Monitoring the impacts of human activity in Antarctica

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Summary

The monitoring of impacts of human activities in Antarctica is important to inform the development of approaches and tools for the management of activities for the protection of the Antarctic environment. This paper provides a summary of some of the programmes that the UK undertakes or supports, which already provide data relevant to the monitoring of human impacts. The paper also describes the results of a recent project to assess the utility of satellite imagery for monitoring human impacts, and outlines proposed next steps for developing an approach to assess the use of RPAS imagery to monitor human impacts at multiple highly-visited tourist sites.

We recommend that Parties:

* Note the summary of UK-led or supported programmes that could contribute data for the future monitoring of impacts of human activities in Antarctica;
* Continue to share information about their own programmes relevant to the monitoring of human impacts on the Antarctic environment;
* Discuss how best to collate information on existing monitoring programmes; and
* Note the results of a recent project to assess the use of satellite imagery for monitoring human impacts, and consider contributing to the proposed continuation project to assess the use of RPAS imagery to monitor human impacts at multiple highly-visited tourist sites.

Background

Following the presentation of ATCM XLIV/WP22, the CEP promoted the development of monitoring programmes to assess the actual impacts arising from tourism activities[[1]](#footnote-1), underscoring the desirability of concrete action on the monitoring of tourism impacts.

In response to the Committee’s recommendations, the UK is providing information on existing monitoring programmes that could contribute information for the future monitoring of human impacts. We also provide the findings from a new project to assess the utility of using satellite imagery to monitor human impacts at some of the most visited tourist sites and provide a proposal for further development of the study.

Existing Monitoring Programmes

Gentoo penguin monitoring at Goudier Island, Port Lockroy

Since 1996/1997 the British Antarctic Survey (BAS) and UK Antarctic Heritage Trust (UKAHT) have undertaken a long-term study of gentoo penguin populations at Goudier Island, Port Lockroy, one of the most heavily visited tourist sites anywhere in the Antarctic. The programme is the longest-running study measuring potential tourist disturbance to breeding penguins in the Antarctic.

The findings of the study were published in 2018[[2]](#footnote-2) and concluded that there had been a notable change in the breeding success of the gentoo penguin population at Goudier Island and Jougla Point, Port Lockroy; however, the processes driving these long-term changes remained unclear and complex. Nevertheless, alterations to the management of visitors to Goudier Island were implemented and ongoing annual monitoring of the Goudier Island and Jougler Point gentoo penguin breeding populations was recommended by the report, and this has been continuing.

Oceanites monitoring around the Antarctic Peninsula

The UK continues to provide annual financial support to Oceanites’ Antarctic Site Inventory project, which has been collecting penguin data consistently since 1994, making over 2,100 census visits and collecting data at 258 different Antarctic Peninsula locations. The project began with the aim of examining whether opportunistic visits could be used:

1. to effectively and economically detect possible visitor-caused changes in the physical features, flora and fauna of sites in the Antarctic Peninsula being visited repeatedly by ship-based tourists;
2. to collect baseline information necessary to detect possible changes in the physical and biological variables being monitored; and
3. to determine how best to minimise or avoid possible environmental impacts of tourism in the Antarctic Peninsula area.

In 2016 the Mapping Application for Penguin Populations and Projected Dynamics (MAPPPD) launched. MAPPPD is an open access, decision-support tool developed for Oceanites that assembles Antarctic penguin population data and makes such data easily and publicly available. The MAPPPD database now contains counts from 740 sites across the entirety of the Antarctic continent, encompassing 4,489 records from 145 data sources of on-the-ground colony counts and satellite photo analyses.

MAPPPD is the reference for Oceanites’ annual State of Antarctic Penguins reports which is regularly submitted to ATCM by SCAR[[3]](#footnote-3).

In 2023, Oceanites began using Remotely Piloted Aerial Systems (RPAS) to count penguins using photogrammetry, with the aim of creating a long-term 3D dataset of penguin colonies showing population change over time due to shifts in snow cover at the colonies.

Time-lapse camera monitoring around the Antarctic Peninsula

Oxford University’s programme uses a network of remote time-lapse cameras across the Antarctic Peninsula to monitor penguins. Approximately 100 camera units across the Scotia Arc region are programmed to capture images once per hour throughout the breeding season. Images are analysed by volunteers through the *Penguin Watch* citizen science project[[4]](#footnote-4). The camera network has been used to assess drivers of intra- and inter-annual dynamics in gentoo penguin breeding success[[5]](#footnote-5). The opportunities for the use of time-lapse cameras for the monitoring of species in the Antarctic Treaty area was also highlighted in ATCM XLIII/IP9.

