Management Plan

Antarctic Specially Protected Area No. 1XX
FARRIER COL, HORSESHOE ISLAND, MARGUERITE BAY

Introduction

The primary reason for the designation of Farrier Col, Horseshoe Island, Marguerite Bay (Lat. 67°49' S, Long. 67°13' W; area c. 0.4 km^2) as an Antarctic Specially Protected Area (ASPA) is to protect scientific and environmental values associated with the freshwater lakes in the Area (see Maps 1 and 2). The Area also protects outstanding wilderness and aesthetic values.

ASPA 1XX consists of largely ice-free undulating ground located on Farrier Col, at an altitude of c. 90 to 160 m above sea level and located more than 500 m from the coast (Map 2). The Area is considered to be of sufficient size as it incorporates the scientifically important lakes and much of the associated lake catchment areas.

Farrier Col was originally designated as an Antarctic Specially Protected Area through Resolution X (202X) after a proposal by Belgium, Türkiye and the United Kingdom. It was designated on the grounds that the Area contains a combination of outstanding scientific and environmental values associated with its freshwater lakes.

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 to the Protocol (see also Morgan *et al*., 2007). Using this model, ASPA 1XX Farrier Col, Horseshoe Island, Marguerite Bay, is contained within Environment Domain B (Antarctic Peninsula mid-northern latitudes geologic). Other protected areas contained within Domain B include ASPAs 108, 115, 134, 140, 153, 177 and ASMA 4. Resolution 3 (2017) further 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 Article 3(2) of Annex V to the Environmental Protocol. ASPA 1XX is located within ACBR 3 Northwest Antarctic Peninsula (Resolution 3 (2017)).

Five other ASPAs are present within the Marguerite Bay area (ASPA 107 Emperor Island, Dion Islands, Marguerite Bay, Antarctic Peninsula; ASPA 115 Lagotellerie Island, Marguerite Bay, Graham Land; ASPA 117 Avian Island, Marguerite Bay, Antarctic Peninsula; ASPA 129 Rothera Point, Adelaide Island; and ASPA 177 Léonie Islands and South-east Adelaide Island, Antarctic Peninsula) (see Map 1). ASPAs 107 and 117 were designated to protect primarily their avifauna, ASPA 129 was designated to monitor the impact of the nearby Rothera Research Station on an Antarctic fellfield ecosystem and ASPA 115 was designated to protect regionally rich terrestrial biological communities. ASPA 177 was designated to protect the avifauna and terrestrial biological communities of the area, established research sites and wilderness and aesthetic values. Therefore, ASPA 1XX Farrier Col, Horseshoe Island, Marguerite Bay, complements the local network of ASPAs by primarily protecting freshwater lake environments, which are little represented in other protected areas in the region.

1. Description of values to be protected

The proposed ASPA contains a combination of outstanding scientific, environmental, wilderness and aesthetic values.

- Sediment cores from Puller Lake contain material radiocarbon dated to 36,000 years old, with unequivocal evidence of biological occupation from at least 29,000 years ago for aquatic mosses and 21,000 years ago for zooplankton. This is the longest known biological occupation of any lake in the Antarctic Peninsula region, most being less than 9000 years old. Thus, these lakes were likely refugia for biota through the last glacial cycle – one of very few such locations known – and make the site of importance for future scientific research.
- The oligotrophic lakes are exceptional as few other examples exist in the region. Furthermore, the lakes contain the fairy shrimp, *Branchinecta gaini* (Daday 1910), which is the largest freshwater invertebrate in Antarctica, and form the southern boundary of its known range on Horseshoe Island.
- The Area has been subject to little human impact and no human infrastructure is present. With the exception of scientific and operational personnel working at the Turkish Scientific Research Camp, the number of visitors to the vicinity of the Area is low, but tourist visitation is increasing. The Area is situated in a location with exceptional views of the ocean, and the mountains and glaciers of islands in Marguerite Bay and the Antarctic Peninsula. As a result, the Area is considered to be of outstanding aesthetic and wildness value.

2. Aims and objectives

Management at Farrier Col aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance to the Area;
- allow scientific research in the Area provided it is for compelling reasons that cannot be served elsewhere, and which will not jeopardise the natural ecological system in the Area;
- allow visits for management purposes in support of the aims of the Management Plan;
- prevent or minimise the introduction to the Area of non-native plants, animals and microorganisms;
- preserve the natural ecosystem of the Area as a reference area for future studies.

3. Management activities

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

- Visits shall be made as necessary to assess whether the ASPA continues to serve the purpose for which it was designated and to ensure management and maintenance measures are adequate.
- The Management Plan shall be reviewed at least every five years and updated as required.
- Markers, signs or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition and removed when no longer required.
- In accordance with the requirements of Annex III to the Protocol on Environmental Protection to the Antarctic Treaty, abandoned equipment or materials shall be removed to the maximum extent possible, provided doing so does not adversely impact the environment and the values of the Area.
- A copy of this Management Plan shall be made available at Rothera Research Station (UK;Lat. 67°34′ S, Long. 68°07′ W), Teniente Luis Carvajal Station (Chile; Lat. 67°46′ S, Long. 68°55′ W) San Martín Base (Argentina; Lat. 68°08′ S, Long. 67°06′ W) and the Turkish Scientific Research Camp (Lat. 67°49′ S, Long. 67°14′ W).
- Copies of this Management Plan shall be made available to vessels and aircraft planning to visit the vicinity of the Area.
- All scientific and management activities undertaken within the Area shall be subject to an Environmental Impact Assessment, in accordance with the requirements of Annex I to the Protocol on Environmental Protection to the Antarctic Treaty.
- Visiting field parties shall be briefed fully by the national authority on the values to be protected within the Area and the measures and mitigation measures detailed in this Management Plan.
- All pilots operating in the region will be informed of the location, boundaries and restrictions applying to entry and overflight within the Area.
- National Antarctic programmes operating in the Area will consult together to ensure the implementation of the management activities detailed above.

4. Period of designation

The ASPA is designated for an indefinite period.

