INITIAL ENVIRONMENTAL EVALUATION (IEE)
For the WEDDELL SEA EXPEDITION
Field Seasons 2021-22

Submitted by
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STONY BROOK UNIVERSITY
to the
US ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF FEDERAL ACTIVITIES
Pursuant to 40 CFR Part 8

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Attachments:
Appendix 1: Pending 2021-22 NSF permit application (including Waste Permit)
Appendix 2: Greenpeace expedition plan and preliminary IEE
Appendix 3: Advance Notification to the US Department of State regarding intended activities for the 2020-21 Antarctic field season (DS-4131)
Appendix 4: Heather Lynch CV
Appendix 5: Tom Hart CV
Appendix 6: Stony Brook IACUC approval[1]

[1] The Stony Brook IACUC includes all proposed census-type work anticipated for the Weddell Sea expedition proposed for 2021-22 as well as additional activities, such as egg shell collection, that are **not** being proposed for this expedition.

1.0 Contact name and address

This Initial Environmental Evaluation (IEE) was prepared by Heather Lynch (Principle Investigator). Heather Lynch is the intended permittee.

Heather Lynch serves as the contact point for any questions or details relating to this IEE or with respect to permitting and field operations.

Heather Lynch can be reached:
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This IEE submission makes reference to general references indicated below, but also reports, scientific papers and other unpublished information prepared by the Principle Investigators (Heather Lynch, Stony Brook; Tom Hart, Oxford), whose CVs are attached to this IEE at Appendices 4-5 and incorporated by reference herein. This IEE is based heavily on the IEE approved for the Chinstrap Survey Expedition in 2019-20, which followed similar methods for ground and UAV-based surveys and which Lynch and Hart helped to organize.

We also refer to the following as general references:

- Antarctic Peninsula Compendium, 3rd edition (the "Compendium"), which describes Antarctic Site Inventory (ASI) census locations and the methodology, coverage, and logistics; [2]
- Wildlife Awareness Manual (WAM), [3]
- Onboard International Association of Antarctic Tour Operators (IAATO) field operations manual updated annually
- IATTO website, http://iaato.org/home
- Antarctic treaty website, http://www.ats.aq/index_e.htm
- Foreign and Commonwealth website, https://www.gov.uk/guidance/visits-to-antarctica-how-to-apply-for-a-permit

Work carried out under any permit granted will be conducted pursuant to the:

- Antarctic Conservation Act, 45 CFR 673 et seq.;
- Scientific Committee on Antarctic Research (SCAR)'s Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica;
- Animal Welfare Act, Institutional Animal Care and Use Committee (IACUC), 9 CFR, Subchapter A;
- IAATO site guidelines and operational protocols.

Also relevant to this submission are:

[2] Naveen and Lynch (2011)
[3] Harris (2006)

- Advance Notification to the US Department of State regarding intended activities for the 2019-20 Antarctic field season (DS-4131)(Appendix 3);
- Netherlands Initial Environmental Evaluation for the MY Arctic Sunrise (Appendix 2)
- IACUC Review (Appendix 6)

2.0 Executive Summary

The last decade has seen a tremendous focus on the population dynamics of the three *Pygoscelis* spp. penguins on the Antarctic Peninsula, and interest in the region continues to grow with the proposal of two new Marine Protected Areas in the region. A recent expedition to the Weddell Sea region identified a major penguin hotspot (Borowicz et al. 2018) in the Danger Islands. The Weddell Sea contains a number of additional known or putative penguin colonies not surveyed on that previous expedition that remain of significant scientific and management interest.

Our surveys will be completed using direct manual counts and the use of unmanned aerial vehicles. We anticipate no significant disturbance caused by either direct manual counting or by UAV survey.

Multi-Scale Population Census: As part of the census monitoring for this project (which also involves ground censusing) we will employ quadcopter-based aerial photography to systematically obtain digital imagery that can be used for post-facto counting of penguin nests. Imagery of penguin colonies will be collected by flying small, quadrotor Unmanned Aerial Vehicles (UAVs) in a survey of the colony, taking pictures at regular intervals. The photographs will be combined into a full mosaic of the colony using commercially available software, and the penguins counted to perform a full colony census. This methodology was used successfully for a previous expedition to the Danger Islands in 2015-16 (Borowicz et al. 2018) and another at Elephant Island in 2019-20 (Strycker et al. 2021).

All penguin colonies targeted in this expedition are relatively small (<20,000 nesting pairs) and the primary flight mode for the vehicles will be manual. The quadcopter will always be flown within visible sight of the pilot on the ground. In case of loss of communication with the vehicle the UAV is pre-programmed with safety features: slowly transiting back to its take-off location and landing if GPS position is still available, and making a slow decent to land in its current location in case of loss of communication and loss of GPS (a highly unlikely scenario).

Any work around penguins, and particularly penguin handling at a time of nesting, poses the potential for take, harmful interference, and site disturbance. We have a highly experienced pair of biologists who have conducted work on the Antarctic Peninsula and who understand penguin biology, sensitivities, and how to work safely in and around penguins. Our disturbance will be mitigated through careful planning and observation of penguin behavior. The techniques we propose to use to conduct counts have been used in Antarctic research for decades and have not been shown to cause adverse harm to reproductive success in penguins.

The use of unmanned aerial vehicles (UAVs or drones) is an emerging technology that we believe may represent the future of bioassessment in the Antarctic. This technology, which in

many ways is less disturbing than ground-based surveys, has unique impacts and the potential to create debris through loss or in the event of catastrophic failure. We plan to mitigate those impacts through use of well-defined operational parameters that would minimize the chance of loss of a drone, and through an adaptive review of disturbance as the drone is deployed and if negative responses in penguins or other fauna are observed. We believe the risks posed by drones in terms of biohazard are de minimus.

3.0 Description of the Expedition

This expedition will be carried out under a permit granted by the NSF under the Antarctic Conservation Act (45 CFR §673 et seq.), a copy of the application (pending) attached as Appendix 1. The MY Arctic Sunrise operates under a permit issued from the Netherlands foreign office (pending application attached as Appendix 2). Relative to activities not covered by our pending permit while ashore and at sea, we will adhere to the IAATO guidelines and site-specific management criteria where applicable.

Regarding our means of conveyance and specific locations where the expedition is planned to occur, we refer you to our form DS-4131, attached at Appendix 3. In general, our expedition will depart Punta Arenas, Chile on the MY Arctic Sunrise on 7 January, 2022 and return to Punta Arenas, Chile on 7 February, 2022. It is worth noting that the timing of this expedition is particularly uncertain due to the shifting quarantine requirements. Our primary area of interest is in the Weddell Sea region and its immediate vicinity (contingent on ice and weather conditions). During transit between locations, and in the event that we must shift priority locations, we are also likely to visit other penguin rookeries for census work on an opportunistic basis. We do not intend to visit any ASPAs during our expedition and correspondingly no ASPAs are included in our permit application.

Our contingency and emergency plans are outlined in the DS-4131, which includes information on our communications and risk management. In addition, the Risk Management Plan for the Arctic Sunrise and plans for self-sufficiency are described in the DS-4131 and Appendix 2.

The expedition profile is listed below. All expedition personnel (not including crew) will be listed as Agents on the pending NSF permit (see Appendix 1).

Name	Title	Affiliation	Years Antarctic Experience	Details of experience/ existing permits	Nationality
Steve Forrest	Contractor	Stony Brook University	24	24 seasons working with the Antarctic Site Inventory, logistics lead for the Danger Islands Expedition in 2015/16 and the Chinstrap Survey Expedition in 2019/20, 5 seasons field camp at Petermann island, 2 cruises RV LM Gould, Agent ACA permits 2014-2020	USA
Michael	Graduate	Stony	1	Participated in the	USA

Wethington	student	Brook University		Chinstrap Survey Expedition in 2019/20 and also completed penguin surveys off a commercial cruise ship under the auspices of the Antarctic Site Inventory	

Both Principle Investigators are involved in long-term studies of the Antarctic environment (see e.g., curriculum vitaes of Heather Lynch [Stony Brook] and Tom Hart [Oxford] and publications listed therein, attached at Appendices 4-5). In particular, the information proposed to be collected will become part of the Principle Investigators' databases and their regular interactions and participation through the Antarctic Treaty System, but also databases such as the Antarctic Peninsula Compendium.

4.0 Description of the proposed expedition activities

This permit is intended to cover a scientific survey of penguin colonies along the Antarctic Peninsula with a specific focus on the Weddell Sea region. In our initial assessment of the population dynamics of the Danger Islands, we found evidence that Adélie abundance was broadly stable when compared to historic imagery taken 50 years ago (Borowicz et al. 2018) but a more recent analysis of penguin colony shape suggested that the Danger Islands' population had likely declined in the last 10-15 years (McDowall and Lynch 2019). This initially paradoxical finding was explained by a recent unpublished re-analysis of Landsat satellite imagery confirming that the Danger Islands population had likely peaked in the mid-1990s and has declined modestly since. We intend to re-survey locations in the Danger Islands to confirm whether the abundance of Adélie penguins is in fact declining, as this would be highly informative as to the mechanisms driving Adélie declines both locally (i.e. the Danger Islands) and more regionally (along the Western Antarctic Peninsula). This expedition also aims to reach several adjacent colonies that are very poorly surveyed. Red Island has never (as far as we are aware) been surveyed directly but Lynch and LaRue (2014) identified approximately 1000 penguin nests (likely Adélie, but unconfirmed) at this location. Red Island would be one of the southernmost colonies on the Weddell Sea side of the Antarctic Peninsula. Likewise, Cockburn Island has not been surveyed directly but Lynch and LaRue (2014) identified approximately 15,000 penguin nests (likely Adélie, but unconfirmed) at this location. Vortex Island and Penguin Point similarly host poorly known Adélie populations that appear from satellite imagery to be declining; a direct census of these islands will confirm the scope and rate of any continued declines. Time and weather permitting, this expedition will aim to re-survey several other populations that are frequently visited but rarely surveyed due to their considerable size, including Brown Bluff and Paulet Island. In all, this expedition will allow us to understand whether the Weddell Sea region is stable or declining and by how much. Heterogeneous patterns across this region would be highly informative of the responsible drivers. Finally, this expedition will provide a comprehensive basemap of penguin distribution and abundance that will inform the planning for and development of a Marine Protected Area in the Weddell Sea region.