Ecosystem monitoring at Signy Island and Ryder Bay

As part of a long-term monitoring programme, BAS undertakes ecosystem monitoring at Signy Island in South Orkneys; and Rothera Point and islands in Ryder Bay in the Antarctic Peninsula. Much of that monitoring contributes to the CCAMLR Ecosystem Monitoring Programme (CEMP), which is intended to monitor any impacts of the fishery for Antarctic krill on krill-dependent predators. At Signy Island, gentoo, chinstrap and Adélie penguins are monitored as a contribution to the CEMP, with additional monitoring of fur, Weddell and elephant seals, southern giant petrels and Antarctic shags[[6]](#footnote-6). At Rothera and islands in Ryder Bay, south polar skuas and Antarctic shags are monitored. Parameters monitored include population sizes, breeding success and chronology, weights of adults and offspring, foraging duration and diet.

Marine debris monitoring at Signy Island and Goudier Island

Marine debris surveys on beaches are undertaken by BAS at Signy Island, South Orkneys, and by the UKAHT at Goudier Island, Port Lockroy. Incidences of entanglements in anthropogenic materials and hydrocarbon soiling of seabirds and seals are also recorded. The results of this monitoring work is submitted annually to the CCAMLR marine debris program.

Project to test utility of satellite imagery for monitoring human impacts

Project outline

During the 2022-23 intersessional period the UK undertook a new project to determine if very high resolution (VHR) satellite imagery can be used to detect signs of change at the most frequently visited Antarctic sites. The intention was to provide evidence to how remote sensing methods might be able to support ongoing monitoring of Antarctic visitor sites to detect change resulting from human visitors.

An assessment was undertaken to visually compare two VHR satellite images from eight different highly-visited sites[[7]](#footnote-7), with the two images separated by approximately five years. Side-by-side comparison was undertaken to assess visible differences, specifically considering:

* Changes in number and extent of trails;
* Changes to extent or density of vegetation; and
* Changes in location of penguin colonies in relation to established trails.

Results

At a number of visitor sites, it was possible to discern trails that corresponded with walking routes from landing sites. In some locations (e.g., Whalers Bay), it appeared that the trails were more significant in recent images, potentially indicating that the impact from human visitors has increased. Elsewhere trails are visible where they cross areas of snow (e.g., Peterman Island, Neko Harbour). In these cases, the impact is probably ephemeral, but it was not possible to determine if there was any lasting impact on the underlying surface.

Based on the images included in this study, it has not been possible to discern changes in vegetation or penguin colonies. This is likely because any changes are small relative to a highly variable background and a longer-term analysis (longer than five years) is required to detect significant trends.

Proposed next steps

VHR satellite imagery provides some limited information about extent of trails caused by human footfall at Antarctic visitor sites but does not provide sufficiently high-resolution detail that is considered necessary to fully assess and monitor changes.

There has already been much work on the use of RPAS for monitoring the Antarctic environment[[8]](#footnote-8). Building on this experience, we propose that a further study could be undertaken to assess the utility of using imagery collected by RPAS, with sufficient high spatial resolution and positional accuracy, to monitor human impacts at the most highly-visited tourist sites.

Recommendation

It is recommended that Parties:

* Note the summary of UK-led or supported programmes that could contribute data for the future monitoring of impacts of human activities in Antarctica;
* Continue to share information about their own programmes relevant to the monitoring of human impacts on the Antarctic environment;
* Discuss how best to collate information on existing monitoring programmes; and
* Note the results of the project to assess the use of satellite imagery for monitoring human impacts, and consider contributing to the proposed continuation project to assess the use of RPAS imagery to monitor human impacts at multiple highly-visited tourist sites.

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1. Final Report of the Forty-fourth Antarctic Treaty Consultative Meeting, paragraph 286. [↑](#footnote-ref-1)
2. Dunn et al. 2018 [↑](#footnote-ref-2)
3. The most recent was State of Antarctic Penguins 2022 report, presented in ATCM XLIV/BP14. [↑](#footnote-ref-3)
4. Jones et al. 2018 [↑](#footnote-ref-4)
5. Youngflesh et al. 2021 [↑](#footnote-ref-5)
6. Phillips et al. 2019 [↑](#footnote-ref-6)
7. The sites selected were Barrientos Island, Half Moon Island, Brown Bluff, Neko Harbour, Whalers Bay, Cuverville Island, Goudier Island and Danco Island. [↑](#footnote-ref-7)
8. Including: Zmarz et al. 2015, Dąbski et al. 2020, Malenovský et al. 2017, Turner et al. 2014 and Rümmler et al. 2018 [↑](#footnote-ref-8)