5. Maps

Map 1. Antarctic Specially Protected Area No. 1XX, Farrier Col, Horseshoe Island, Marguerite Bay, location map, showing the location of the Turkish Scientific Research Camp (Türkiye), San Martín Base (Argentina), Teniente Luis Carvajal Station (Chile) and Rothera Research Station (UK). Also shown are the locations of the other protected areas in the region: Rothera Point, Adelaide Island (ASPA 129), Emperor Island, Dion Islands, Marguerite Bay, Antarctic Peninsula (ASPA 107), Leonie Islands and South-east Adelaide Island, Antarctic Peninsula (ASPA 177), Lagotellerie Island, Marguerite Bay, Graham Land (ASPA 115) and Avian Island, Marguerite Bay, Antarctic Peninsula (ASPA 117). 'Base Y' (UK) (Historic Monument No. 63) on Horseshoe Island is shown. Inset: the location of the region relative to the Antarctic Peninsula.

Map 2. Antarctic Specially Protected Area No. 1XX, Farrier Col, Horseshoe Island, Marguerite Bay. Inset (left): Location of Horseshoe Island in relation to the Antarctic Peninsula. Inset (right): Location of Farrier Col in relation to Horseshoe Island.

6. Description of the Area

6(i) Geographical coordinates and natural features

Boundaries and co-ordinates

The Area encompasses all of the ice-free ground, permanent ice, semi-permanent ice and lakes found within the boundaries (see Map 2 and the boundary co-ordinates provided in Table 1). In large part, the ASPA boundary encloses the catchment area of the lakes, and generally includes a 10-20 m buffer zone beyond the catchment area extent. The ASPA is divided into two sub-sites (northern site and southern site) by a corridor (c. 50 m wide) that is used as a safe route to access the rest of the island from the Turkish Scientific Research Camp. The corridor passes through the catchment areas of Rasp, Puller and Pritchel Lakes, which has necessitated the need for measures to reduce the risk of impacts to the lakes (see section *6(ii) Access to the Area*). To the north of the lakes, the catchment area likely extends to the summit of Mt Searle across areas of permanent ice (see Map 2). To allow access to the rest of the island via routes over permanent ice to the north of the lakes (and to the south of Mt. Searle), the northern boundary of the ASPA follows the current extent of ice-free ground. The position of the boundary may need to be revised should the extent of the permanent ice change, for instance, as a result of climate change.

General description

Horseshoe Island is the third largest island within the Marguerite Bay, with an area of c. 60 km^2. Glaciers or semi-permanent ice and snow cover 66% of the island. Mount Searle (537 m a.s.l.) and Mount Breaker (879 m a.s.l) are the highest peaks on the island. Farrier Col is a largely ice-free area located in an isthmus at the centre of the island. Four freshwater lakes are located on the plateau of Farrier Col (c. 90 m a.s.l.) and are the main features protected within the ASPA.

Climate

Marguerite Bay and the islands to the west of the Fallières Coast are under a cold and dry maritime climate (Yıldırım, 2020). Climatic data collected at Base Y for four years (1955/56 to 1958/59) showed the mean annual temperature to be -6.9 ^{o}C, mean daily duration of sunshine from February to March to be 5.5 h, mean annual relative humidity as 76%, and the average number of days per year with cloud and gales 217 and 30 days, respectively (Longton, 1967). A weather station was installed on Farrier Col (Lat. 67°49'47" S, Long. 68°14'04" W) by the Turkish State Meteorological Service in 2020. Climatic data for Farrier Col is available for the period Feb 2020 to Feb 2023 and is shown in Table 2.

Geology

The geology of Horseshoe Island is complex and exhibits a large degree of variation (Matthews, 1983). The southern half of the island is dominated by coarse grained/megacrystic granite that has been dated as Late to Mid-Cretaceous (106 – 67 Ma). The granites intrude earlier, more mafic intrusive rocks (gabbro-diorite), with the granite being cut by north-south trending dolerite dykes. Gneissose metamorphic rocks are locally dominant across eastern Horseshoe Island at Square Bay and Bourgeois Fjord.

The geology of the isthmus region, which includes Farrier Col, is also complex and is dominated by strongly foliated black schists, quartz-mica schists and silicified metasedimentary rocks. The metasedimentary succession has a near vertical foliation across the low-lying, but prominent, hillocks of this region (e.g., Forge, Blacksmith and Bellows Knolls). There are also coarse grained, matrix-supported conglomerate units associated with the metasedimentary rocks, which are host to granite cobbles that have been dated as Silurian in age. The metasedimentary rocks are intruded by gneissic granite, which is in turn intruded by a later granodiorite pluton that is characterized by abundant mafic xenoliths. The entire succession is cut by quartz-feldspar porphyry dykes. Volcanic rocks are reported from the northeast of Gaul Cove and comprise dark grey laminated siliceous units associated with agglomerate dykes (Matthews, 1983).

Geomorphology

Horseshoe Island is of considerable interest in terms of its glacial and periglacial landscape evolution and for glacio-isotatic investigations because of well-preserved landforms and deposits (Yıldırım, 2020). Horseshoe Island is comprised of three distinct geomorphologic sectors, i.e., the northern, central and southern sectors (see Map 2, second inset). The northern and southern sectors are still under the influence of glaciers, with the northern sector partly covered by a remnant of an ice cap and the higher, larger and more rugged southern sector containing a diverse range of erosional glacial landforms such as nunataks, horns, arètes, glacial steps, cirques and truncated spurs.

Farrier Col is located within the central sector and is rich in terms of glacial and periglacial landforms and deposits such as frost shattered bedrock, patterned ground and talus cones. The plateau area of Farrier Col is around 90 m a.s.l where four freshwater lakes are situated. The plateau resembles a subtle knock and lochan topography with irregular depressions. Till produced as a result of palaeoglacial activity on Farrier Col plateau is generally not well preserved. However, this till is the source of the finer material that is found in frost-sorted polygons. Glacial till, within an east–west oriented high moraine, defines the boundary between Farrier Col and the more glaciated northern sector. The terminal moraine of Shoesmith Glacier defines the boundary between the southern sector and Farrier Col. The presence of several moraine ridge crests on Farrier Col indicates the recent recession of Shoesmith Glacier. The western and eastern coasts of Farrier Col comprise well-preserved uplifted shorelines as an indicator of glacio-isostatic processes.

Freshwater bodies

The Area contains approximately 38,700 m^2 of lacustrine environment in the form of the four oligotrophic lakes: Clincher Lake, Puller Lake, Pritchel Lake in the northern sub-site, and Rasp Lake in the southern sub-site. The size and depth of the lakes may vary due to changing levels of meltwater input from surrounding snow slopes and levels of evaporation. All the lakes have a closed catchment, i.e., they do not have outflows.