As part of the census monitoring for this project (which also involves ground censusing) we will employ quadcopter-based aerial photography to systematically obtain digital imagery that can be used for post-facto counting of penguin nests. Imagery of penguin colonies will be collected by flying small, quadrotor Unmanned Aerial Vehicles (UAVs) in a survey of the colony, taking pictures at regular intervals. The photographs will be combined into a full mosaic of the colony using commercially available software, and the penguins counted to perform a full colony census. This methodology was used successfully for a previous expedition to the Danger Islands in 2015-16 (Borowicz et al. 2018) and a second expedition to Elephant Island in 2019-20 (Strycker et al. 2021).

We propose conducting these surveys from approximately 7 January- 7 February, 2022, during what is anticipated to be the peak of chick incubation for Adélie penguins.

We will conduct the following activities:

4.1 Penguin Censuses

Background: The focus of this project will be to obtain a complete census of penguin populations at each site visited.

Objective & Hypothesis: We propose to visit all penguin colonies in the Weddell Sea region to establish a comprehensive base map of penguin distribution and abundance in the region and to establish whether these colonies are stable (as implied by Borowicz et al. 2018) or declining (as suggested by a recent analysis of archival Landsat imagery).

Expected outcome: Where we are able to complete hand counts of colonies, we should end up with counts of each sub-group of penguins (in triplicate) for every sub-colony on every island or site visited. We should also have waypoints and tracklogs clearly labeled and filed so they can be matched with the count data, and photographs of each site (including panoramas and landscape scale photos to orient interpretation of the satellite imagery).

Penguin census work will be done at every landing site, which may include information gathered opportunistically at rookeries on non-target sites gathered in-transit. Preferably, all sites will be simultaneously both imaged via UAS (see below) and direct counted for complete replication of population assessment.

The methods for penguin census depend on the logistics of each site and the number of penguins present. Penguins should be counted by direct counting of individual nests using a hand-held tally counter. Penguins are grouped for counting as needed by the site and the personal preference of the counter, but generally each well -defined group of penguins will be counted and recorded separately. This usually results in a group size of 10-200 penguins. Sometimes, large groups of penguins will need to be divided artificially using neon climbing rope or other easily identified markers. Each group counted is counted 3 times, either by three separate people or by the same person three times. If those counts are within 5% of each other, the group is considered “counted” and the team moves to the next subgroup. If the range of counts obtained is larger than 5% than the count is repeated until there is consensus about the

correct count or it is determined that the group cannot be counted to 5% accuracy and the count is given a lower accuracy assessment (N2=±10%, etc.).

During and after peak egg laying, we define a nest as a pile of stones being actively incubated by a penguin. We will not attempt to see if closely incubating birds actually have eggs in the nest, although clearly empty nests will not be counted. These definitions have been developed in consultation with other penguins census programs and represent the maximization of our desire to estimate true breeding population size while recognizing the limits of a short-duration census count over a large area.

During the course of our penguin survey work, we anticipate additional surveys of flying birds or marine mammals on an opportunistic basis. These surveys would be based entirely on visual surveys using binoculars, either from the ground or from an offshore boat as appropriate and would entail no additional impacts on the wildlife or the environment.

Personnel required: This depends on the size of the colony, will take approximately one person hour for every 500-1000 penguin nests, excluding travel time between penguin colonies.

Censuses involve bringing survey teams ashore, foot travel to and from landing sites and between colonies and census locations, and potential disturbance of nesting penguins due to proximity.

All censuses are accomplished by walking the perimeter of the colonies, watching the animals closely to ensure that there are no disruptions or changes in behavior. The researchers carry metal or plastic hand-clickers to accomplish their censuses. Binoculars, cameras, compasses, and GPS units are standard gear carried by the researchers. Researchers communicate with each other, the expedition leader, and with the ship by hand-held radio.

The physical nature of a particular census depends on the size of a colony and the terrain on which it is located. In some cases, researchers may work from one vantage point, if it allows the researcher to see the whole colony and readily enables her to complete the requisite number of counts for statistical purposes. With larger colonies (e.g. >150 penguin nests) or colonies located on a steep slope or hummocky terrain, the researcher likely will need to walk around the colony to obtain the counts. Researchers avoid walking within colonies to obtain their data.

In addition, we will be measuring the colony perimeter to map it with use of a hand-held GPS. These tracklogs will NOT be used for area estimation, so there is no need to walk close to penguins or keep the distance to the colony exactly the same. Any disturbance to penguins will be similar to the researcher approaching penguins to count them.

4.2 Aerial censuses using Unmanned Aerial Surveillance (UAS):

Objective & Hypothesis:
The objective is to use small quadcopter UAVs to get full mosaic maps of penguin colonies that can be used to perform a census of the colony. The ideal case is to run computer vision

algorithms on the resulting mosaic to rapidly generate census data, allowing for fast and cheap census operations on a colony with minimal person hours required.

Expected outcome:

The expected outcomes of these experiments are full mosaic maps of penguin colonies as well as automatically generated counts of penguins in the colony. This data will prove useful both as a census of the colony and as an engineering test of using UAVs for automatic data collection. Our UAV system will provide high-resolution vertical aerial photographs (from which high resolution digital elevation models can be created) and coupled spectrometry measurements of ground targets. The aerial photographs will be used primarily to survey penguin colonies in conjunction with ground counts.

Study Sites & Methods:

Imagery of penguin colonies will be collected by flying UAVs in a survey of the colony and taking pictures at regular intervals. The photographs will be combined into a full mosaic of the colony using commercially available software, and the penguins counted to perform a full colony census.

Equipment: We will be bringing two DJI Mavik Air 2 drones. These UAVs will be purchased specifically for this expedition and as such we do not yet have serial numbers or registration numbers for them.

Each drone will come with its own flight controller, which are interoperable in case of equipment malfunction. Each drone will come with 4 batteries (one for operation and three spare).

Flight mode: The primary flight mode for the vehicles will be manual remote control operation of the UAV by a trained pilot on the ground. The quadcopter will always be flown within visible sight of the pilot on the ground. In case of loss of communication with the vehicle the UAV is pre-programmed with safety features: slowly transiting back to its take-off location and landing if GPS position is still available, and making a slow decent to land in its current location in case of loss of communication and loss of GPS (a highly unlikely scenario).

Wildlife Disturbance: Measurements shown in Goebel et al. (2015) and more recently by Krause et al (2021) suggest that distances of over 30 m from wildlife virtually eliminates concerns for disturbance of wildlife, and as such all take-off and landing sites will be at least 30 m away from wildlife. In addition, during all flights a dedicated spotter will keep watch for birds that may become disturbed by the flight of the UAV. To ensure bio- security fresh landing struts will be used after entering Antarctica, and the vehicle will be thoroughly cleaned in between sites.

Operational window: As a baseline the 10 m/s maximum wind speed estimate of Goebel et al. (2015) will be used. However, final say on beginning and aborting operations will rest on the primary pilot on the ground in consultation with the skipper of the MY Arctic Sunrise and the expedition coordinator.

Materials & Supplies required:
- 2 UAVs (DJI Mavik Air 2)
- 6 spare DJI batteries
- 2 DJI controllers
- detox wipes
- spare propellers

Personnel required:
Each operation will require two people for UAV flight, one dedicated pilot and one spotter. One individual will act as pilot in command and this person will be in command of the UAS, while the second will act as a ground observer, will communicate to the pilot information necessary to complete the photographic survey, and will monitor the surrounding area for safety hazards (flying birds, ship passengers, other aircraft).

In addition to flight time each deployment will require ~30 minutes of landing/survey site visual inspection and setup time and ~15 minutes break down time for each take-off/landing site. Goebel et al. (2015) suggests that ~3 km of trackline can be flown on a single 15 minute charge, however the exact distance flown and battery life will be dependent on the UAV in use and the current weather conditions.

Timing and duration of mission flights will depend on permissible weather conditions as determined by the pilot in command, and pertinent logistical constraints related to operation of the MY Arctic Sunrise.

Flight coordination and notification
We do not plan to operate UAVs within the area of flight operations for any national programs. Irrespective of this, the general UAV protocol will be as follows: 1) If we are within 25 nm of any known base where air operations are frequently expected, we will contact said base directly to notify them of our proposed air operation and coordinate flight planning; 2) For all operations we will provide a general call on the ship's radio to alert any vessels in the area that we are commencing air operations.

5.0 Description of the existing environment (e.g. the environmental reference state)

5.1 Dundee Island vicinity

We are targeting three penguin colonies near Dundee Island: Dundee Island, Eden Rocks, and Paulet Island (Figures 1a and 1b).

Dundee Island (-63.47, -56.05, 21.2 km × 25 km) recorded a single survey from 1895 when 40 Gentoo Penguin nests were reported (Croxall and Kirkwood 1979). No further site information is available.

Figure 1a: Location of Dundee Island penguin colony (Croxall and Kirkwood 1979).

Eden Rocks (-63.50, -55.68, two rocks, one 0.9 km × 0.26 km and the other 0.79 km × 0.26 km) was surveyed in 1996/97 by the Antarctic Site Inventory, which estimated the population of Adélie penguins to be 46,855 nests (Naveen and Lynch 2011). That survey also reported breeding populations of Cape Petrels and Skuas (species unidentified), as well as non-breeding adults of Southern Giant Petrels, Snowy Sheathbills, Wilsons Storm Petrels, and Kelp Gulls.

Paulet Island (-63.58, -55.77, 1.56 km × 2.23 km) is well known because it is frequently visited by commercial cruise vessels (ATS Visitor Site Guide 8, https://www.ats.aq/devAS/Ats/Guideline/ea07581b-ee37-49bf-94c3-68dd20fef6a9). Sensitivities are discussed in ATS Site Guide 8. The site has historical interest due to the presence of a hut constructed by the Swedish Antarctic Expedition 1901-03. Because of the size of the colony, it has been difficult to get precise population estimates for the island's Adélie penguins, but the most recent estimate from the 2010/11 season suggested approximately 100,000 nests (Lynch and LaRue 2014). Several other species breeding on Paulet Island, including Cape Petrels, Snow Petrels, Blue-eyed Shags, Snowy Sheathbills, South Polar Skuas, Brown Skuas, Wilsons Storm Petrels, Kelp Gulls, and Antarctic Terns (Naveen and Lynch 2011). Non-breeding adults of Chinstrap Penguins and Gentoo Penguins have also been reported (Naveen and Lynch 2011).

