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State of Knowledge of Wildlife Responses to Remotely Piloted Aircraft Systems (RPAS)

State of Knowledge of Wildlife Responses to RPAS

A Working Paper submitted by SCAR

Summary

The increasing use and utility of Unmanned Aerial Vehicles (UAVs), which are now preferably known as Remotely Piloted Aircraft Systems (RPAS), across the globe, including in Antarctic, brings corresponding challenges to their management. The CEP has recognised on several occasions the need for more information to inform guidelines on RPAS use around wildlife in Antarctica, including a request for SCAR to present a summary of the current state of knowledge regarding wildlife responses to RPAS. Here we present a synthesis from 23 published scientific research papers on wildlife responses to RPAS. Responses to RPAS were not consistent across species, and responses also varied in relation to flight path parameters (e.g. height and approach angle) and the type of RPAS. It is likely that wildlife responses are under-estimated in many cases due to a lack of data on physiological responses. Data on demographic effects (for example, changes in breeding numbers or breeding success) are also lacking. Guidelines for minimising RPAS disturbance to wildlife have been developed (see Hodgson and Koh 2016 [1] and Background Paper 1) and should be considered in Antarctic biological field research, but further studies are required to inform best-practice RPAS use in Antarctica around wildlife.

Introduction

1) Unmanned aerial vehicles (UAVs), also known as unmanned aerial systems (UAS), drones, or preferably, to avoid gender bias, Remotely Piloted Aircraft Systems (RPAS), are increasingly used in wildlife research around the world (including Antarctica) due to their efficiency, cost effectiveness and accuracy [2,3,4].
2) In Antarctica, RPAS have been used for population monitoring [5,6,7], fine scale vegetation mapping [8], determining ecosystem function [9], operational applications [10,11] and during tourist activities (with permits [12])
3) Applications of RPAS in other parts of the world are even more diverse. Environmentally related applications include: monitoring habitat and biodiversity loss [13], biodiversity assessment [14], population monitoring [15,16,17,18), fine scale habitat assessment [19], locating tracked wildlife [20], as an anti-poaching measure [21] and vegetation monitoring [22].
4) Concomitant with this increasing use is an increasing awareness of the potential impacts, both from an operational and wildlife disturbance perspective [1, 7].
5) At ATCM XXXVII (2014) discussions on the use of RPAS in Antarctica culminated in a request to COMNAP, SCAR and IAATO to consider the issue of wildlife responses to RPAS and bring back information which explored the utility and risks of RPAS operation in Antarctica.
6) In ATCMXXXVIII WP27, SCAR presented results of a meta-analysis of wildlife approach distances (see also [23]), and concluded that:
   a. Consistent with earlier recommendations, there was no one-size-fits-all approach to managing human disturbance effects on wildlife. Management guidelines for different sites and species need to be developed on a case-by-case basis, ideally in conjunction with carefully designed experiments.
   b. Animal behavioural changes do not necessarily reflect cryptic (physiological), and more deleterious impacts, such as changes in physiology, or long-term changes in population trends.
   c. The scientific evidence base for limiting human disturbance impacts to Antarctic wildlife is inadequate, and is in urgent need of improvement via a range of dedicated studies on RPAS, and other disturbances across a range of sites and species.

7) In its subsequent advice to ATCM XXXVIII (2015), the CEP recognised the benefits of developing guidance on the environmental aspects of RPAS use in Antarctica. Following submission of further information to CEP XIX in 2016 on RPAS use in Antarctica from Germany (ATCMXXXIX WP01- see also [7]), Poland (ATCMXXXIX IP057 – see also [24]), COMNAP (ATCMXXXIX WP014 [11]) and IAATO (ATCMXXXIX IP120 [12]), the CEP provided similar advice to the ATCM and agreed to initiate work in this respect at CEP XX in 2017.
8) Following the discussions at CEP XVIII, SCAR agreed to report back to the CEP in 2017 on the current state of knowledge of wildlife responses to RPAS.

Approach

9) Literature searches were made using a range of search terms covering all RPAS nomenclature using Google Scholar, Web of Science, reference mining and citation tracking from key references. National Guidelines on RPAS use were also requested from SCAR Delegates, National Antarctic Committees and COMNAP.
10) Studies were included in our assessment if they i) were published in peer reviewed literature, ii) included RPAS use around wildlife that was not captive, semi-captive or domesticated, and iii) included some form of monitoring of wildlife response to RPAS (even if it was incidental).
11) Summaries of the findings of these studies were compiled based on target species, RPAS type, behavioural response and flight path details (Appendix 1). A full list of references is provided in Appendix 2.

