SCAR Action Group on the Development of an Antarctic-wide remote sensing approach to monitor bird and animal populations

Leuven, July 2017

State of knowledge on wildlife response to UAV/RPAS

Introduction

The environmental aspects of UAV/RPAS usage in the Antarctic have been an issue of CEP and ATCM since about three years (Final Report ATCM XXXVII 2014, Final Report ATCM XXXVIII 2015). The CEP has recognized the benefits of developing guidance on the use of UAV in Antarctica. At ATCM XXXIX 2016, COMNAP presented guidelines for certification and operation of UAV/RPAS. Hence, the need for the development of guidance on the environmental aspects has been expressed by CEP. In 2017 in Beijing, CEP XX “decided to establish an ICG to develop guidelines for the environmental aspects of the use of UAVs / RPAS in Antarctica. It noted that the work of the ICG could draw on ATCM XL/WP020 (SCAR), ATCM XL 2017/IP77 (COMNAP) and other papers submitted on the subject to CEP meetings, as well as the results of ongoing scientific research and experiences of national competent authorities.” (CEP 2017). The convener of this Intersessional Contact Group is Germany and it will start with the first round of discussion at the CEP Forum (http://www.ats.aq/e/cep_intersessional.htm) briefly.

The legal basis for the requirement of protecting aggregations of birds and seals is the Annex II of the Environmental Protocol to the Antarctic Treaty.

After discussing the use of UAV/RPAS at Annual Meetings since 2015, the International Association of Antarctica Tour Operators (IAATO) has banned flights for recreational purposes in coastal areas for seasons since 2015.

This document is the result of the workshop on ‘Drones in Antarctic Biology’ during XII SCAR Biology Symposium 2017. It relies on WP020 (XL ATCM) which was submitted by SCAR. Its intention is a specification and extension of those parts of WP020 that are based on Antarctic species. We regard it as a living document to be completed during the process of guideline development. It summarizes the current state-of-the-art of research and experience on the disturbance potential of UAV/RPAS operations to Antarctic wildlife. Considerations related to safety of human infrastructures or traffic systems are not topic of this document.

Scientific findings and knowledge gaps on the disturbance of animals by UAV/RPAS

In recent years, triggered by the high and rising number of scientific and private UAV/RPAS applications, the amount of studies investigating their impact on animals has increased. Surveys have been conducted worldwide and specifically in the Antarctic with varying extensiveness and setups. In the following section, results of studies on Antarctic species will be shown with their most important traits.

Species traits				study traits		RPAS type			Results				Reference
Group	Species	life-history stage	aggregation	Vertical Heights (m)	Disturbance study?	size	Type & engine	flight pattern	Were responses to sound observed?	Were behavioural responses observed?	Were physiological responses observed?		
penguins	gentoo penguin	breeding	colony	N.A.	NO	80 cm	6-Copter electric	lawn-mower	N.A.	No	N.A.	no reaction above 30 m	Gardner et al. (2010) [1]
		breeding	colony	23-60	NO	80 cm	6-Copter electric	N.A.	No	No	N.A.	no signs of disturbance at 30-60 m	Goebel et al. (2015) [2]
		breeding	colony	30	NO	N.A.	6-Copter electric	lawn-mower	N.A.	Yes	N.A.	at 30 m breeding birds did not leave nest; non-breeders walked away	Ratcliffe et al. (2015) [3]
		breeding	colony	10-50	YES	70 cm	8-Copter electric	lawn-mower	N.A.	Yes	N.A.	significant reaction at 40 m	Rümmler et al. (in press) [5]
		breeding, chicks	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	clear reaction at 25 m	Weimerskirch et al. (in press)[6]
	chinstrap penguin	breeding	colony	N.A.	NO	80 cm	6-Copter electric	lawn-mower	N.A.	No	N.A.	no reaction above 30 m	Gardner et al. (2010) [1]
		breeding	colony	23-60	NO	80 cm	6-Copter electric	N.A.	No	No	N.A.	no signs of disturbance at 30-60 m	Goebel et al. (2015) [2]