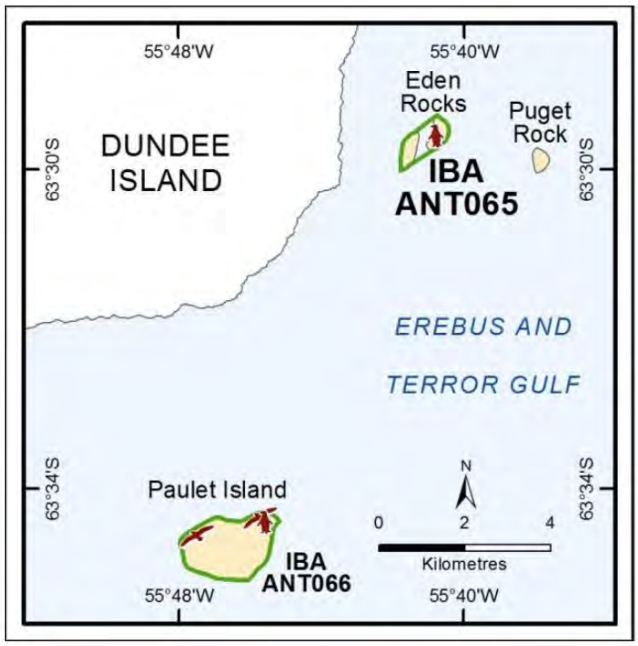

Figure 1b: Map of the Dundee Island area (Map source: Wilderness Awareness Manual).

5.2 Weddell Sea penguin colonies (excluding Danger Islands)

We are targeting five penguin colonies in the Weddell Sea region: Cockburn Island and Penguin Point (Seymour Island) (Figure 2), Devil Island (Figure 3), Red Island, and Vortex Island.

Cockburn Island (-64.22, -56.68, 2.78 km × 1.78 km; Figure 2) has not been surveyed for penguin populations from the ground previously to our knowledge. Vegetation was described by Smith (1993) and this island was apparently was the site of one of the first botanical surveys on the Antarctic Peninsula during the James Clark Ross expedition of 1843. Geology has been described by Stillwell (2002) and the island contains numerous fossils. Croxall and Kirkwood (1979) report a "fairly big colony" on Cockburn Island in 1901-03 but we were not able to track down the original source for this assessment (likely the Swedish Antarctic Expedition of 1901-03). Using high-resolution satellite imagery from the 2010/11 season, Lynch and LaRue (2014) estimated 15,721 Adelie penguin nests on Cockburn Island. The only other reported breeding species on this island is Blue-eyed Shag (Naveen and Lynch 2011), where 800 nests were recorded in 2006/07. On account of the number of Shag nests, Cockburn Island is considered an Important Bird Area (Harris et al. 2015). Our survey will allow us to re-census the Shag colony at Cockburn Island and identify any changes in the population over the last 16 years.

Penguin Point is located on Seymour Island (-64.25, -56.75, 18.56 km × 8.4 km; Figure 2) and in the 2009/10 season a survey found 16,015 Adélie penguin nests (Lynch et al. 2013) easily approached from the site's landing beach. In addition to Adélie penguins, Penguin Point contains breeding populations of South Polar Skuas, Brown Skuas, Kelp Gulls, and Antarctic Terns. Non-breeding adults of Gentoo Penguins, Southern Giant Petrels, Cape Petrels, Blue-eyed Shags, Snowy Sheathbills, and Wilsons Storm Petrels have also been reported (Naveen and Lynch 2011). Penguin Point is considered an Important Bird Area on account of the number of Adélie penguins nesting at the site (Harris et al. 2015).

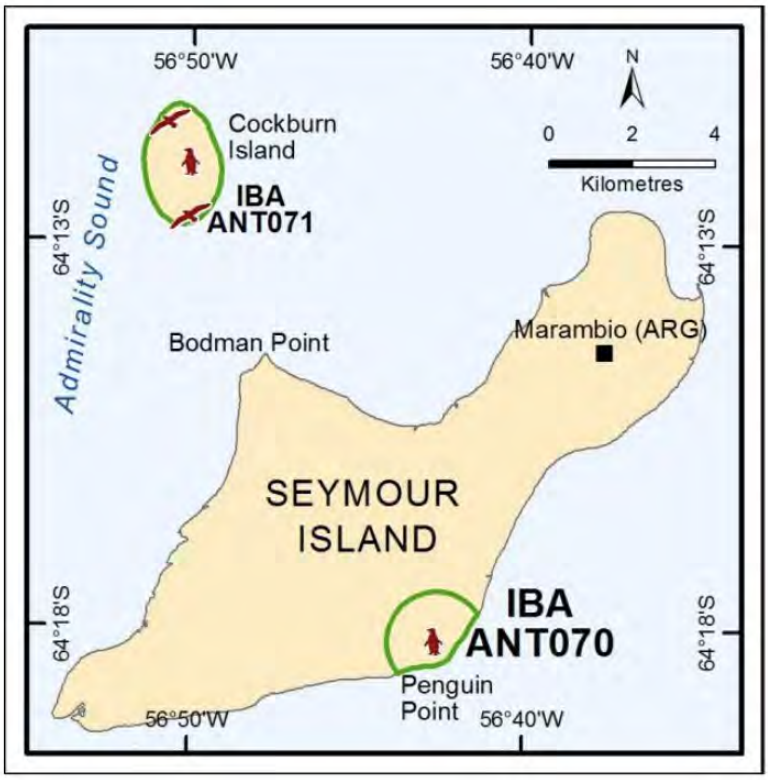

Figure 2: Seymour Island and Cockburn Island area (Map source: Wilderness Awareness Manual).

Devil Island (-63.80,-57.28, 2.0 km × 0.65 km; Figure 3) is a frequently visited penguin colony in this region and several surveys were completed from commercial cruise vessels between 1996 and 2011. The most recent population estimate from the 2010/11 season found 7,108 Adélie penguin chicks at Devil Island. In addition to Adélie penguins, this island had breeding populations of South Polar Skuas, Brown Skuas, Kelp Gulls, and Antarctic Terns (Naveen and Lynch 2011). This island also hosts occasional non-breeding Chinstrap Penguins, Southern Giant Petrels, Cape Petrels, Snow Petrels, and Wilsons Storm Petrels (Naveen and Lynch 2011). Other key site features noted in the Site Visitor Guidelines for Devil Island include *Usnea Antarctica*, *Xantheoria* spp. and *Caloplaca* spp. and large areas of mosses. Because of the late season timing of our expedition, we are likely to encounter fur seals at Devil Island as well.

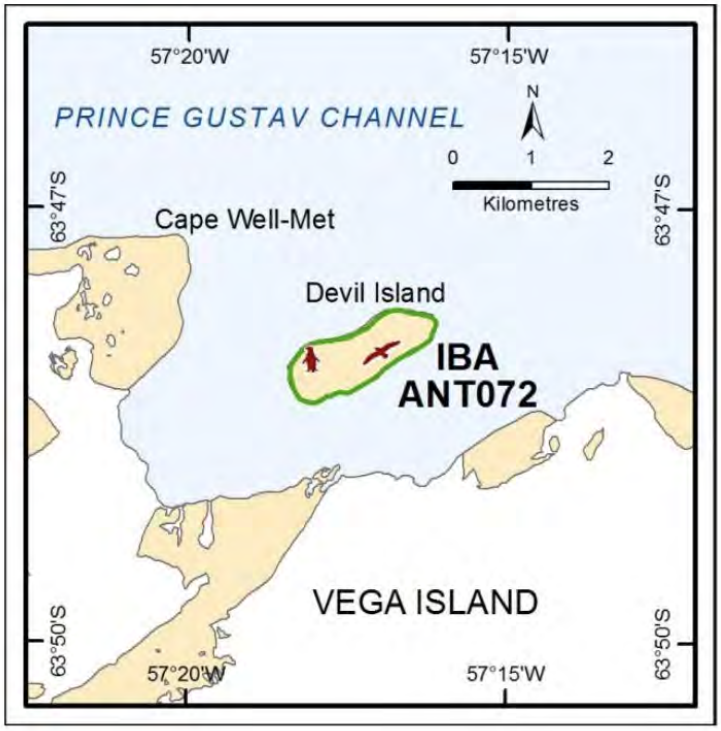

Figure 3: Devil Island area (Map source: Wilderness Awareness Manual)

To our knowledge, **Red Island** (-63.73, -57.87, 1.92 km × 2.15 km; Figure 4) has not been surveyed previously. It is described as a small flat-topped island. A satellite-based estimate of 1,002 Adélie penguin nests from Lynch and LaRue (2014) is the only reference to wildlife at this location.

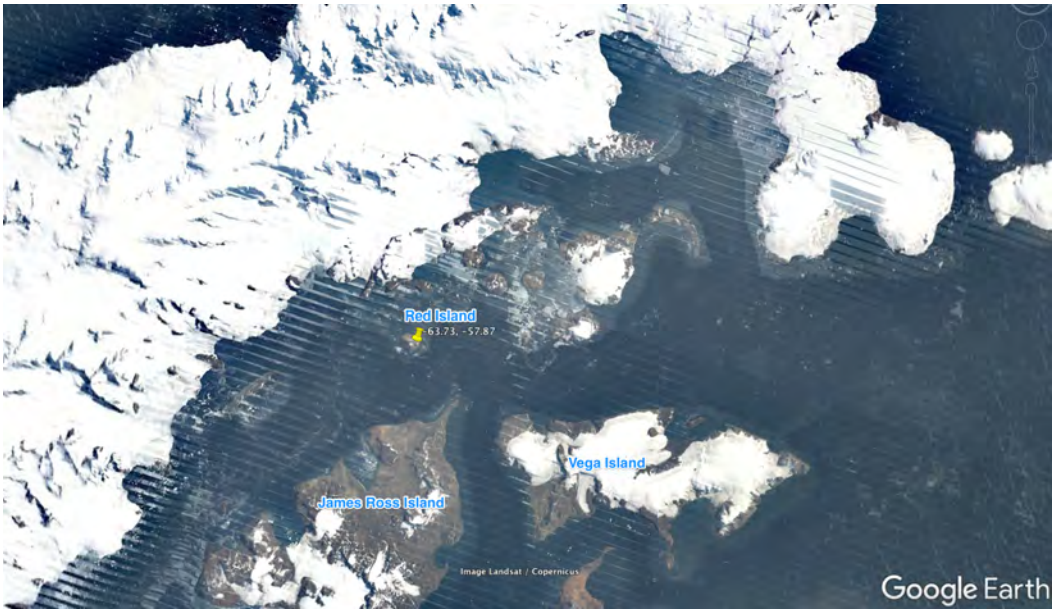

Figure 4: Red Island and its proximity to James Ross Island and Vega Island.