1. **Puller Lake** is an elongate, shallow clear water lake, 162 m long, 64 m wide (approximate area 8600 m^2) and up to 3.2 m deep situated at an altitude of c. 90 m above sea level. The water chemistry is typical of a polar freshwater oligotrophic lake (see Table 3). Profiles of the water column (measured on 17 Jan 2003) showed a marginally warmer surface layer to 1.6 m followed by steady cooling through the lower water column. The water column is otherwise well mixed with little change in conductivity, and no evidence of oxygen depletion with depth. Of the four lakes on Farrier Col, Puller Lake has been subject to the highest level of scientific investigation.
2. **Clincher Lake** is the most westerly of the lakes on Farrier Col. It is roughly circular in shape, has a maximum width of c. 115 m. and has an area of approximately 6850 m^2. Details of its water chemistry are available in Table 3.
3. **Pritchel Lake** is the most north-easterly and largest of the lakes on Farrier Col. It is roughly circular in shape with a maximum width of c. 175 m and an area of approximately 14,500 m^2. A small island, c. 20 x 30 m across, is present in Pritchel Lake; decreases in water level can cause the development of an isthmus on the south side of the island that can link the island to the rest of the col (as shown by aerial images collected at different times). Details of its water chemistry are available in Table 3.
4. **Rasp Lake** is the only lake within the Area's southern sub-site. It is an elongate lake, c. 170 m long and 90 m wide, with an approximate area of 8750 m^2. Its catchment area extends southwest to the summit of Forge Knoll, northeast to the summit of Blacksmith Knoll and south to the summit of Bellows Knoll. Rasp Lake has not been the subject of substantial research activity.

Freshwater biological communities

The diversity of Antarctic freshwater fauna is poor, as compared with the marine fauna, owing to the more extreme and variable environmental conditions. Comprehensive investigations into the biological communities present within the lakes of Farrier Col have not been undertaken. However, Puller Lake contains the fairy shrimp, *Branchinecta gaini* (Daday 1910), which is the largest freshwater invertebrate in Antarctica, with a length of 16 mm, and is present at the southern boundary of its known range on Horseshoe Island. It generally survives the winter as dormant eggs, with juveniles and adults being microbivorous. The freshwater copepod *Boeckella poppei* is found in several lakes on Horseshoe Island including Puller Lake (Hodgson *et al*., 2013; Maturana *et al*., 2022). Being only c. 3.2 m deep, light penetrates to the bottom of Puller Lake, resulting in well-developed benthic and epilithic mats of cyanobacteria, and a grazing zooplankton community (Hodgson *et al*., 2013).

Diatoms are silica-shelled eukaryotic aquatic phytoplankton that are amongst the most important primary producers and play roles in various biogeochemical processes. The occurrence of different diatom species is strongly influenced by the chemical characteristics of a water body. Shifts in dominant diatom species over time can therefore be used as a proxy for reconstructing past environmental changes (Wasell & Håkansson, 1992). Therefore, sediments in the lakes on Horseshoe Island, including Farrier Col, can be used to track past environmental changes, particularly given the exceptional length of their sedimentary record. Analysis of the diatom community in a sample containing mosses from the littoral zone of Puller Lake showed 12 species in total, based on the analysis of 400 specimens. The diatom community was dominated by a several *Gomphonema* species. *Psammothidium subatomoides, Humidophila australis* and *Pinnularia australomicrostauron* all had a relative abundance between 3 and 1.5%; other species had a relative abundance below 1% (Verleyen *et al*. 2021). Further work on samples collected from Puller Lake and Clincher Lake suggested the presence of the diatom species *Gomphonema sarcophagus*, *Planothidium lanceolatum*, *Achnanthes* spp., *Achnanthes sinaensis*, *Achnanthidium* spp., *Navicula* spp. and several unidentified species (Cura, 2020).

Analysis of the 16S and 18S rRNA genes in a sample containing mosses from the littoral zone of Puller Lake using high-throughput sequencing showed that four of the most abundant prokaryotic operational taxonomic units (OTUs) belonged to the Cyanobacteria and another OTU was an unclassified Bacteroidetes belonging to the Saprospiraceae. Two OTUs that could be classified to the genus level belonged to the cyanobacterial genera *Leptolyngbya* and *Pseudanabaena*. Two out of the five most abundant eukaryotic OTUs were classified as species belonging to the tardigrade genera *Acutuncus* and *Diphascon*. The three other dominant eukaryotic OTUs were a protist belonging to the *Labyrinthulea*, a green algae and an unclassified rotifer (E. Verleyen, pers. comm., 13 January 2023).

The lakes of Farrier Col were likely refugia for biota through the last glacial cycle (see section on Glacial History), and as such are one of very few such locations known in Antarctica. Consequently, the lakes are of substantial importance for future scientific research.

Terrestrial biological communities

While no comprehensive survey of terrestrial and freshwater biodiversity has been undertaken within the Area, it is thought that the biota of Farrier Col will comprise a subset of the species found elsewhere on Horseshoe Island (BAS, 2020). A list of vascular plant, moss, lichen, cyanobacteria and algal species recorded on the island is provided in Table 4. Patchy moss beds are present within the Area, particularly towards the edges of the lakes. While little is known of the Area's terrestrial invertebrate fauna, Block and Starý (1996) reported the presence of the common oribatid mite, *Alaskozetes antarcticus* (Michael, 1903).

Vertebrate fauna

No seal or penguin species are routinely found within the Area due to its inland location at c. 90 m a.s.l. A small number of Adélie penguin (*Pygoscelis adeliae*) breed on Horseshoe Island, and Weddell (*Leptonychotes weddellii*), crabeater (*Lobodon carcinophaga*), and Antarctic fur seal (*Arctocephalus gazella*) haul out sites are found around the coast within c. 500 metres of the ASPA boundary. Flying birds observed within the Area include south polar skua (*Catharacta maccormicki*), Antarctic tern (*Sterna vittata*), and Antarctic imperial shag (*Leucocarbo bransfieldensis*).