		breeding	colony	8-92	Yes	80 cm	6-Copter electric	lawn-mower and hover	Yes	Yes	No	Preliminary: low disturbance even below 15 m	Watters et al. (pers. Comm.) [8]
	Adélie penguin	breeding	colony	10-50	YES	70 cm	8-Copter electric	lawn-mower	N.A.	Yes	N.A.	significant reaction above 50 m	Rümmler et al. (2016) [4]
		breeding	colony	350	YES	3,8 m	Fixed wing fuel	lawn-mower	N.A.	Yes	N.A.	short vigilance when directly overhead at 350 m	Korczak-Abshire et al. (2016) [7]
		breeding	colony	350	YES	2,1 m	Fixed wing electric	lawn-mower	N.A.	Yes	N.A.	not recognized at 350 m altitude	Korczak-Abshire et al. (2016) [7]
	King penguin	non-breeding	solitary (?)	30	NO	N.A.	6-Copter electric	lawn-mower	N.A.	Yes	N.A.	at 30 m walking away	Ratcliffe et al. (2015) [3]
		breeding	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	Yes	minor behavioral reaction at 25 m & change in heart rates	Weimerskirch et al. (in press)[6]
		non-breeding	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	clear response at 25 m	Weimerskirch et al. (in press) [6]
		chicks	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	Yes	Behavioral response observed at 50 m, heart rate increased at 25 m	Weimerskirch et al. (in press) [6]
	Macaroni penguin	breeding	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	Slight reaction at 25 m	Weimerskirch et al. (in press) [6]

	Southern rock-hopper penguin	breeding	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	Slight reaction at 25 m	Weimerskirch et al. (in press) [6]
mammals on land	Fur seal		small groups	23-60	NO	80 cm	6-Copter electric	N.A.	N.A.	No	N.A.	no response above 23 m	Goebel et al. (2015) [2]
			small groups	10-70	YES	70 cm	8-Copter electric	lawn-mower	N.A.	Yes	N.A.	response depends on group characteristics	Rümmler et al. (pers. comm.) [5]
		breeding	small groups	8-92	YES	80 cm	6-Copter electric	hover	Yes	Yes	No	Preliminary: low disturbance even below 15 m	Watters et al. (pers. comm.) [8]
	Weddell seal		solitary	23-60	NO	80 cm	6-Copter electric	N.A.	No	No	N.A.	no response above 23 m	Goebel et al. (2015) [2]
	Leopard seal		solitary	23-60	NO	80 cm	6-Copter electric	N.A.	No	No	N.A.	no response above 23 m	Goebel et al. (2015) [2]
			solitary	8-92	YES	80 cm	6-Copter electric	hover	Yes	Yes	Yes	Preliminary: low disturbance even below 15 m	Watters et al. (pers. comm.) [8]
Other birds	Kelp gull	breeding	colony	25-50	YES	70 cm	8-Copter electric	lawn-mower	N.A.	Yes	N.A.	almost no reaction	Rümmler et al. (pers. comm.)[5]
		breeding	colony	20-100	NO	30 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	almost no reaction	Rümmler et al. (pers. comm.) [5]
		breeding	colony	6-50	NO	100 cm	Fixed wing electric	lawn-mower	N.A.	Yes	N.A.	enhanced fly-offs below 10 m, above almost no reaction	Rümmler et al. (pers. comm.) [5]

		breeding	colony	N.A.	NO	45 cm	4-Copter electric	hobby	N.A.	Yes	N.A.	attacks above colony	Rümmler et al. (pers. comm.) [5]
	Terns	probably breeding	Pair	70-90	NO	70 cm	Fixed wing electric	lawn-mower	Yes	Yes	N.A.	Take-offs and following UAV over long time periods (several minutes)	Vieira et al. (2017) [9]
	Southern giant petrel	breeding	small group	30-160	YES	70 cm	8-Copter electric	lawn-mower	N.A.	Yes	N.A.	strong disturbance and observation at 30 – 160 m, no trend between altitudes	Rümmler et al. (pers. comm.) [5]
		breeding	small group	30-160	YES	100 cm	Fixed wing electric	lawn-mower	N.A.	Yes	N.A.	observation and weak signs of disturbance at 30 – 160 m; observation increasing in lower altitudes	Rümmler et al. (pers. comm.) [5]
		breeding	small group	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	clear response at 50 m	Weimerskirch et al. (in press) [6]
	Northern giant petrel	non-breeding	small group	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	Slight response at 50 m	Weimerskirch et al. (in press) [6]
	Brown-/ Southpolar-skua	breeding	solitary	20-150	YES	30 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	only weak disturbance at 20 m	Rümmler et al. (pers. Comm) [5]
		breeding	solitary	20-150	YES	100 cm	Fixed wing electric	lawn-mower	N.A.	Yes	N.A.	observation and disturbance at 170 m and below, repeated cases of attacks	Rümmler et al. (pers. comm.) [5]