Vortex Island (-63.73, -57.63, 0.83 km × 0.70 km) was surveyed as part of the Antarctic Site Inventory in 2008/09 and 2009/10 (Naveen and Lynch 2011). These initial surveys reported 4,319 Adélie penguin nests and breeding Skuas (species not reported), as well as non-breeding Southern Giant Petrel, Wilsons Storm Petrels, and Kelp Gulls.

5.3 Danger Islands

The Danger Islands (-63.43, -54.68; Figures 5 and 6) are a group of seven islands, including: **Scud Rock, Earle, Platter, Dixey Rock, Heroina, Comb and Darwin**, approximately 24 km from Joinville Island (Figures 4, 5). Although they were discovered in 1842 by James Clark Ross, due to their location and the presence of seasonal pack ice, and large tabular icebergs following spring breakup, they are difficult to access and are seldom visited.

Physical characteristics
The islands are composed primarily of gabbroic rocks (Hamer and Hyden 1984), which form steep cliffs on many of the islands, rising to 100m. On Heroina, there is a spacious plateau accessed through eroded gullies. Because of their small stature and exposure the islands are largely ice-free in austral summer. No large permanent glaciers are present. The largest island (Darwin) is approximately 1 km in diameter, and the smallest (Dixey Rock) is a sea stack 35 m high.

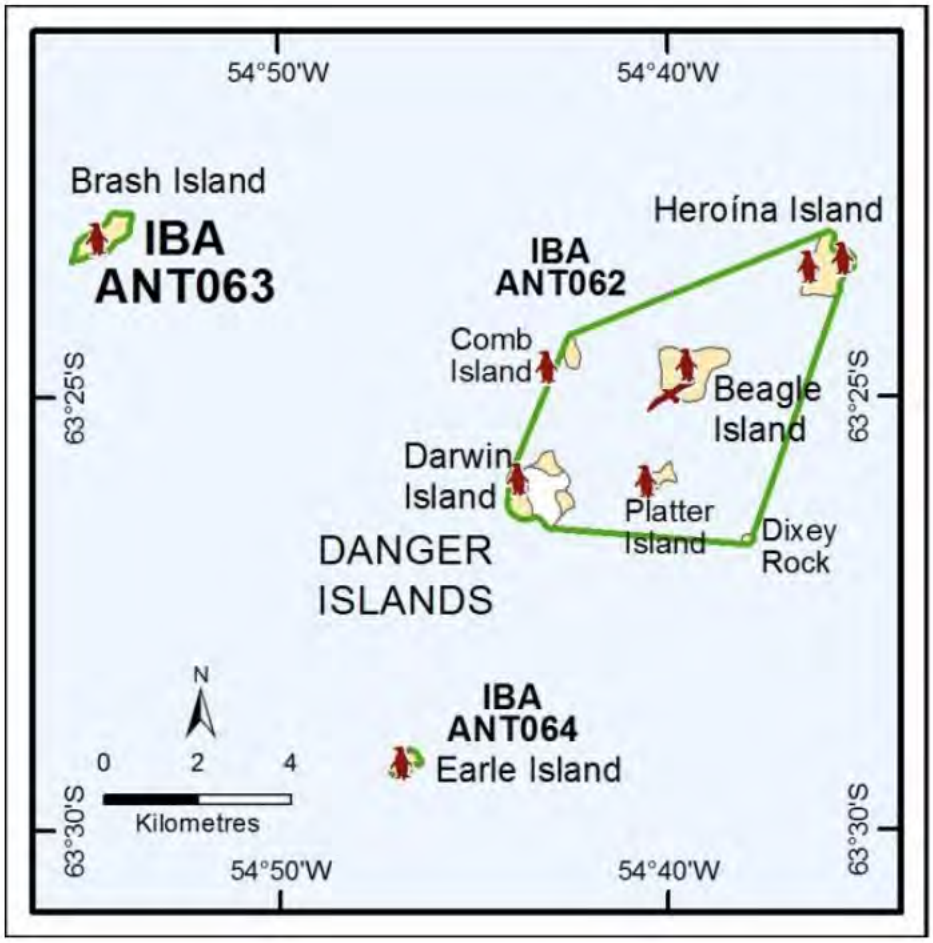

Figure 5: Danger Islands (Map source: Wilderness Awareness Manual)

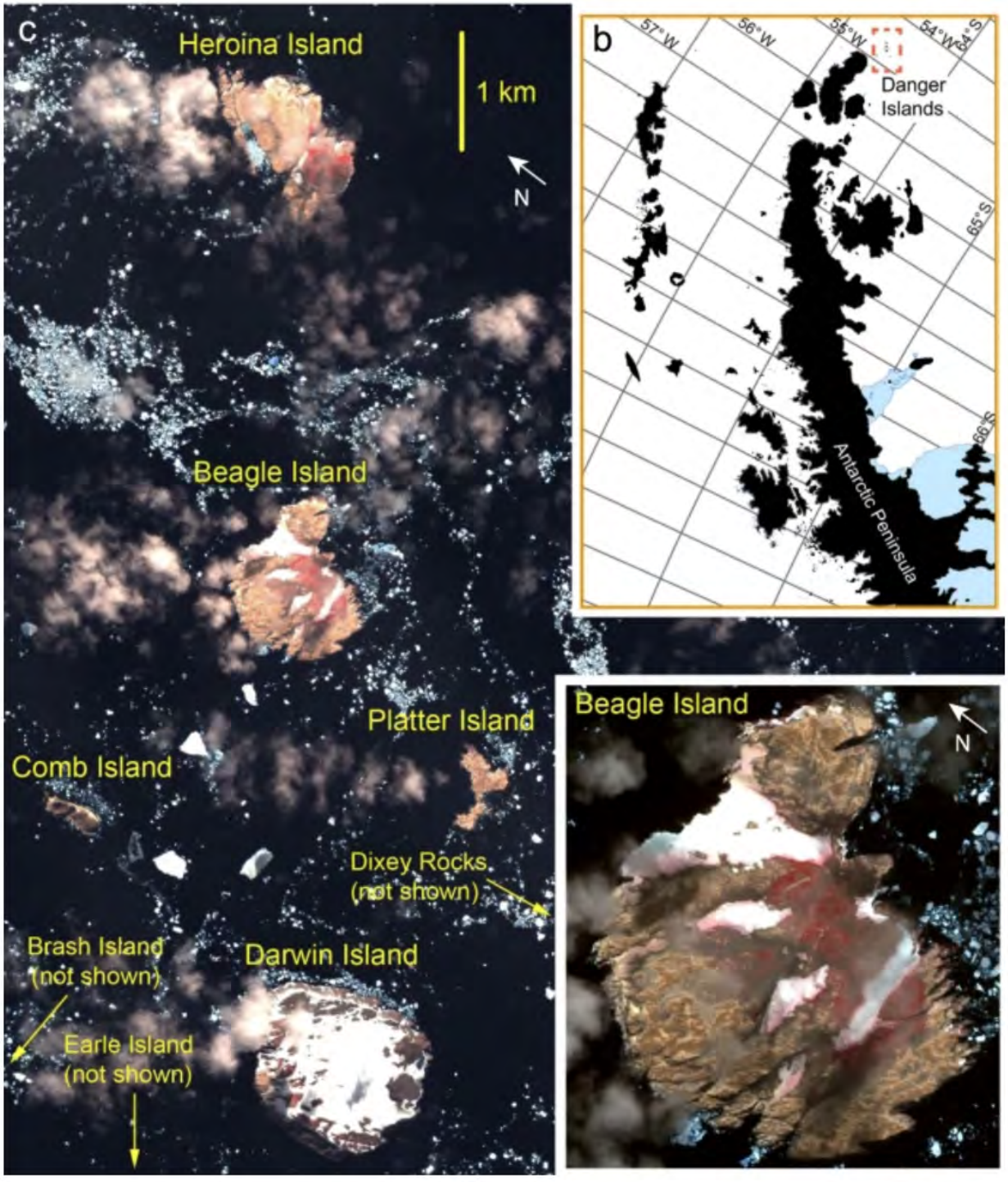

Figure 6: Danger Islands satellite imagery, reproduced from Borowicz et al. (2018).

	Beagle†	Brash†	Comb†	Darwin†	Dixey Rock†	Earle†	Heroína	Platter†	Scud Rock†
Pygoscelis adeliae	284535‡ (N2)	94951‡ (N2)	12000# (N4)	5804# (N1)	0 (N1)	21071‡ (N2)	292363‡ (N2)	40803 (N1)	0 (N1)
Pygoscelis papua	0 (N1)	2270 (N1)	186 (N1)	0 (N1)	0 (N1)	847 (N1)	999 (N1)	223 (N1)	0 (N1)
Pygoscelis antarctica	0 (N1)	0 (N1)	0 (N1)	0 (N1)	0 (N1)	0 (N1)	27 (N1)	0 (N1)	0 (N1)
Phalacrocorax atriceps					0 (N1)	156 (N1)			0 (N1)

†First direct census of this location; ‡Count from drone imagery; #Count from ground or ship-based photography.

Figure 7: Penguin census summary, reproduced from Borowicz et al. (2019).

A comprehensive survey of the Danger Islands was completed in the 2015/16 season, and the number of penguins on each island is shown in Figure 7. Other species found in the Danger Islands are shown in Figure 8.

Supplementary Table S1: List of species present in the Danger Islands. B=Verified as breeding, I=Individuals present, NB=Ver as not breeding, – =Not observed or No data.

Species	Beagle	Brash	Comb	Darwin	Dixey Rock	Earle	Heroina	Platter	Scud Rock
Birds									
Adélie penguin (*Pygoscelis adeliae*)	B	B	B	B	NB	B	B	B	NB
Gentoo penguin (*Pygoscelis papua*)	NB	B	B	–	NB	B	B	B	NB
Chinstrap penguin (*Pygoscelis antarctica*)	NB	NB	NB	–	NB	NB	B	NB	NB
Antarctic shag (*Phalacrocorax atriceps*)	NB	NB	–	–	NB	B	I	B	NB
Skua species (*Stercorarius spp.*)	–	I	I	B	–	B	B	I	–
Southern giant petrel (*Macronectes giganteus*)	NB	I/NB	NB	–	–	NB	I/NB	I/NB	–
Cape (pintado) petrel (*Daption capense*)	–	–	–	–	–	–	B	B	–
Snow petrel (*Pagodroma nivea*)	–	–	B	–	–	I	I	–	–
Wilson's storm petrel (*Oceanites oceanicus*)	–	B	–	–	–	–	I	I	–
Kelp gull (*Larus dominicanus*)	–	B	I	–	–	I	I	I	–
Snowy sheathbill (*Chionis albus*)	–	B	B	I	–	B	B	B	–
Antarctic tern (*Sterna vittata*)	–	–	I	–	–	–	I	–	–
Seals									
Weddell seal (*Leptonychotes weddelli*)	–	–	I	–	–	I	I	I	–

Figure 8: Summary of species found in the Danger Islands during the 2015/16 survey, reproduced from Borowicz et al. (2018).