Glacial history

Sediment records obtained from the lakes of Farrier Col have been of great importance in providing evidence of late-Quaternary environmental change in the Marguerite Bay region (Hodgson *et al*., 2013). Lake sediment cores were radiocarbon dated and analysed using a combination of sedimentological, geochemical and microfossil methods. Chronologies for the sediment cores were established by AMS radiocarbon (^{14}C) dating of macrofossils including microbial mats, fragments of the moss *Warnstorfia fontinaliopsis* (Muell. Hal.) Ochyra, and preserved eggs of the fairy shrimp *Branchinecta gaini* Daday, 1910 (Hodgson *et al*., 2013).

Results suggested the following:

- Farrier Col was subject to a non-erosive glacial regime from 35,780 (38,650–33,380) or 32,910 (34,630–31,370) cal yr BP onwards.
- The earliest onset of deglaciation on Farrier Col, as indicated by the presence of moss fragments embedded within the lake sediment matrix, was 28,830 cal yr BP, which is the earliest reported for the region and immediately post-dates Antarctic Isotopic Maximum 4 (Hodgson *et al*., 2013). This corresponds with regional evidence for ice sheet thinning after c. 30,000 cal yr BP.
- At least one part of the ice sheet in inner Marguerite Bay was <140 m thick (relative to present sea level) from 21,110 cal yr BP. This was indicated by the colonisation of Puller Lake by *B. gaini* from 21,110 (21,510–20,730 interpolated) cal yr BP, which required the existence of a perennial water body. This coincides with, or immediately post-dates Antarctic Isotopic Maximum 2.
- The Holocene deglaciation of Horseshoe Island commenced from 10,610 (11,000–10,300) cal yr BP as revealed by radiocarbon dated aquatic moss fragments in Puller Lake, which was followed by a peak abundance of *B. gaini* eggs at 9830 (9940 to 9720 interpolated) cal yr BP and accompanied by a positive shift in $d^{13}C$ suggesting the freshwater biota was well established at this time. Palaeoclimate data, including from lake sediments, suggested an extended period of regional warming sometime between 6200 and 2030 cal yr BP.
- The onset of Neoglacial conditions commenced from 2030 cal yr BP in the area around Farrier Col. This was indicated by decreases in organic carbon and sediment accumulation in Puller Lake cores caused by nearby snowbanks expanding across the lakes as the climate cooled.
- An increased sedimentation rate in the Puller Lake sediment core, after c. 400 (490–310) cal yr BP, which may be a response to the regional late-Holocene warming of the Antarctic Peninsula.

Cosmogenic ^{10}Be exposure dating of samples collected from four erratic pink granite boulders (three of which were located within the Area, close to Puller Lake) allowed researchers to identify the age of deglaciation as 9.4 ± 0.8 ka, which confirmed a rapid thinning of the Marguerite Trough Ice Stream at the onset of the Holocene (Çiner *et al*., 2019).

Human impact

Horseshoe Island was discovered and named by the British Graham Land Expedition under John Rymill who first mapped the area by land and from the air in 1936–37. While substantial long-term human activity has occurred on the island, much of which was associated with the British Base Y located to the north of the island, evidence of human impact within the Area is limited. Base Y was operated year-round from 1955 to 1959, was last used to support research activities in 1969 and has since been designated as HSM 63. Site Guidelines for Visitors have been developed for Base Y, which receives regular visits and landings from yachts and larger vessels (over 2300 visitors in 2019/20). Earlier levels of tourist visitation to Farrier Col were likely to be low, but recent observations suggest this could be increasing with a tourist camping site recently established close to the Turkish Scientific Research Camp, c. 400 m from the Area. Camping debris, possibly dating back to the 1980s, was discovered and recorded during the Fourth Turkish Antarctic Expedition I (TAE-4) outside the Area, close to the shoreline of Lystad Bay.

The lakes within ASPA 1XX are located c. 400 m from the temporary Turkish Scientific Research Camp, which was constructed in 2019 on the shore of Lystad Bay, to the west of Farrier Col. Plans are now in place to construct a permanent research station in the same general location, which once completed will accommodate up to 50 personnel in summer and c. 12 during the winter. Construction is due to commence in the near future, and the research station is anticipated to be in use for a minimum of 25 years.

Samples of newly fallen snow, old snow, as well as water from lakes, ponds and streams were collected from locations, including Farrier Col, for a study of trace and major elements (Kakareka, 2022). High enrichment factors from some elements (especially in newly fallen snow) indicated possible anthropogenic impact connected with long-range air mass transfer.

Analyses of polyaromatic hydrocarbons, polychlorinated biphenyl and metal found in sediments collected from Puller, Clincher and Pritchel Lakes are shown in Tables 5, 6 and 7, respectively (Turkiye, 2021). Analyses targeting eleven organochlorine pesticides (OCPs) in lake sediments detected only dichlorodiphenyltrichloroethane (DDT) derivatives and hexachlorocyclohexanes (HCH) isomers with the concentrations at trace levels. In general, the levels of pollutants detected in lake sediments were low. However, for most pollutants analysed, detected levels were highest in Puller Lake (see Tables 5, 6 and 7).

6(ii) Access to the Area

- No point for accessing the Area is specified, although the access point shall be selected to minimize potential trampling impacts within the Area (see Section *7 (ii) Access to, and movement within or over the Area*).
- Due to the steep terrain, access to the Area is generally by foot. Occasionally, vehicles (including snowmobiles, quad bikes and utility vehicles) may be used to access the Area. In order to minimize vehicle impacts on periglacial landforms and terrestrial biological communities the mitigation measures in the associated Environmental Impact Assessment should be adhered to.
- The corridor between the northern and southern sites of the ASPA passes through the catchment areas of Rasp, Puller and Pritchel Lakes. Soil/substrate compression and mobilization caused by vehicle use in the corridor may increase minerogenic input into the lakes. Furthermore, any pollution events, including vehicle fuel spills, within the corridor could have major negative impacts upon the values of the Area. Taking these factors into consideration, use of vehicles within the corridor, should be minimized. Care should be taken to avoid pollution events when transiting across the lakes' catchment area via this corridor. When vehicles are used to move along the corridor, then it is recommended that appropriate absorbent fuel spill kits be carried to contain any spilt fuels.