Findings

12) Twenty-three published studies were included in the assessment. Of these, 12 documented a change in wildlife behaviour in response to RPAS. All studies used behavioural change as a measure of response, but only one [26] quantified physiological changes to measure the level of response to RPAS.
13) Measurement of behavioural change ranged from observational (no recording, qualitative assessment of change) to experimental, where video recording was used with a quantifiable scale of behaviour change.
14) Responses to RPAS were not consistent across species, and responses also varied in relation to flight path parameters (e.g. height and approach angle [7,26] and the type of RPAS [24,27]. However, most studies that reported a response, found that lower RPAS flights elicited a stronger response. Vertical approaches to birds typically elicited more responses than horizontal or angled approaches [7,26].
15) Launching RPASs no closer than 100 m to bird colonies has been recommended [26], and supported by preliminary data on Antarctic penguins [7].
16) Noise of RPAS can be detected from large distances, and the ability to detect RPAS varies considerably among species [28]. Noise was identified in several studies as an important factor of interest in eliciting responses [6,7,24,29] and there is some evidence that electric powered fixed wing RPAS elicited less response than wet-fuel powered RPAS at the same altitude [24].
17) Preliminary evidence suggests that group size influences response [26,27] and that animals at different stages of the breeding cycle show different responses [30].
18) Physiological responses, for example heart rate, are a good indicator of acute and/or chronic stress in wildlife [23,31]. A variety of methods have been used successfully to measure the physiological responses of wildlife to disturbance in the Antarctic region. These include heart rate measurements using artificial eggs (e.g. [32,33,34]) or externally-mounted/implanted data loggers (e.g. [35,36]). Monitoring changes in blood chemistry can also provide important insights into stress responses (e.g. [37,38]).

19) Pilot training is a key element in minimising the risk of accidents and major disturbance or injury to species under study. While this aspect received a higher profile in the operational guidelines (e.g. from national authorities), it is also relevant in mitigating negative responses from wildlife [1].
20) While there is some evidence that some species may habituate in response to repeated drone flights [39], data on this aspect are sparse and other studies present no evidence of habituation [7].
21) In addition to the COMNAP UAS Handbook [11], there are a range of national guidelines in place for use of RPAS in Antarctica that have been made available by national authorities. Most are operational in nature, and deal with the safe flying of RPAS with regard to other aircraft or infrastructure. Several require permits to be obtained prior to flying around any concentrations of wildlife. Some also prescribe specific minimum approach distances ranging from 100-350 m. All note that minimizing disturbance to wildlife needs to be considered as part of any plan to deploy RPAS in Antarctica. Some national authorities have separate guidelines for recreational use of RPAS in Antarctica.
22) IATTO currently bans any use of RPAS for recreational use, although permits are issued by the appropriate national authorities for commercial or scientific use during tourist activities [12].

Conclusions

23) Use of RPAS around wildlife is increasing in Antarctica, and considering the similar increase observed globally, their use in Antarctica will not only continue to increase but also expand in their application.
24) Consistent with the SCAR recommendations in ATCMXXXVIII WP027, this review supports the conclusion that there will not be a one-size-fits-all solution to the mitigation of wildlife responses to RPAS. Guidelines will clearly need to be site- and species-specific and consider the type of RPAS used, including noise output.
25) Given that physiological responses (indicative of a stress) can occur without any sign of behavioural responses (e.g. [25]), further studies that include the physiological response of wildlife to RPAS are needed. Data on demographic changes in response to RPAS use are also lacking and more studies are required.

Recommendations

26) SCAR recommends that the CEP considers implementation of the following preliminary best practice guidelines for all RPAS use in the vicinity of wildlife in Antarctica until further information becomes available:

   i. Take-off should be further than 100 m from wildlife and if possible, out of sight of the target species. Horizontal approaches to wildlife are preferable [7,26] and RPAS should be flown at the maximum height practicable to achieve the study objectives.

   ii. Electric powered RPAS should be used where possible to minimise noise impacts, and careful consideration should be given to the altitude at which wet fuel driven RPAS are used.

   iii. The recommendations of Hodgson and Koh (2016) ([1] and Background Paper 1) should be consulted and adhered to or exceeded wherever possible when planning RPAS use around wildlife in Antarctica.