The Danger Islands are notable for the numbers of penguins nesting there and several of the islands are considered Important Bird Areas (Harris et al. 2015; Handley et al. 2021).

5.3 South Shetlands and Antarctic Sound

In the event of severe weather or other contingencies that prevent or preclude access to one of the two primary sites, and opportunistically during transit or while awaiting conditions to improve elsewhere, we will utilize the time allocated to the charter to access other penguin rookeries in the South Shetlands and Antarctic Sound and Joinville Island areas that have received little or no visitation by researchers. These rookeries, which would include all colonies within the Antarctic Sound, Joinville Island, and South Shetland region are identified in the Wildlife Awareness Manual (WAM, Harris 2006) and incorporated by reference herein. We have reviewed WAM and the Compendium and have not identified site sensitivities at these general sites that would preclude visitation or carrying out any of the activities we have already identified. More detailed information regarding previous censuses of penguins at any of these alternative sites can be found in the MAPPPDD application (Mapping Application for Penguin Populations and Projected Dynamics), http://www.penguinmap.com/

6.0 Analysis of direct, indirect and cumulative potential impacts

6.1 General impacts:

- *Inadvertent translocation of invasive species*
  Because expedition staff and crew will be traveling from areas outside of Antarctica, the opportunity to bring invasive non-native species into Antarctica (spores, seeds, propagules) on equipment or clothing is a possibility. There is the potential to bring biological "stowaways" on the transporting vessel.

  Climate change likely enhances the probability that nonnative propagules could become established in Antarctica.

  We plan to reduce the likelihood of transmission through compliance with IAATO biosecurity protocols, e.g., use of decontamination stations (Virkon) prior and following every landing to clean footware and equipment. Prior to the first landing, crew will conduct an inspection of all equipment to be taken ashore (backpacks, walking sticks, tripods, velcros).

- *Operation of the expedition, including all procedures to handle waste, fuel, and garbage (see Appendix 2, Risk Management, Arctic Sunrise)*
  General quantities of oil are relatively small, (e.g., deck crane using 45 liters of biodegradable oil) or outboard engine tanks (2x 20 liters gasoline). Spillage on the deck can usually be contained by mopping: a spill kit with oil absorbent wadding is kept in readiness in the engine room casing. In case of a spill entering the sea, quick detergent action can suppress any surface pollution. Biodegradable oil detergent/dispersant is kept aboard.

  Any waste oil spill would occur within the machinery spaces and so be contained by the hull. Waste oil would be pumped into the internal holding tank and/or jerrycans. All waste oil is stored within the vessel (holding tank or jerrycans in aft peak) so there cannot be a further spill into the environment.

- *Procedures to prevent physical disturbance to the Antarctic environment*

Our expedition researchers are well trained and familiar with the Antarctic environment. We will have an operational organization structure where at least one non-PI (not including the skipper, who will be responsible for ship safety) is in a position to make the final determination whether proposed activities fall within the permit parameters, and the operation of the expedition is designed with checks and balances so that inadvertent risks or deploying the research team in conditions that may lead to environmental damage will be minimized.

6.2 Ground Censusing

There are a number of potential, direct and indirect impacts that expedition biologists may cause while conducting censusing activity ashore. Penguins and flying birds, and seals may be "taken" in various fashions, including (among a number of possible impacts) harming them physically, interfering with their breeding activities, or causing their behavior to be altered or changed. Flora may be trampled and consequently damaged or destroyed in the course of navigating around the site.

To obtain censuses of penguins, flying birds, and seals, researchers necessarily are in close proximity with their subjects. Close interactions are anticipated and it is recognized that there is always a potential for disruption of normal nesting behaviors. These are invariably transitory, as researchers move on to another vantage point within 3-5 minutes. Distraction of penguins by the presence of researchers may expose nests to predation by skuas or sheathbills, but this can be avoided with proper awareness and caution.

Conversely, it appears that there is little potential for proposed activity to degrade or pose substantial risk to areas of aesthetic or wilderness significance from census activities. Boot-washing, sterilization, and cleansing of equipment and clothing will be used to minimize potential impacts relating to the introduction of foreign species or diseases onshore, to soils and other geological components, to historic monuments, or to any other scientific activities at the sites we propose to visit. We have no knowledge of highly uncertain environmental risks, or of particularly unique or unknown risks, relating directly to the proposed activity. There also does not appear to be any potential transportation-related impacts from the proposed activity (see e.g., IAATO protocols regarding vessel safety considerations and emergency response action).

Similarly, it is not anticipated that the proposed activity will have potentially adverse, direct effects on climate, weather patterns, air quality, water quality, the atmospheric environment, the terrestrial or aquatic environment, or the glacial and marine environment.

As noted, census surveys will involve multiple day visits to individual islands, but at different colonies. For each individual colony, once the colony is counted, researchers will move on to another location and penguins will be unlikely, except at a distance, to observe researchers moving near their nests. We do not anticipate resurveying these sites for the next five years except in the event that a commercial cruise ship on which we are operating makes a landing at any of the surveyed colonies. With the exception of Brown Bluff and Paulet Island, which represent two locations we may reach on this expedition that are frequently visited by commercial cruise vessels, we anticipate little or no additional research activity at these sites in the near future and therefore do not envision any cumulative impacts from this activity.

6.3 UAV censusing

There are a number of potential, direct and indirect impacts: 1) potential disturbance to penguins that might regard a low-flying object as an avian predator, causing disruption of feeding, preening and breeding; 2) Penguins and flying birds, and seals may be "taken" in various fashions, including (among a number of possible impacts) harming them physically through equipment malfunction and crash landing, displacing penguins from nests exposing incubating eggs to predation or exposure, collisions with flying birds, entanglements with wildlife in the air or on the ground with the UAV or equipment; 3) The possibility of leaving non-biodegradable waste from collisions with the ground that result in shattering of UAV components; 4) The possibility of contamination to the Antarctic environment from battery components on impact; 5) The potential for loss of the UAV at sea, resulting in contamination of the Antarctic marine environment; 6) The potential loss of the UAV in inaccessible locations (e.g. crevasses).

There is little potential for proposed UAV activity to degrade or pose substantial risk to areas of aesthetic or wilderness significance from census activities due to the presence of other mechanized activity in the areas we will be censusing. There is the potential to transmit organisms from equipment and platforms used to manage the UAV. There is no impact likely to soils and other geological components, to historic monuments, or to any other scientific activities at the sites we propose to visit. With respect to highly uncertain environmental risks, or of particularly unique or unknown risks, relating directly to the proposed activity, we are aware that this is a fairly new technology which has been tested in the Antarctic environment but has not been deployed over a long period to thoroughly test uncertainties. The highest uncertainties are 1) mechanical failure (for various reasons); 2) weather-dependent operational windows; and 3) operator training and certification/skill. Therefore, the highest concern is for operational failure resulting in take or contamination of the Antarctic environment. Given the size of the UAV package and the generally inert composition of the materials from which it is made, the footprint of any take or contamination would be expected to be quite small.

Outside of these concerns, it is not anticipated that the proposed activity will have potentially adverse, direct effects on climate, weather patterns, air quality, water quality, the atmospheric environment, the terrestrial or aquatic environment, or the glacial and marine environment.

Hazards and hazardous waste: The quadcopters are powered by a single Lithium-ion polymer battery (DJI LiPo 3500mAh) running 11.55 V, giving a flight time of ~34 minutes with only a camera for cargo.

Unlike NiMH and NiCd batteries, LiPos are not hazardous to the environment. When discharged, they can be disposed of with regular waste. However, if the battery is punctured, the lithium can react with the humidity in the atmosphere and can heat up the battery. This heat excites the unstable bonds, which break, releasing energy in the form of heat. Then thermal runaway starts, and a very hot intense brief fire can result. The types of impact that could result in compromising the housing of the battery pack are not anticipated with the use we are contemplating. This is an extremely remote possibility, as the batteries are well-sealed.

As noted earlier, we see many advantages to use of UAVs in census work. Primarily: 1) time ashore at any site will be minimized if drones are able to collect data faster than ground-based

census takers; 2) it will not be necessary to put observers in close proximity to nesting penguins (excepting ground-truthing and verification), thus it will limit disturbance to penguins at sensitive times in their life history; and 3) it will minimize site travel and the potential to spread invasive species and trampling of vegetation. These benefits will have to be weighed against costs and operational utility (e.g., it may be that weather operational windows make use of UAVs impractical in the majority of cases). Thus, the cumulative effects of UAV use could be viewed as positive over the long term if they are capable of reducing observer presence to carry out census work in the future. This will have to be further weighed against the probability that UAV's will malfunction from time to time causing the potential harms described above. Until UAVs develop a track record through use, the balance of impacts is unquantifiable.

6.4 Cumulative impacts of concurrent activities of other national program research

We are unaware of any ongoing research activities that we would overlap at any of the sites we have described or may visit opportunistically. However, it is always possible that other national programs may also be opportunistically conducting research at sites we might visit. The cumulative impacts of research activities are as follows:

Penguins and other wildlife
Penguins could be repeatedly disturbed during a single nesting season or from repeated approaches to census them or conduct other research activities (such as live capture) in the vicinity of their nests by uncoordinated research activities, or, may be disturbed over the course of multiple censuses/research activities over the course of several years from duplicated research efforts. Both types of cumulative disturbance do not appear to affect penguin reproductive success, however (e.g., Fraser and Patterson 1997), to the extent that the exposure is limited to that type of activity. If a site is receiving highly invasive research activity already, it is possible that the incremental activity proposed by this expedition could cross a disturbance threshold that would affect reproductive output or predation, but the level of baseline disturbance would have to be substantially greater than the multiple interactions at currently intensively studied sites where no researcher effects have been documented.