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

The temporary Turkish Scientific Research Camp is located c. 400 m west of the Area. Historic Site and Monument (HSM) No. 63 'Base Y', a historic British scientific station, is located 3.5 km to the northwest. Site Guidelines for Visitors have been agreed for Horseshoe Island (No. 24, agreed through Resolution 4 (2014), available at: *https://www.ats.aq/devAS/Ats/Guideline/7119d548-3a5c-4f09-b5f3-9db689252464*) primarily to inform visitation of the HSM 63. A meteorological station (Lat. 67°49'47" S, Long. 68°14'04" W) and a Global Navigation Satellite System (GNSS) station (Lat. 67°49'30" S, Long. 67°13'45" W) are present to the west of the Area.

Year-round scientific research stations operate in the vicinity: San Martín Base (Argentina; Lat. 68°08' S, Long. 67°06' W) which is located 34 km south-southeast and Rothera Research Station (UK; Lat. 67°34' S, Long. 68°07' W) which is 47.4 km to the northwest. A currently summer-only station, Teniente Luis Carvajal (Lat. 67°46' S, Long. 68°55' W), has been operated by Chile at the southern end of Adelaide Island since 1985, on the site of the previous British Adelaide Island station.

6 (iv) Location of other protected areas in the vicinity

The nearest protected areas to Farrier Col are ASPA 115 Lagotellerie Island, Marguerite Bay, Antarctic Peninsula (9.5 km), ASPA 107 Emperor Island, Dion Islands, Marguerite Bay, Antarctic Peninsula, (62 km west), ASPA 117 Avian Island, Marguerite Bay, Antarctic Peninsula (70 km west), ASPA 177 Leonie Islands and south-east Adelaide Island, Antarctic Peninsula (50 km to the northwest) and ASPA 129 Rothera Point, Adelaide Island (47.5 km to the northwest) (See Map 1). Several HSMs are located in the vicinity: 'Base Y' (UK) on Horseshoe Island (HSM No. 63); 'Base E' (UK) (HSM No. 64) and buildings and artefacts at and near East Base (US) (HSM No. 55), both on Stonington Island; and installations of San Martín Base (Argentina) at Barry Island (HSM No. 26).

6(v) Special zone within the Area

None.

7. Permit conditions

7(i) General permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority as designated under Article 7 of Annex V to the Protocol on Environmental Protection to the Antarctic Treaty.

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

- it is issued for a compelling scientific purpose that cannot be served elsewhere;
- it is issued for essential management purposes such as inspection, maintenance or review;
- the actions permitted will not jeopardise the natural ecological system in the Area;
- any management activities are in support of the objectives of this Management Plan;
- the actions permitted are in accordance with this Management Plan;
- the Permit must be carried within the Area;
- permits shall be issued for a stated period;
- a report or reports are supplied to the authority or authorities named in the Permit;
- 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

- Movement within the Area shall be on foot.
- 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, i.e., all movement should be undertaken carefully so as to minimise disturbance to the soil, periglacial features and vegetated surfaces, walking on rocky terrain if practical.
- Vehicles are prohibited within the Area
- 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*).
- Winged aircraft, helicopters and RPAS are not permitted to land within the Area.
- Low altitude helicopter overflight of the air is permitted to facilitate delivery or retrieval of cargo essential for scientific or environmental management purposes.
- Use of helicopter smoke grenades is prohibited within the Area unless absolutely necessary for safety. If used all smoke grenades should be retrieved.
- Within the Area 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). When conditions require aircraft to fly at lower elevations than recommended in the guidelines, aircraft should maintain the maximum elevation possible and minimize the time taken to transit.
- Use of small boats in the lakes within the Area is permitted. To reduce the potential for pollution and to minimise disturbance of the water column and underlying microbial mats and soft sediments, propulsion of boats using propellors or other forms of mechanical propulsion is prohibited. Boats should be propelled and maintained in position on the lakes by, for example, securing clean floating ropes across the lake and using the ropes to pull the boat into the desired position and secure it there. In circumstances where the use of ropes is not practicable, the use of oars to manually propel boats is permitted, but particular care shall be taken to minimize disturbance to the water column and underlying microbial mats and sediment.
- To prevent the short-range transfer of native freshwater species or propagules between the lakes, appropriate biosecurity practices shall be employed to adequately clean small boats and any associated equipment, including ropes.

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

- Scientific research that will not jeopardise the ecosystem or scientific values of the Area and which cannot be served elsewhere;
- 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 (see Section 7(vi)). 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

- Camping within the Area is prohibited.
- Accommodation may be available at the nearby Turkish Scientific Research Camp or planned Turkish Antarctic Research Station.

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

No living animals, plant material or microorganisms shall be deliberately introduced into the Area. To ensure that the floristic, limnological and ecological values of the Area are maintained, special precautions shall be taken against accidentally introducing microbes, invertebrates or plants from other Antarctic sites, including stations, or from regions outside Antarctica. All sampling equipment or markers brought into the Area shall be cleaned or sterilized. To the maximum extent practicable, footwear and other equipment used or brought into the Area (including bags or backpacks) shall be thoroughly cleaned before entering the Area. Further guidance can be found in the CEP Non-native Species Manual (Resolution 4 (2016)) and the SCAR Environmental Code of Conduct for Terrestrial Scientific Field Research in Antarctica (Resolution 5 (2018)). In view of the presence of small numbers of breeding birds within the Area, no poultry products, including wastes from such products and products containing uncooked dried eggs, shall be released into the Area.

To reduce the risk of contamination of the lakes, the use of equipment requiring hydrocarbon fuels (e.g., petrol, diesel, paraffin, etc.) in the Area shall be minimized to the maximum extent practicable. No fuel, chemicals or other potential pollutants shall be stored in the Area.

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

Taking 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 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) Collection and 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 or management needs. Permits shall not be granted in instances where it is proposed to take, remove or damage such quantities of soil, native flora or fauna that their distribution or abundance on Horseshoe Island would be significantly affected. Anything of human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit Holder or otherwise authorized, may be removed unless the impact of removal is likely to be greater than leaving the material *in situ*; if this is the case the appropriate authority should be notified.

7(ix) Disposal of waste

All wastes, including all human waste, shall be removed from the Area.

7(x) Measures that may be necessary to ensure that the aims and objectives of the Management Plan continue to be met

- Permits may be granted to enter the Area to carry out scientific research, monitoring and site inspection activities, which may involve the collection of a small number of samples for analysis, to erect or maintain signboards, or to carry out protective measures.
- Any long-term monitoring sites shall be appropriately marked and the markers or signs maintained.
- 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)).