27) SCAR further recommends that future studies on wildlife response to RPAS in the Antarctic should consider:

   i. A range of species including flying seabirds and seals.

   ii. Both behavioural and physiological responses.

   iii. Demographic effects, including breeding numbers and breeding success.

   iv. Ambient environmental conditions, for example, wind and noise.

v. The effects of RPAS of different sizes and specifications.
vi. The contribution of RPAS noise to wildlife disturbance.
vii. Comparisons with control sites and human disturbance.
viii. Habituation effects.

Appendix 1 – Summary of peer reviewed published papers that monitored responses of wildlife to Remotely Piloted Aircraft Systems (RPAS)

Reference	Journal	Species	RPAS type	Disturbance study?	Vertical Heights (m)	Were responses to sound observed?	Were behavioural responses observed?	Were physiological responses observed ?
Antarctic region								
Rümmler et al. (2016) [7]	Polar Biology	Adélie penguins	Octocopter	Yes	10-50	NA	Yes	NA
Goebel et al. (2015) [6]	Polar Biology	Chinstrap penguins Gentoo penguins, Fur seals	Hexacopter	No	23-60	No (but compared with ambient)	No	NA
Korczak-Abshire et al. (2016) [24]	CCAMLR Science	Adélie penguins, Southern giant petrels	Fixed wing	Yes	350	NA	Yes	NA
Ratcliffe et al. (2015) [40]	Journal of Unmanned Vehicle Systems (JUVS)	Gentoo penguins	Hexacopter	No	30	NA	Yes	NA
Global								
Ditmer et al. (2015) [25]	Current Biology	Bears	Quadcopter	Yes	20	Yes	Yes	Yes
Vas et al. (2015) [26]	Biology Letters	Greenshanks, Flamingos.	Quadcopter	Yes	4-30	NA	Yes	NA
McEvoy et al. (2016) [27]	JPress	Mixed waterbirds	Multirotor, fixed wing	Yes	40-120	NA	Yes	NA
Smith et al. (2016) [41]	JUVS	Marine mammals	Multirotor, fixed wing	Yes	5-300 +	Yes	Yes	NA
Sarda-Palomera et al. (2012) [16]	Ibis	Gulls	Fixed wing	No	30-40	NA	No	NA
Grenzdörffer (2013) [42]	Book chapter	Gulls	Multirotor	No	15	NA	No	NA
Weissensteiner et al. (2015)	Journal of Avian Biology	Canopy nesting birds	Quadcopter	No	5	NA	Yes	NA

[43]								
Chabot et al. (2015) [39]	PLoS One	Terns	Fixed wing	No	90-122	NA	Yes	NA
Chabot and Bird (2012) [15]	Waterbirds	Geese	Fixed wing	No	30-40	NA	No	NA
Pomeroy et al. (2015) [30]	JUVS	Grey seals	Multirotor	No	40-250	NA	Yes	NA
Durban et al. (2015) [44]	JUVS	Killer whales	Hexacopter	No	35-40	NA	No	NA
Duvala et al. (2015) [45]	Environmental Practice	Mixed waterbirds	Fixed wing, gas powered	No	15-146	NA	Yes	NA
Moreland et al. (2015) [29]	JUVS	Ribbon and spotted seals	Fixed wing	No	122	NA	Yes	NA
Koski et al. (2015) [46]	JUVS	Bowhead whales	Mini-copter	No	120	NA	No	NA
Acevedo-Whitehouse et al. (2010) [47]	Animal Conservation	Whales	RC Helicopter	No	13	NA	No	NA
Vermeulen et al. (2013) [17]	PLoS One	Elephant	Fixed wing	No	100	NA	No	NA
Mulero-Pázmány et al. (2014) [21]	PLoS One	Rhino	FW	No	100-180	NA	No	NA
Jones et al. (2006) [48]	Wildlife Society Bulletin	Manatee	FW	No	100-150	NA	No	NA
Hodgson et al. 2016 [18]	Scientific Reports	Frigate birds, Crested terns, Royal penguins	Multirotor, fixed wing	No	75-120	NA	No	NA

Appendix 2

References

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