The Antarctic Environment
The cumulative impacts from additional research visitation could involve additional disturbance of soils and plants, depending on baseline research activity already underway. We are unaware of any research underway that would be sampling guano or ticks in the manner we have proposed. We believe the protocols we have developed minimize site disturbance and absent any additional information regarding baseline research disturbance at other sites believe that our incremental disturbance will not cumulatively impact the Antarctic environment.

Conversely, it appears that there is little potential for proposed activity to cumulatively degrade or pose substantial risk to areas of aesthetic or wilderness significance, potential impacts relating to the introduction of foreign species or diseases onshore. Soils and other geological components may be disturbed, which could cause redistribution of soil microfauna and interfere with soil-forming processes in these ornithogenic soils, however we don't anticipate that additional sampling will be conducted at these sites.

7.0 Alternatives

7.1 Sampling locations

We have already described why this survey will target the Weddell Sea region: we are interested in providing a comprehensive map of penguin distribution and abundance in this region and believe that trends in this region may help us understand drivers of documented Adelie declines along the Western Antarctic Peninsula. This area is also of high interest to a number of regulatory bodies, including CCAMLR, due to proposals to designate certain portions of the Weddell Sea as Marine Protected Areas. Data will assist CCAMLR and others in assessing the current status of wildlife resources in the region.

7.2 Different timing

We selected this timeframe because this is when the vessel was available for use and because all active breeding pairs should be present at the site incubating eggs or chicks.

7.3 Alternatives to ground censusing

While satellite imagery has been used successfully to survey penguin colonies, satellite image interpretation is most precise when there is a map of site features derived from ground surveys. Because species identification from satellite imagery in the absence of a ground survey is speculative, these ground surveys will allow us to more confidently monitor these sites using satellite imagery in the future. Therefore, we believe the proposed expedition will make it more likely that monitoring can be done using satellite-based methods in the future, thus minimizing the long-term impacts of monitoring on these colonies.

7.4 Alternatives to aerial UAV censusing

We could acquire population data through ground censuses only, but UAVs often allow for faster surveys and less time on the ground. Therefore, combining ground surveys with the option for deploying UAVs allows maximizes the data collected while minimizing penguin disturbance. UAV-based imagery also provides auxiliary information on the spatial ecology of penguin nesting (see, for example, McDowall and Lynch 2017, 2019) that cannot be obtained through ground counts alone. This approach has been used successfully in previous large-scale penguin census efforts we have conducted (See, e.g., Borowicz et al. 2018; Strycker et al. 2021) but also is the preferred approach when ground censusing of penguins involves disturbance concerns or is impossible due to terrain (Krause et al. 2021; Dunn et al. 2021)

7.5 No action

With no activity, there certainly would be no potential environmental impacts from researchers working at the various sites. However, given that the purpose of the expedition is to add to the long-term monitoring, knowledge of populations in the AP, and further our understanding of penguin distribution and behavior throughout the AP, that information would be lost and there will be a gap in our understanding of ecosystem processes driving penguin population dynamics. To the extent that this data helps explain climate-mediated changes occurring in the AP and provides information relevant to the establishment of MPAs in the region.

8.0 Mitigation measures

8.1 General impacts:

- *Inadvertent translocation of invasive species*
  We plan to reduce the likelihood of transmission from personnel through compliance with IAATO biosecurity protocols, e.g., use of decontamination stations (Virkon) prior and following every landing to clean footware and equipment. Prior to the first landing, crew will conduct an inspection of all equipment to be taken ashore (backpacks, walking sticks, tripods, Velcro material). We will purchase a separate set of landing gear for the UAS that will be used only in Antarctica, to avoid any cross contamination from practice flights in the US. Between sites, the UAS will be completely disinfected with Virkon and wiped down to prevent seeds or other biological materials being transferred between sites.

- *Operation of the expedition, including all procedures to handle waste, fuel, and garbage (see Appendix 2, Risk Management, Esperanza)*
  Care will be taken in handling fuels. No fuel is anticipated to be carried ashore, with the exception of small quantities of propane in sealed canisters intended for emergency use only. Zodiac operations from ship to shore will be carried out under operational conditions expected to eliminate any chance of capsizing or spilling fuel. All equipment, with the exception of permitted monitoring equipment intended to remain ashore, will be accounted for prior to departure from any site. Any spill entering the sea will be addressed immediately and biodegradable oil detergent/dispersant applied in sufficient quantities to control any contamination before it reaches the intertidal area or the shore. All expedition personnel will be trained in contamination control and briefed on responsibilities to manage waste while ashore.

- *Procedures to prevent physical disturbance to the Antarctic environment*
  We will rely upon these means for minimizing and hopefully avoiding potential, adverse environmental effects from the proposed activity:
  • Education and training of research personnel
  • Awareness of site-specific sensitivities
  • Actual on-site conduct by researchers

  Education and training of research personnel. To assist our efforts to mitigate potential environmental impacts from the proposed activity, it is important for expedition personnel to be properly educated and trained, not only about the project's methodology, but in further respects, about legal, administrative, logistical, and operational considerations tied to the conduct of the proposed activity. As described above, researchers are educated and trained with respect to the project's data collection priorities and procedures, and are fully cognizant of mandates and prohibitions of the Antarctic Treaty, the Antarctic Environmental Protocol, and pertinent recommendations, resolutions, and guidelines adopted by the Parties with respect to the activities of visitors and of tour operators and organizers. Researchers will comply with these requirements and conduct their onshore activities accordingly. In addition, because this expedition is utilizing an IAATO vessel, staff will be trained in IAATO guidelines and will comply with various safety rules, operational requirements, and transportation-related procedures established by the Arctic Sunrise.

Awareness of site-specific sensitivities. To further assist expedition personnel to mitigate potential environmental impacts from the proposed activity, it is also important that researchers, before reaching a particular research site, have access to information describing potential on-site sensitivities that may be encountered during the course of the proposed activity. With *a priori* knowledge of these sensitivities in hand, it is expected that researchers will be able to minimize and totally avoid any potential, adverse environmental impacts. As noted, this is a highly knowledgeable expedition team, with a number of years of experience in detecting and being aware of site sensitivities.

Actual on-site conduct by researchers. Another component of our effort to mitigate potential environmental impacts from the proposed activity is to ensure that expedition researchers comport themselves properly while conducting their work. As noted below, researchers clearly have no intention to inflict any form of taking on their research subjects, but their work cannot proceed without close interaction with census and sampling subjects. Except for when animals are handled under permitted conditions, if it appears that research is creating an unacceptable level of disturbance, researchers will back off until the animals have calmed and acclimated to the researcher's presence.

To minimize and avoid potential impacts to the flora, researchers pay very close attention to where they are standing, walking, and hiking, and avoid these flora at all times. Sites selected for noninvasive guano sampling are in all likelihood too "hot" to support vegetation, but in the event that soils are supporting vegetation, care will be taken not to disturb vegetation as a result of the sampling and digging process.

8.2 Ground Censusing

To minimize and avoid potential impacts to penguins, expedition researchers will pay very close attention to the animals — both individually and collectively —and maintain a distance that does not cause the animals to detrimentally alter their behavior. If it appears that research is creating an unacceptable level of disturbance, researchers will back off until the animals have calmed and acclimated to the researcher's presence.

Census takers will attempt in the first instance to find vantage points that minimize disturbance to nesting penguins. In the event that a penguin abandons its nest as a result of disturbance, researchers will remain in close proximity and observe the nest until the penguin returns to incubate the eggs or guard chicks, to discourage predatory birds (skuas, sheathbills, and southern giant petrels). Researchers will travel to avoid any hauled-out seals. Researchers will conduct their counts as quickly as allows, and will move away from the colony when finished with the count.

8.3 UAV censusing

There are a number mitigations proposed for this activity:

- *Biosecurity:* As described above, to ensure bio- security fresh landing struts will be used after entering Antarctica, and the vehicle will be thoroughly cleaned in between sites.

  Wildlife Disturbance: Measurements shown in Goebel et. al. (2015) and Krause et al. (2021) suggest that distances of over 30 m from wildlife eliminates concerns for disturbance of wildlife, and as such all take-off and landing sites, as well as flying heights, will be at least 30 m away from wildlife. In addition, during all flights a dedicated spotter will keep watch for birds that may become disturbed by the flight of the UAV. Additional spotters will be deployed as necessary when site conditions warrant. All UAS operators will have their own Remote Pilot Certificates and that while we are outside US airspace we will follow the spirit and the letter of FAA regulations for all operations.

- *Wildlife Take:* The UAV will be programmed for soft landing in the event of a malfunction (see discussion below). This should minimize the possibility of injury to penguins and nests if the UAV lands inside a penguin colony.

- *Weather conditions:* As a baseline the 10 m/s maximum wind speed estimate of Goebel et. al. (2015) will be used. However final say on beginning and aborting operations will rest on the primary pilot on the ground after consultation with the expedition coordinator and the skipper of the MY Arctic Sunrise. Flights will not occur when visibility is restricted regardless of the wind speed.

- *Collisions with the ground:* At any site where there is a "hard landing" there will be a thorough inspection following the hard landing to check for micro debris. The UAV team will spend enough time at any such site to assure that any debris is identified and collected and removed from the site. Loss of batteries that involves leakage or rupture will remove the battery and the top 1 cm of soil and any small rocks that are contaminated and removed from the site to be disposed of with other ship hazardous waste. If fire results from a battery puncture, all scorched and burned material within 1 m radius of the battery will be removed, if possible.

- *Loss of the UAV at sea:* The UAV is not intended to be flown over open water, except when a penguin colony is adjacent to the water. In that instance the UAV may transit open water but only to the extent necessary to complete its photographic transect. However, whenever the UAV is deployed where open water transit is a possibility, the MY Esperanza or one of the zodiac tenders will be on standby ready to move to the last observed location identified by one or more of the spotters. If the UAV is retrievable at the surface or in shallow water, every effort will be made to retrieve all or accessible parts of the UAV.

- *Lost communication with UAV:* The Autonomous Avionics UAS aircraft has several failsafe modes for both loss of communication with the ground control station (GCS) and loss of GPS or navigation. For loss of communication with the GCS, the failsafe mode will immediately place the autopilot on a return course to the designated safe landing zone. If communication is not regained in a specified amount of time, the autopilot will perform a vertical landing at the designated safe landing zone. When designating safe landing zones, the UAS pilot will make sure there are not obstructions or other hazards that could

interfere with flight operations or emergency landing. If the onboard GPS signal is lost during autonomous flight, the UAS system will immediately and automatically be set into a loiter orbit at the current location. The pilot can then place the aircraft into manual mode to return it to the designated safe landing zone, or a backup safe landing zone. In the unlikely event that both communication with the GCS and GPS are lost at the same time then the autopilot will assume a loiter orbit for a short designated period of time. If neither GCS communication nor GPS are regained in this time then the autopilot will land the aircraft at the current location.