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 in accordance with national procedures.
- Such reports should include, as appropriate, the information identified in the visit report form contained in the Revised Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas (Resolution 2, 2011).
- Wherever possible, 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.
- Parties working in the Area are encouraged to exchange information on visit reports annually. Wherever possible, Parties should deposit originals or copies of such 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 organizing the scientific use of the Area.

8. Supporting documentation

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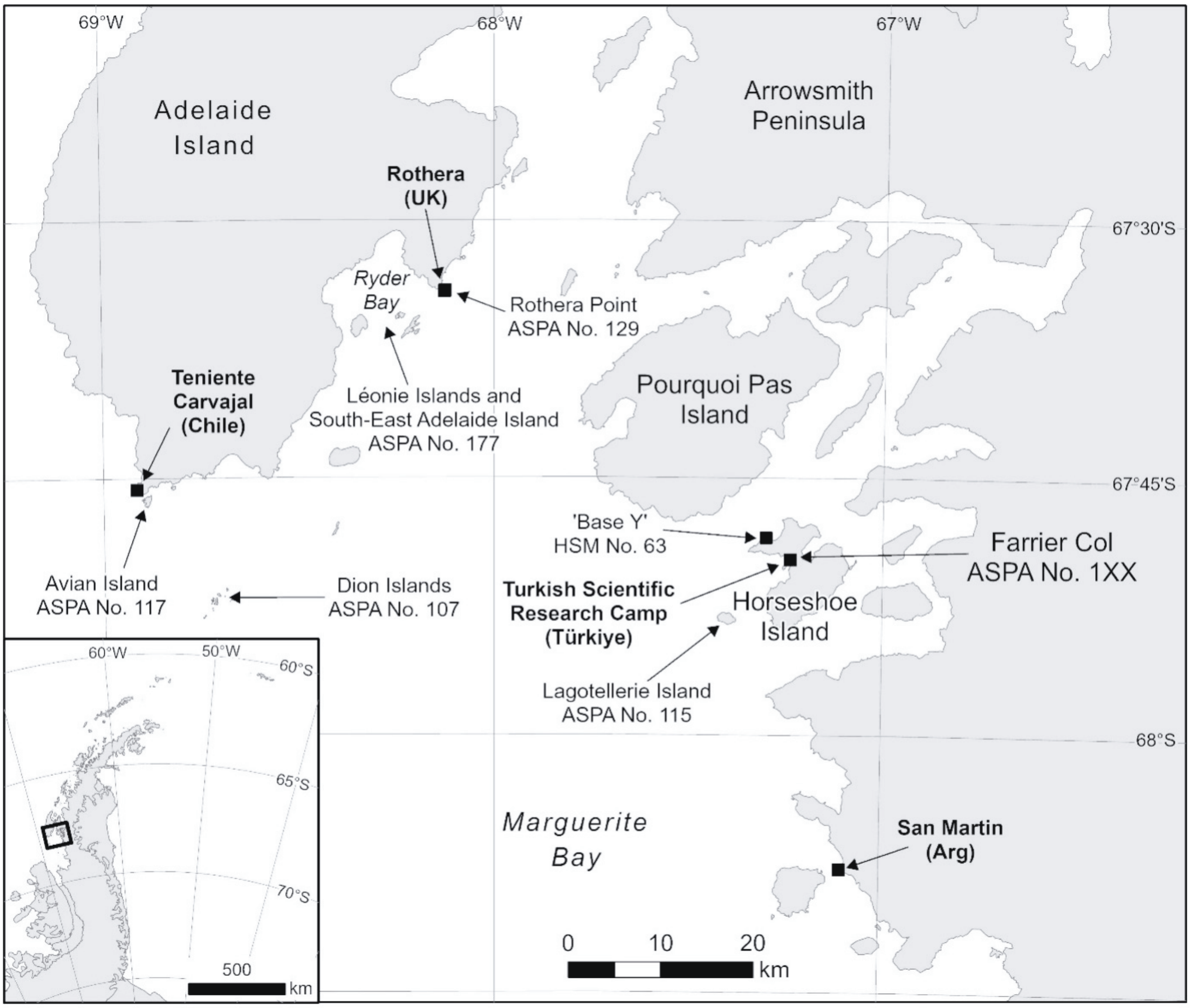
Map 1. Antarctic Specially Protected Area No. 1XX, Farrier Col, Horseshoe Island, Marguerite Bay, location map, showing the location of the Turkish Scientific Research Camp (Türkiye), San Martín Base (Argentina), Teniente Luis Carvajal Station (Chile) and Rothera Research Station (UK). Also shown are the locations of the other protected areas in the region: Rothera Point, Adelaide Island (ASPA 129), Emperor Island, Dion Islands, Marguerite Bay, Antarctic Peninsula (ASPA 107), Leonie Islands and South-east Adelaide Island, Antarctic Peninsula (ASPA 177), Lagotellerie Island, Marguerite Bay, Graham Land (ASPA 115) and Avian Island, Marguerite Bay, Antarctic Peninsula (ASPA 117). 'Base Y' (UK) (Historic Monument No. 63) on Horseshoe Island is shown. Inset: the location of the region relative to the Antarctic Peninsula.



Map 2. Antarctic Specially Protected Area No. 1XX, Farrier Col, Horseshoe Island, Marguerite Bay. Inset (left): Location of Horseshoe Island in relation to the Antarctic Peninsula. Inset (right): Location of Farrier Col in relation to Horseshoe Island.

