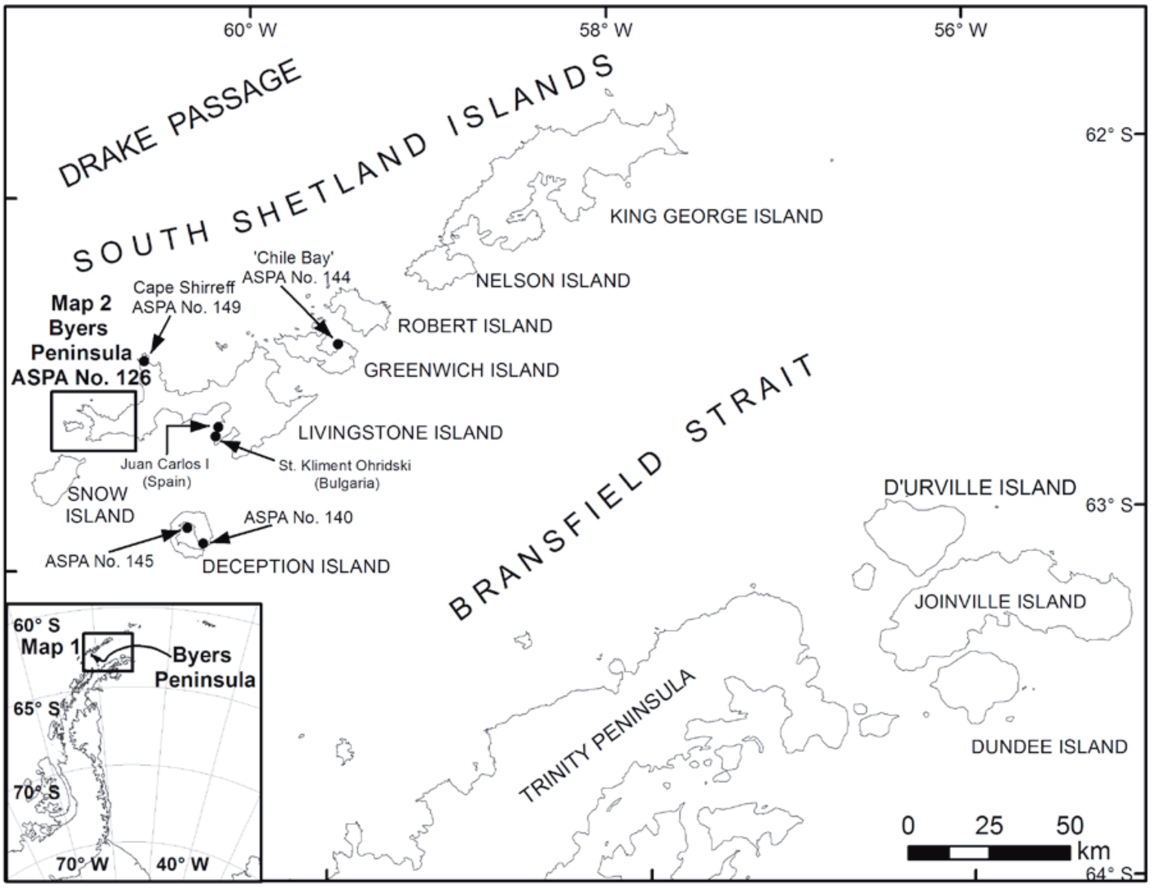
Unofficial name	Coordinates	Description
Sealer Cave 2	62° 40′ 21.42″S 61° 06′ 52.08″W	A structure made up of a series of curved walls of stone forming a roughly circular space. Between two rock stacks (Zarankin & Senatore, 2007: 76-77).
Sealer Cave 3	62° 40′ 23.08″S 61° 06′ 12.02″W	Stone-walled structure and an annex containing a whale jaw bone. On small 3 m high outcrops east of Sealers Hill on Western end of Southern Beaches. Excavated 1995, 2010 (Zarankin & Senatore, 2007: 78-79; Zarankin et al., 2011: 20-25; Moreno, 2000; Villagran & Schaefer, 2011).
Sealer Cave 4	62° 40′ 20.4″S 61° 06′ 17.16″W	Two stone-walled enclosures, one on each side of an isolated low rock outcrop. Western end of Southern beaches. Excavated 2010. (Zarankin & Senatore, 2007: 79-80; (Villagran & Schaefer, 2011).
Sealer Cave	62° 40′ 27.52″S 61° 06′ 47.10″W	Lewis Smith and Simpson reported cave in the 1950s with a stone wall across the rear of the cave, with timbers and seal bones on the floor. Not now visible. Western end of Southern beaches. (Lewis-Smith & Simpson 1987: 60; Zarankin & Senatore, 2007: 80-81).
Long Rocks	62° 40′ 26″S 61° 08′ 32.4″W	An area of 1.2 x 3 m with a high density of artefacts (leather shoes, fragments of wood, glass), between rock stack and parallel rock outcrop. (Zarankin & Senatore, 2007: 82-83).
Devil Point 1	62° 40′ 18.66″S 61° 10′ 42″W	Stone wall hut contains whale jaw bone suggesting roof support. Against sloping rock outcrop. Devils Point (Zarankin & Senatore, 2007: 81-82).
Devil Point 2	62° 39′ 49.08″S 61° 09′ 32.7″W	Located at the northern edge of a penguin rookery on the slope of a hill sheltered by a vertical stack. Devils Point. Reported in the 1950s, recorded by biologist Martin White 1965/66 as: 'Small hut 8′ x 7′ hut constructed on sledge runners and planking; charcoal & clinker from a cast iron stove; oil soaked into floor material'. In 2007 only the remains of a sledge were located and excavated, with no other evidence of occupation (Zarankin & Senatore, 2007: 84-85; Pearson et al., 2008; Stehberg et al., 2009).
Punta Varadero	62° 36′ 29.8″S 61° 04′ 51.84″W	Three stone walls enclosing an area of 2.4 x 2.1 m. The hut contains four whale ribs suggesting roof supports. The annex behind contains one whale rib. Between a rock stack and 1.5 m high rocks. Northern Beaches. Exacavated 2011 (Zarankin & Senatore, 2007: 85-86).
Pencas 1	62° 36′ 26.1″S 61° 06′ 5.34″W	Three stone walls against rock stack, 15 m away from an elephant seal colony. West of Punta Varadero, Northern Beaches. Excavated 1995 (Zarankin & Senatore, 2007: 87). Recorded by biologist Martin White 1965/66.
Pencas 2	62° 36′ 24.84″S 61° 06′ 14.52″W	Small rock shelter formed between two large sloping rocks. Northern Beaches. (Zarankin & Senatore, 2007: 88). Recorded by biologist Martin White 1965/66.
Pencas 3	62° 36′ 10.62″S 61° 06′ 20.34″W	Straight stone walls enclose a roughly square space. It contains whale vertebra "seats". 6 x 4 m. Placed on an open stone terrace on a small peninsula. East of a large berm-enclosed lake. Northern Beaches. Excavated 2012 (Zarankin & Senatore, 2007: 89).