				30-100		80 cm	6-Copter electric	lawn-mower	N.A.	Yes	N.A.	No response	Watters et al. (pers. comm.)[8]
		breeding		<60	NO	35 cm	4-Copter electric	lawn-mower	Yes	Yes	N.A.	Fildes Pen.: no interaction; Cierva Cove: aggressive	Vieira et al. (2017) [9]
		breeding	solitary	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	clear response at 50 m	Weimerskirch et al. (in press) [6]
		breeding	solitary	>120	NO	70 cm	Fixed-wing	lawn-mower	Yes	Yes	N.A.	Normally following, escorting UAV, closer to cliffs with probable nests repeated attacks. Attack also following take-off.	Vieira et al. (2017) [9]
	Wandering albatross	non-breeding, fledgelings	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	Clear response at 50 m	Weimerskirch et al. (in press) [6]
	Sooty albatross	breeding	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	Slight reaction at 25 m	Weimerskirch et al. (in press) [6]
	Light-mantled sooty albatross	breeding	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	Clear reaction at 25 m	Weimerskirch et al. (in press) [6]
	Imperial cormorant	breeding	colony	2-50	YES	35 cm	4-Copter electric	lawn-mower	N.A.	Yes	N.A.	slight response at 50 m	Weimerskirch et al. (in press) [6]

Table 1: Summary of the current knowledge on the impact of UAV on Antarctic Wildlife

* flight pattern: following Mulero-Pázmány et al. (2017), the characteristics of the flight pattern have been categorized as follows: “target-oriented” (directly approaching animals), “lawn-mower” (transects of constant altitudes), “hobby” (irregular flight schemes)

[1] Gardner et al. (2010)

[2] Goebel et al. (2015)

[3] Ratcliffe et al. (2015)

[4] Ruemmler et al. (2015)

[5] Ruemmler et al. (pers. comm.)

[6] Weimerskirch et al. (in press)

[7] Korczak-Abshire et al. (2016)

[8] Watters et al. (pers. comm.)

[9] Vieira et al. (2017)

Additionally to the results of these studies most researchers in the field agree on the following observations during their work:

- Changes in noise intensity, as for example caused by gusts of wind, sudden movements of the UAV/RPAS or take-offs induce a strong reaction in most of the animals
- Take-offs and altitude changes (vertical movements) have a high impact on animals and should be accomplished outside the colony area/territory
- Habituation could not be proved or observed

Those observations are not proved statistically but should be taken into account when formulating guidelines based on the general agreement between researchers.

To complete the described findings studies are in process and are highly recommended to be enlarged furthermore by investigating the physiological (heart and respiratory rates, hormonal stress responses) reactions of UAV/RPAS disturbance. This way more objective measurements could be provided to compare disturbances.

Additionally, there is a clear need to increase the number and extent of future studies to include: 1) more data on different UAV platforms and locations along with additional species, 2) direct comparisons between traditional ground monitoring techniques (e.g., ground surveys) and UAV-based responses, 3) assessments of the impact of take-off and landing operations, and 4) initiation and maintenance of long-term observations to address cumulative effects.

Existing recommendations for the use of UAV/RPAS

Mulero-Pázmány et al. (2017):

"UAS flights are avoided unless they constitute the least invasive option for necessary wildlife studies, and discouraged if they are performed just for leisure purposes such as flying or filming"

1) Use reliable UAS operated by experienced pilots

2) Favor low-noise or small UAS against noisier or larger ones

3) Mount the ground control station 100 - 300 m away from the study area

4) Conduct missions as short as possible

5) Fly at the highest altitude possible

6) Avoid maneuvers above the animals

7) Favor lawn-mower flight patterns

8) Minimize flights over sensitive species or during breeding period

9) Avoid UAS silhouettes that resemble predator shapes

10) Avoid close-distance direct approaches and favor indirect ones

11) Monitor target animals before, during, and after the flight

12) For nest inspections, fly at times in which eggs/chicks are out of risk

13) If the flights are around aggressive raptor's territories, perform them at day times when the temperature is low and birds are less prone to fly.