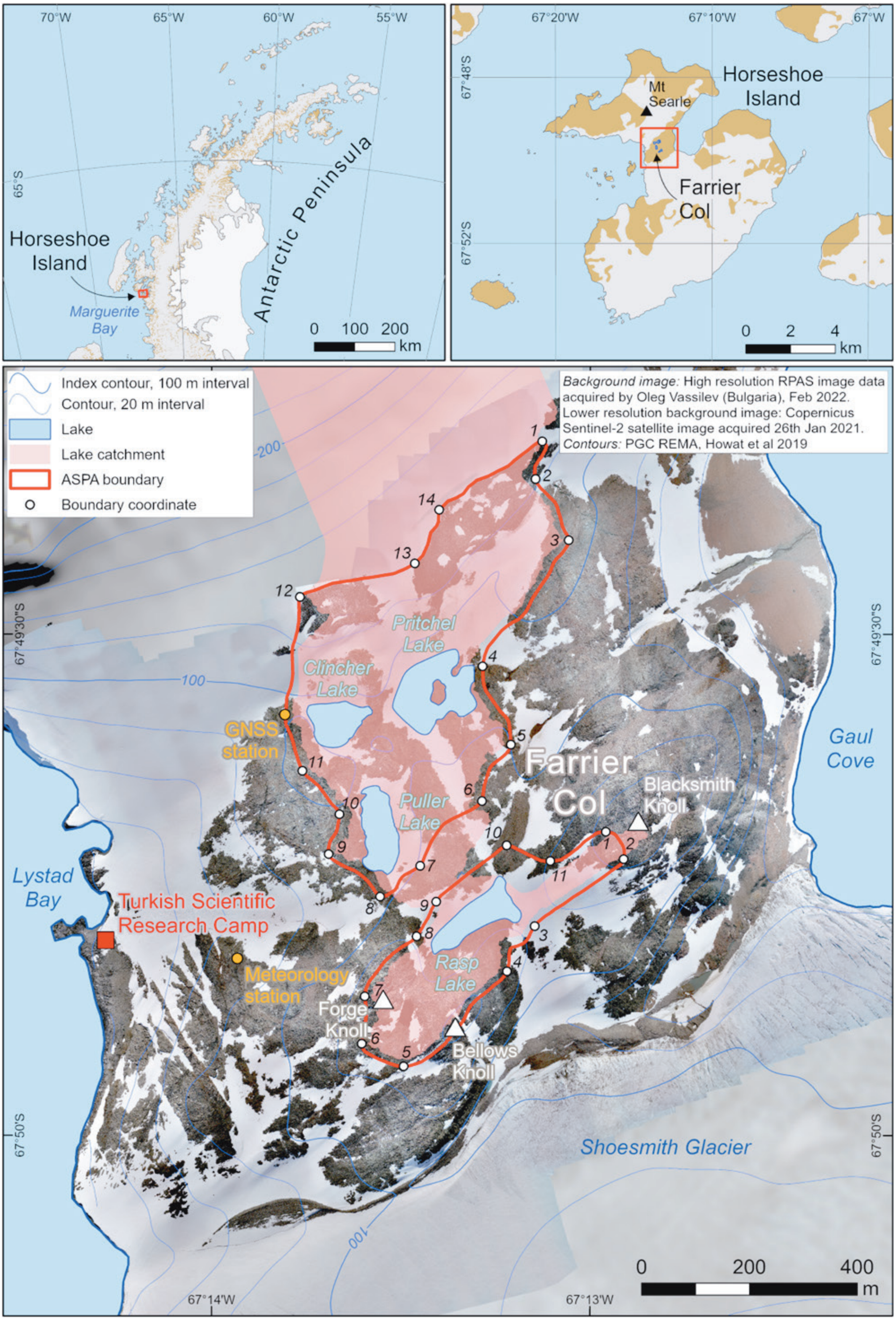


Table 1. Boundary coordinates for the northern and southern sites of ASPA 1XX Farrier Col, Horseshoe Island, Marguerite Bay. Points are shown on Map 2

Boundary coordinate number	Longitude	Latitude
Northern site		
1	-67.21878263	-67.82179297
2	-67.21907028	-67.8224196
3	-67.21761067	-67.82343954
4	-67.22140222	-67.82553113
5	-67.22016102	-67.82683532
6	-67.22142951	-67.82777553
7	-67.22415282	-67.82885042
8	-67.22590717	-67.82936468
9	-67.22818502	-67.82865503
10	-67.22770047	-67.82799528
11	-67.22933526	-67.82727561
12	-67.22944681	-67.82438248
13	-67.22438900	-67.82382615
14	-67.22332292	-67.82293240
Southern site		
1	-67.21597795	-67.82828623
2	-67.21518982	-67.82873758
3	-67.21911005	-67.82985578
4	-67.22032635	-67.83060515
5	-67.22487722	-67.83218431
6	-67.22672053	-67.83181176
7	-67.22659234	-67.83102289
8	-67.22430032	-67.83002271
9	-67.2234479	-67.82944674
10	-67.22034093	-67.82850793
11	-67.21841171	-67.82877090

Table 2. Summary of meteorological data collected at Farrier Col, Horseshoe Island, from February 2020 - February 2023.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temp (°C)	1.9	2.3	-3.3	-3.2	-4.0	-5.2	-7.1	-7.6	-5.4	-3.8	-0.4	0.6
Mean Pressure (mbar)	977	977	979	978	986	979	986	980	974	970	970	972
Mean Relative Humidity (%)	66	70	69	70	74	75	74	68	75	68	71	73
Mean Wind Speed ($m\ s^{-1}$)	6.2	5.9	5.5	5.8	5.7	5.8	5.2	6.9	5.9	7.0	6.8	5.2

Table 3. Water chemistry of Puller, Clincher and Pritchel Lakes, Farrier Col, Horseshoe Island. Data are taken from Hodgson et al. (2013), Cura (2020) and Türkiye (2021).

		Puller Lake		Clincher Lake		Pritchel Lake*
		2003	2022	2003	2022	2022
Temperature, oxygen saturation, conductivity, dissolved oxygen and pH						
Temperature	°C	3.7	2.8	5.6	1.1	1.4
Oxygen saturation	%	96.2	-	122	-	-
Conductivity	$\mu S\ cm^{-1}$	131.2	108	166.8	122	128
Dissolved oxygen	mg/l	-	12.7	-	11.8	12.3
pH		-	8.0	-	8.1	8.1
Anions						
Cl	mg/l	28	-	41.4	-	-
SO_4–S	mg/l	13.1	-	20.1	-	-
Cations, incl. Si						
Al	mg/l	<0.002	-	<0.002	-	-
Fe	mg/l	0.016	-	0.003	-	-
Mg	mg/l	2	-	3.03	-	-
Ca	mg/l	1.43	-	2.08	-	-
K	mg/l	0.72	-	0.894	-	-
Na	mg/l	14.6	-	21.8	-	-
Si	mg/l	0.054	-	0.054	-	-
Nutrients						
NO_3–N	mg/l	<0.100	-	<0.100	-	-
NH_4–N	mg/l	0.036	-	0.015	-	-
PO_4–P	mg/l	<0.005	-	<0.005	-	-
Total Nitrogen (N), Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)						
Total N	mg/l	0.14	-	0.07	-	-
TOC	mg/l	1.1	<5	0.78	<5	-
DOC	mg/l	1.06	-	0.91	-	-