HUMAN ACTIVITIES/IMPACTS

The modern era of human activity at Byers Peninsula has been largely confined to science. The impacts of these activities have not been fully described, but are believed to be minor and limited to items such as campsites, trampling (Tejedo et al., 2012; Pertierra et al., 2013a), markers of various kinds, sea-borne litter washed onto beaches (e.g., from fishing vessels) and from human wastes and scientific sampling. More recently the impacts of the field activities originating from the International Field Camp (62°39′49.7′′ S, 61°05′59.8′′ W) between 2001-2010 were quantified (Pertierra et al., 2013b). Several wooden stake markers and a plastic fishing float were observed in the southwest of the Area in a brief visit made in February 2001 (Harris 2001). In summer 2009-2010, a beach litter survey was undertaken (L. R. Pertierra pers. comm. 2011).

The highest proportion of litter on beaches (averaged over beach length) was found in Robbery Beach (64%) followed by President Beach (28%) and beaches to the southwest of the Area (8%). This is likely to be related to their exposure to the Drake Passage (Torres and Jorquera, 1994). The majority of the litter found on the three beaches was wood (78% by number of items) and plastic (19%) whereas metal, glass and cloth were found more rarely (less than 1%). Several pieces of timber were found, some of them quite large (several meters in length). The plastic items were highly diverse, with bottles, ropes and tape the most numerous items. Floats and glass bottles were also found on the beaches. Further research to quantify beach plastic was undertaken by Almela and Gonzalez (2020) while González-Pleiter et al. (2020) reported finding microplastics in a stream at the Southern Beach.

Map 1. Byers Peninsula, ASPA No. 126, Livingston Island, South Shetland Islands, location map. Insert: location of Byers Peninsula on the Antarctic Peninsula.



Map 2. ASPA 126: Byers Peninsula topographic map.