They also recommend adapting the legal frame to take action if wildlife is harmed by UAV/RPAS activities.

Weimerskirch et al. (in press):

"Yet, when used at an altitude of 50 m, the drone impact is likely to be negligible for all species […]"

Hodgson and Koh (2016)

1) Adopt the precautionary principle in lieu of evidence
2) Utilise the institutional animal ethics process to provide oversight to UAV/RPAS-derived animal observations and experiments.
3) Adhere to relevant civil aviation rules and adopt equipment maintenance and operator training schedules
4) Select appropriate UAV/RPAS and sensor equipment.
5) Exercise minimum wildlife disturbance flight practices.
6) Cease UAV/RPAS operations if they are excessively disruptive.
7) Detailed, accurate reporting of methods and results in publications.

Vieira et al. (2017)

1) Avoid flight activities during breeding season
2) Avoid flights below 150 – 200 m above ground level over bird colonies
3) If lower flights are necessary -> flight should be observed by a second person (binoculars) to be able to react to incidents with wildlife
4) Take-off as far as possible from colonies

Watters et al. (pers. comm)

1) UAV-animal disturbance should be considered in comparison with alternative (e.g., ground-based) options for data collection.

Conclusions and condensed recommendations for guidelines

Considering all the above findings the SCAR Action Group on "Development of a satellite-based, Antarctic-wide, remote sensing approach to monitor bird and animal populations" recommends the following guidance for further considerations regarding the development of guidelines for responsible use of drones in the Antarctic. These recommendations are not yet based on a precautionary approach and they do not have a final status, but interpret the current state of knowledge. It should be regarded as a basis for further development.

Group	Species	Multicopter / electric	Fixed wing / electric	Fixed wing / gas fueled
Penguins	Gentoo penguin	50 m	?	?
	Chinstrap penguin	50 m	?	?
	Adélie penguin	> 50 m	< 350 m	> 350 m
	King penguin	> 50 m	?	?
	Macaroni penguin	50 m	?	?
	Southern rock-hopper penguin	50 m	?	?
Mam mals	Fur seal	50 m	?	?
	Weddell seal	50 m	?	?
	Leopard seal	50 m	?	?
Other birds	Kelp gull	30 m	30 m	?
	Antarctic Tern	?	>100 m	?
	Southern giant petrel	200 m	200 m	?
	Northern giant petrel	≥ 50 m	?	?
	Brown Skua	100 m	200 m	?
	South Polar Skua	100 m	200 m	?
	Wandering albatross	> 50 m	?	?
	Sooty albatross	50 m	?	?
	Light-mantled sooty albatross	> 50 m	?	?
	Imperial cormorant	> 50 m	?	?

Table 2: Minimal flight distances with no proved disturbance according to the existing knowledge on the basis of the studies listed above (well founded knowledge, knowledge needs further refining, only first hints)

Table 2 only refers to flight altitude above different species, and may not be appropriate to set limits for scientific programs depending on their scientific objectives.

The members of the Action Group came to the following agreements during the workshop:

- Species-specific guidelines are not practical and useful given to the current state of knowledge
- A vertical and horizontal limit to animal aggregations should be defined beyond which disturbance can be excluded. Inside this distance UAV/RPAS operations need risk assessment. Risk assessments should include factors such as UAV size, weather conditions, and a comparison to alternate ground-based survey methods (if applicable).
- To increase the base of knowledge, national environmental authorities are encouraged to hand out a standardized questionnaire to assess the reactions during permitted scientific UAV/RPAS operations (will be provided by the AG)
- Parallel UAV/RPAS operations over the same animal aggregation should be avoided.
- Management plans of ASPAs should be revised individually regarding UAV/RPAS operations.

Necessary points for further discussion on the compilation of guidelines are

- Which disturbance level is acceptable (e.g. in relation to the need to scientifically inform monitoring and management, and in relation to the potential disturbance caused by other methods)?
- How to handle solitary animals?
- Should UAV/RPAS operations for other purposes than science be allowed?
- Should guidelines differentiate between different purposes of flights?
- Is it useful to establish site specific guidelines instead of general ones?

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