Lost Communication Procedure – Observation of the aircraft will be maintained, and every attempt will be made to regain communication with the aircraft. If communication cannot be regained, the landing zone will be cleared and observation will be maintained until the aircraft is safely on the ground. Reasons for the communication failure will be assessed and recorded in the flight log. If necessary the manufacturer will be contacted for corrective instructions. The aircraft will not be flown again until the reasons for communication failure have been reasonably assessed and the causes mitigated for future flights.
Lost GPS Procedure – The pilot will take manual control of the aircraft as soon as possible. The aircraft will be immediately returned under manual control to the landing zone where it will be landed and recovered for assessment. If GPS is regained at anytime it will be the decision of the pilot in command whether it is safe to continue the planned mission or the aircraft should be returned for assessment. Reasons for the GPS failure will be assessed and recorded in the flight log. If necessary the manufacturer will be contacted for corrective instructions. The aircraft will not be flown again until the problem is reasonably assessed and the reliability of GPS can be reasonably assured.
Loss of both Communications and GPS – An attempt to regain communication will be made. If any people are in the vicinity of the aircraft they will be notified to take cover as quickly as possible. Observation of the aircraft will be maintained until it has landed and can be recovered. This situation would require the simultaneous loss of both GPS and Communication. It is believed that this situation is **highly unlikely**, because of the redundancy of the automatic and manual control. In order to prevent this situation, any loss of either GPS or communication will be taken very seriously. If a repeat loss of either the communication or GPS occurs individually, the aircraft will be grounded until the situation can be corrected and the reliability improved.

- *Pilot Training:* Our pilots will have training that is equivalent to ground school training provided to obtain a private pilot's license. This exceeds the mandate set forth by the FAA. This will include:

1) An overview of the airplane systems and flight principles or airplane aerodynamics as covered in the FAA Principles of Flight question bank;
2) Information a private pilot needs to know to operate an aircraft safely. This includes knowledge about aircraft performance in a number of situations and about human performance;
3) Aviation weather, including the general principles of weather formation as well as the effects that certain weather features have on flight;
4) Airplane navigation methods, such as pilotage, dead reckoning and various airplane

navigation systems that pilots needs to know.

In addition, the pilots will have extensive training on simulators and significant flight time with the quadcopters before deploying. Our pilots will have gone over material associated with weather, the airframe (in this case the specifics of the DJI motors, propellers, motor controllers, circuitry and ground station programming), safe flying procedures (including the use of mandatory checklists), and the maintenance of the airframe and flying logs. Michael Wethington will be the only person who will fly the DJI Mavic Air 2 during the expedition (in consultation with the expedition coordinator and Arctic Sunrise master) although other members of the expedition may be called on to help for ancillary tasks such as preparing the UAV and spotting.

The DJI flight control software makes it very easy to switch between autonomous hands off flying and manual flight. While we can fly all our missions manually or autonomously, for collecting data it is easier to run controlled grid track lines in autonomous mode. At all times however the Pilot has the option of immediately switching between the modes and taking over manual control. We usually like to start the mission manually, check airframe functionality in the air, switch to autonomous mode for data collection, and then switch back to manual mode for landing. The DJI software has built in functions (required by the FAA) that automatically take over if the radio link is lost (whether in autonomous mode or during manual flying). This function then guides the plane back to its original take off location and lands automatically. This function also takes over if it senses that the battery life is below a threshold. While we have tested this functionality on test flights locally we will be flying conservatively and do not expect to use the automatic takeoff and landing functionality. We note that all flights will always be conducted within a small radius of the pilot such that the airplane will always be visible by the unaided naked eye of the pilot and/or a scientific observer.

8.4 Cumulative impacts of multiple research projects

In the case of encountering unexpected or unknown activities conducted by other national programs, we will use our best professional judgment to determine whether to proceed with any activity at that site, depending on the apparent level of existing disturbance, presence of equipment, presence of researchers, and other indicia.

9.0 Conclusion

Based on the activities proposed, analysis of alternative activities that were considered but rejected, potential direct, indirect and cumulative impacts that may be caused by the expedition, and measures we will take to mitigate the impacts of the proposed activities, we believe that the proposed activities will have no more than a minor or transitory impact on the Antarctic environment.

The expedition members are aware of specially protected areas, their management plans, provisions of the ACA relevant to research activities, and IAATO guidelines. The expedition team has extensive experience in working in the Antarctic environment and around Antarctic wildlife. We have vetted the animal handling protocols internally with two institutional animal

welfare committees, and have insured that specialized technical training has been procured for UAV flight operations and have provided evidence for absence of impacts from all of the activities that we are proposing.

The expedition has protocols in place to manage on site awareness of its activities ashore and that the impact of all activities will be minimized and avoided, including operational parameters for activities that may have impacts, such as awareness of animal behavior during censusing, minimalist handling protocols, and strict conditions imposed on operation of the UAV.

10.0 External consultation and proponent response

The following external sources were consulted as part of the development of this IEE and the expedition plan:
1) IEE for the 2019/20 Chinstrap Survey Expedition to Elephant Island
2) Stony Brook Institution Animal Care and Use Committee – approved (Appendix 6);
3) Oxford Animal Handling Ethical Review – approved.

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Appendix 1

FORM APPROVED
OMB NO. 3145-0034

NATIONAL SCIENCE FOUNDATION ARLINGTON, VIRGINIA 22230	ANTARCTIC CONSERVATION ACT APPLICATION AND PERMIT FORM	PROPOSAL NO.

1. TYPE OF PERMIT REQUESTED

☐ TAKE
X HARMFUL INTERFERENCE
☐ ENTER ANTARCTIC SPECIALLY PROTECTED AREA
☐ INTRODUCE NON-INDIGENOUS SPECIES INTO ANTARCTICA
☐ IMPORT INTO USA—PORT OF ENTRY _____
☐ EXPORT FROM USA

2. NAME, ADDRESS, PHONE/FAX NO. AND E-MAIL ADDRESS OF APPLICANT (IF A CORPORATION, FIRM, PARTNERSHIP, INSTITUTION, OR AGENCY, EITHER PUBLIC OR PRIVATE, COMPLETE BLOCK 3).

Heather J. Lynch
Stony Brook University
IACS 163, Stony Brook, NY 11794
tel: 631-632-2384; fax: 631-632-7626
heather.lynch@stonybrook.edu

3. NAME AND ADDRESS OF PRESIDENT OR PRINCIPAL OFFICER

Stony Brook University

4. IF APPLICANT IS AN INDIVIDUAL, INCLUDE BUSINESS OR INSTITUTIONAL AFFILIATION

5. NAME OF APPLICANT'S AGENTS (FIELD PARTY MEMBERS), IF ANY (USE "TBA" IF NAMES UNKNOWN)

Michael Wethington, Steve Forrest

6. DESIRED EFFECTIVE DATES

Jan 1, 2022-April 1, 2022

7. LOCATION(S)—INCLUDE MANNER OF TAKING OR HARMFUL INTERFERENCE AND PROPOSED ACCESS TO THE LOCATION

Antarctic Peninsula locations being censused/surveyed by the expedition include several penguin colonies in the Weddell Sea region, including Brown Bluff, Devil Island, Vortex Island, Red Island, Cockburn Island, Penguin Point (Seymour Island), Heroina Island, and Paulet Island. Other locations in the Antarctic Peninsula region may also be surveyed depending on weather and logistics.

8. SPECIMEN INFORMATION

SPECIES	NUMBER	AGE	SEX	SIZE	CONDITION	IMPORT TO USA	ULTIMATE DISPOSITION
None contemplated.							

CERTIFICATION

I certify that the information submitted in this application for a permit is complete and accurate to the best of my knowledge and belief. Any false statement will subject me to the criminal penalties of 18 U.S.C. 1001.

SIGNATURE Heather J Lynch

DATE 10/12/21

FOR NSF USE ONLY

This application for a permit under the Antarctic Conservation Act, P.L. 95-541, as amended, and NSF regulations contained in Title 45 Part 670 of the Code of Federal Regulations is approved subject to the following conditions:

THIS PERMIT EXPIRES ON: _____
(Date)

TYPED NAME AND TITLE AND SIGNATURE OF NSF AUTHORIZING OFFICIAL

DATE

NSF Form 1078

CONTINUE ON REVERSE SIDE

9. DESCRIPTION OF ACTIVITY FOR WHICH PERMIT IS NEEDED AND JUSTIFICATION FOR PROJECT. ALSO INCLUDE HERE ADDITIONAL INFORMATION RELATING TO THE SPECIFIC ACTION FOR WHICH THE PERMIT IS BEING SOUGHT.

The last decade has seen a tremendous focus on the population dynamics of the three *Pygoscelis* spp. penguins on the Antarctic Peninsula, and interest in the region continues to grow with the proposal of two new Marine Protected Areas in the region. A recent expedition to the Weddell Sea region identified a major penguin hotspot (Borowicz et al. 2018) in the Danger Islands. The Weddell Sea contains a number of additional known or putative penguin colonies not surveyed on that previous expedition that remain of significant scientific and management interest.

This permit is intended to cover a scientific survey of penguin colonies along the Antarctic Peninsula with a specific focus on the Weddell Sea region. In our initial assessment of the population dynamics of the Danger Islands, we found evidence that Adelie abundance was broadly stable when compared to historic imagery taken 50 years ago (Borowicz et al. 2018) but a more recent analysis of penguin colony shape suggested that the Danger Islands' population had likely declined in the last 10-15 years (McDowall and Lynch 2019). This initially paradoxical finding was explained by a recent unpublished re-analysis of Landsat satellite imagery confirming that the Danger Islands population had likely peaked in the mid-1990s and has declined modestly since. We intend to re-survey locations in the Danger Islands to confirm whether the abundance of Adelie penguins is in fact declining, as this would be highly informative as to the mechanisms driving Adelie declines both locally (i.e. the Danger Islands) and more regionally (along the Western Antarctic Peninsula). This expedition also aims to reach several adjacent colonies that are very poorly surveyed. Red Island has never (as far as we are aware) been surveyed directly but Lynch and LaRue
(2014) identified approximately 1000 penguin nests (likely Adelie, but unconfirmed) at this location. Red Island would be one of the southernmost colonies on the Weddell Sea side of the Antarctic Peninsula. Likewise, Cockburn Island has not been surveyed directly but Lynch and LaRue (2014) identified approximately 15,000 penguin nests (likely Adelie, but unconfirmed) at this location. Vortex Island and Penguin Point similarly host poorly known Adelie populations that appear from satellite imagery to be declining; a direct census of these islands will confirm the scope and rate of any continued declines. Time and weather permitting, this expedition will aim to re-survey several other populations that are frequently visited but rarely surveyed due to their considerable size, including Brown Bluff and Paulet Island. In all, this expedition will allow us to understand whether the Weddell Sea region is stable or declining and by how much. Heterogeneous patterns across this region would be highly informative of the responsible drivers. Finally, this expedition will provide a comprehensive basemap of penguin distribution and abundance that will inform the planning for and development of a Marine Protected Area in the Weddell Sea region.