* Data represent the mean of four replicate measurements taken from Pritchel Lake (see Türkiye 2021, Table 4.2)

***Table 4. Species of vascular plants, bryophytes, lichens, cyanobacteria and algae known to occur on Horseshoe Island. The Area is likely to contain a subset of the species listed below. Data taken from Broady (1979), Komarkova et al. (1985) and the British Antarctic Survey Plant Database** (https://data.bas.ac.uk/metadata.php?id=GB/NERC/BAS/PDC/00023).*

Vascular plants
Colobanthus quitensis (Kunth.) Bartl. (N.B. This is an old record and the presence of *C. quitensis* on the island may now be in doubt.)
Bryophytes
Bartramia patens Brid.
Bryum argenteum Hedw
Bryum pseudotriquetrum (Hedw.) Gaertn.
Ceratodon purpureus (Hedw.) Brid
Coscinodon reflexidens Mull. Hal.
Pohlia nutans (Hedw.) Lindb.
Sanionia uncinata (Hedw.) Loesk.
Schistidium antarctici (Card.) L. Savic. & Smirn.
Syntrichia magellanica (Mont.) R.H. Zander
Syntrichia sarconeurum Ochyra & R.H. Zander
Willia austroleucophaea (Besch.) Broth.
Lichens
Acarospora convoluta Darb.
Acarospora macrocyclos Vain.
Buellia cladocarpiza M. Lamb
Buellia subpedicellata (Hue) Darb.
Caloplaca isidioclada Zahlbr.
Candelariella vitellina (Hoffm.) Mull. Arg.
Catillaria corymbosa (Hue) M. Lamb
Haematomma erythromma (Nyl.) Zahlbr.
Huea coralligera (Hue) Dodge & Baker
Lecania brialmontii (Vain.) Zahlbr.
Lecanora atrobrunnea
Lecanora physciella (Darb.) Hertel
Lecidea atrobrunnea (Ram.) Schaer.
Leptogium puberulum Hue
Physcia caesia (Hoffm.) Furnr.
Placopsis pycnotheca Lamb
Polycauliona candelaria (L.) Th. Fr.
Pseudephebe minuscula (Nyl. ex Arnold) Brodo & Hawksw.
Pseudephebe pubescens (L.) Choisy
Psoroma cinnamomeum Malme
Rhizocarpon disporum (Hepp) Mull. Arg.
Rhizoplaca aspidophora (Vain.) Redon
Rhizoplaca melanophthalma (Ram.) Leuck. & Poelt

Lichens
Sphaerophorus polycladus Mull. Arg.
Umbilicaria decussata (Vill.) Zahlbr.
Usnea sphacelata R. Br.
Usnea subantarctica F.J. Walker
Xanthoria elegans (Link.) Th. Fr.
Cyanobacteria
Anabaena sp.
Leptoyngbya spp.
Nostoc spp.
Oscillatoria amoena Gom.
Oscillatoria spp.
Phormidium autumnale (Ag.) Gom.
Phormidium frigidum Fritsch
Phormidium priestleyi Fritsch
Phormidium rubroterricola Gardner
Plectonema sp.
Schizothrix fragilis (Kuetz.) Gom.
Schizothrix sp.
Tolypothrix tenuis Kuetz.
Eukaryotic algae
Monodus subterraneus Boye Pet,
Heterococcus sp.
Chlorhormidium flaccidum (A. Br.) Fott
Stichococcus bacillaris Naeg. *sens. ampl.*

Table 5. Polyaromatic hydrocarbon (PAH) levels in lake sediment samples collected within the Area (μg/kg dry mass) (see Türkiye, 2021)

Compound	Puller Lake	Clincher Lake	Pritchel Lake
Naphthalene	3.5	3.0	4.1
Acenaphthylene	0.150	0.045	bdl
Acenaphthene	0.077	0.079	0.069
Fluorene	0.69	0.27	0.18
Phenanthrene	14.0	12.0	9.7
Anthracene	0.670	0.072	0.073
Fluoranthene	7.5	8.3	4.7
Pyrene	7.9	9.3	5.0
Benzo(a)anthracene	0.330	0.055	0.100
Chrysene	0.34	0.033	0.041
Benzo(b)fluoranthene	1.600	0.110	0.092
Benzo(k)fluoranthene	0.519	bdl	bdl
Benzo(a)pyrene	0.770	0.030	0.099
Indeno(1,2,3,c-d)pyrene	0.290	0.039	0.050
Dibenzo(a,h)anthracene	0.049	bdl	bdl
Benzo(g,h,i)perylene	0.300	0.041	0.048
Total PAHs	**39**	**33**	**24**

*bdl: Below detection limit

Table 6. Polychlorinated biphenyl (PCB) levels in lake sediment samples collected within the Area (μg/kg dry mass) (see Türkiye, 2021)

Compound	Puller Lake	Clincher Lake	Pritchel Lake
PCB 28/31	0.0078	0.0043	0.0035
PCB 52	0.0044	0.0028	0.0041
PCB 101	bdl	bdl	0.0035
PCB 118	0.0058	bdl	0.0078
PCB 138	0.0078	0.0035	0.0051
PCB 153	0.0100	bdl	00.0061
PCB 180	0.0090	bdl	0.0032
Total PCBs	**0.0450**	**0.0110**	**0.0330**

*bdl: Below detection limit

Table 7. Metal levels in lake sediment samples collected within the Area (µg/kg dry mass) (see Türkiye, 2021)

Metal	Puller Lake	Clincher Lake	Pritchel Lake
Al	69455	62509	61851
As	4.7	3.8	4.7
Cd	0.18	0.14	0.09
Co	11.0	12.0	9.2
Cr	43	41	30
Cu	19	17	28
Fe	39567	36674	36190
Li	16	18	12
Mn	601	642	607
Ni	12	13	10
Pb	20	18	20
V	103	97	95
Zn	90	103	79
Hg	bdl	bdl	bdl

*bdl: Below detection limit