Our surveys will be completed using direct manual counts and the use of unmanned aerial vehicles. We anticipate no significant disturbance caused by either direct manual counting or by UAV survey. This permit is requested in case our survey efforts involve slight disturbances to resident fauna, potentially involving these species:

Adelie penguin (Pygoscelis adeliae)
Chinstrap penguin (P. antarctica)
Gentoo penguin (P. papua)
Southern giant petrel (Macronectes giganteus)
Southern fulmar (Fulmarus glacialoides)
Cape petrel (Daption capense)
Antarctic blue-eyed shag (Phalacrocorax atriceps)
Antarctic brown skua (Catharacta antarctica)
South polar skua (C. maccormicki)
Kelp gull (Larus dominicanus)
Antarctic tern (Sterna vittata)

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested in this application is solicited under the authority of the Antarctic Conservation Act (ACA), as amended, the National Science Foundation Act of 1950, as amended, and NSF regulations at 45 CFR Part 670. The information will be used in administration of the ACA, particularly to make a determination on eligibility for an ACA permit. The information requested may be disclosed to other Federal agencies or a court, administrative, or adjudicative body involved in implementing or enforcing the ACA; to Federal, state, or local agencies, or foreign governments, where necessary to obtain records in connection with an investigation, or to persons, including witnesses, who may have information, documents, or knowledge relevant to an ACA investigation or enforcement proceeding; to other Federal agencies when relevant to a decision by that agency on a security clearance, on the award of a contract or grant, on the issuance of a license or other benefit, or on a disciplinary or other administrative action concerning its employee; to government contractors, experts, volunteers and researchers as necessary to complete assigned work; to a grantee institution or contractor in connection with an investigation or enforcement proceeding where an ACA violation is alleged against it or one of its employees, researchers, or subcontractors; and to another Federal agency, court or party in a court or Federal administrative proceeding if the government is a party. See Systems of Records, NSF-56, "Antarctic Conservation Act Files," 59 Federal Register 5784 (February 8, 1994). Submission of this information is voluntary. However, failure to provide full and complete information necessary for an eligibility determination may reduce the possibility of receiving a permit.

Public reporting burden for this collection of information is estimated to average one half hour per response, including the time for reviewing instructions. Send comments regarding this burden estimate and any other aspect of this collection of information, including suggestions to reduce this burden, to the NSF Reports Clearance Officer at c/o the address directly below.

MAIL THIS APPLICATION TO:	OFFICE OF POLAR PROGRAMS (PERMIT OFFICE) NATIONAL SCIENCE FOUNDATION, ROOM 755 ARLINGTON, VIRGINIA 22230

Appendix 2

Greenpeace Antarctica Expedition 2022

MY Arctic Sunrise Expedition Plan & Preliminary Initial Environmental Evaluation (IEE)

GREENPEACE

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Summary

This austral summer Greenpeace intends to conduct an expedition to the Antarctica Peninsula and the Weddell Sea, beginning in January 2022 and terminating in March 2022. The expedition will gather evidence of the impacts of climate change in the area, as well as documentation of its wildlife and will call for their protection. To this end, the expedition will have two key areas of focus:

1. **Submersible dives for Vulnerable Marine Ecosystem (VME) identification**

This work will form the focus in January 2022 and will build on the science work conducted during our expedition in 2018, aiming to reach sites we were unable to visit owing to ice and weather conditions in 2018. Findings from the submersible dives will support Marine Protected Area (MPA) proposals for the areas by identifying further Vulnerable Marine Ecosystems (VME) and other flora and fauna of particular importance in need of protection.

2. **Surveying penguin colonies**

This will form the focus of our work from early February to early March 2022 and will build on the work conducted during our expedition in 2020. Findings from the penguin surveys will add to our understanding of the extent to which recent changes are related to climate change, fishing, or tourism.

Further to these two areas of focus, as a secondary activity, we will conduct Passive Acoustic Monitoring (PAM) recordings whenever possible when transiting between sites, collecting valuable data on cetaceans. Again this activity builds on our work from 2020. This work will be conducted on an opportunistic basis, as time and conditions allow, and involves deploying a towed hydrophone array from the back of the ship during transit.

Greenpeace will document these scientific activities with photographs and videos. This will enable us to provide communications materials that will aid the public campaign to create MPAs in Antarctica.

Throughout the expedition, as with our previous work in the Antarctic Ocean, we will adhere to the IAATO guidelines with respect to any interaction with wildlife and landings, with the exception of where our scientific research dictates otherwise, as outlined in the activities section below.

The voyage will sail in the area around the Antarctic Peninsula and into the Weddell Sea. Greenpeace is aware of the special status accorded to Antarctica by the Antarctic Treaty System, including its status as a natural reserve devoted to peace and science. We will be diligent and carry all the management plans and maps for the Antarctic Specially Protected and Managed areas as well as the information on Historical Sites and Monuments. Detailed monitoring will take place during the expedition and a cruise report submitted to all relevant

authorities. This document is produced by Greenpeace to fulfill the obligations required under the Antarctic Environmental Protection Act, 1994.

We intend to use our vessel, the MY Arctic Sunrise. In 1997, MY Arctic Sunrise became the first ship to circumnavigate James Ross Island in the Weddell Sea, a previously impossible journey until a 200m (660ft) thick ice shelf connecting the island to the Antarctic continent collapsed. This was just one of the many signs of climate change which the MY Arctic Sunrise has helped document over the years, from Antarctica to the Arctic.

Greenpeace also conducted research into the presence of macro plastics in the marine environment in Antarctica in the 2007/2008 season using the ship MY Esperanza. In 2018 MY Arctic Sunrise traveled to the Antarctic Peninsula and the Weddell Sea with a submersible onboard. The work conducted led to the identification of new VMEs that were adopted at the 2018 Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) meeting. The sampling led to a publication on the presence of micro-fibers and PFCs in the area furthering the scientific knowledge of human impacts in Antarctica. The work on krill fishing led to the majority of krill fishing vessels with membership of ARK agreeing to stay out of areas of high importance to Antarctic wildlife. Our 2020 expedition facilitated vital research into the rapid decline in a number of remote chinstrap penguin colonies, some of which had not been surveyed for several decades. Further to this we conducted cetacean monitoring (audio and visual), and eDNA sampling - the latter of which was a first in the Antarctic Ocean.

Our VME work for this expedition will be led by John Hocevar, an Oceans specialist on our Greenpeace staff. We are also in talks with collaborators to partner with us on this work. The team undertaking penguin surveys, as in our 2020 expedition, will arrange their own research permits.

It is our conclusion that the proposed activities for this expedition will have no more than a minor or transitory impact on the Antarctic environment, especially as previous cumulative impacts are virtually non-existent in most of the locations the expedition plans to visit. It is a clear objective of all members of the expedition that the impacts from our own journey are kept to the absolute minimum.

Classifying the Activities

To ensure the protection of the Antarctic environment, the Antarctic Treaty nations adopted the Protocol on Environmental Protection to the Antarctic Treaty in 1991 (hereafter referred to as the Environmental Protocol).

Annex I of the Environmental Protocol: Environmental Impact Assessment (EIA)
One of the guiding principles of the Environmental Protocol is that an EIA be carried out before any activity is allowed to proceed. It states that activities should be planned and conducted on

the basis of 'information sufficient to allow prior assessments of, and informed judgements about, their possible impacts on the Antarctic environment' (Article 3, Environmental Protocol).

Annex I of the Environmental Protocol sets out the detailed regulations for EIA in Antarctica, and establishes a three-stage procedure based on different levels of impact. The levels are:

- Preliminary Assessment;
- Initial Environmental Evaluation (IEE); and
- Comprehensive Environmental Evaluation (CEE).

An IEE is for activities likely to have a minor or transitory impact on the Antarctic environment. It is considered that an IEE is appropriate for the work Greenpeace aims to carry out in Antarctica. The IEE is subject to review by the Foreign Ministry of the Netherlands which also makes the final decision on whether the activity should proceed.

Itinerary

The ship will be stocked up in Punta Arenas, Chile. We are looking into two options, as the final decision will depend on the ice situation. The exact days for departure are not set and also depend on the weather in the Drake passage. Pending ice conditions, the MY Arctic Sunrise will head into the Weddell Sea and undertake a range of the scientific research outlined in the proposal below. Precise locations and dates can change due to the uncertainty of conditions, however there will be at least one small personnel change towards the start of February, before returning to Punta Arenas at the start of March. If no access to the Weddell Sea is possible due to ice conditions, then we anticipate finishing the trip slightly earlier.

Draft itinerary here:

Date	**Location**	**Activity**
06/01/22 - 10/01/22	Punta Arenas - Weddell Sea	Transit
11/01/22 - 29/01/22	Northwest Weddell Sea	Submersible VME identification
29/01/22 - 02/02/22	Weddell Sea - Punta Arenas	Transit and crew change
02/02/22 - 05/02/22	Punta Arenas - Weddell Sea	Transit
05/02/22 - 02/03/22	Antarctic Sound and Northwest and North Weddell Sea	Penguin colony surveys
03/03/22 - 07/03/22	Exit Convention Waters	Depart

COVID-19 Protocols

Greenpeace International established a Duty of Care team dedicated to supporting the organisation and staff on Covid-19 related matters. Everyone joining our ships is required to follow our strict covid protocols. Please see our current protocols listed in Annex A. Our Duty of Care team is continually monitoring the situation, as well as the latest research and findings and updating our protocols accordingly as and when required.

Please note that everyone joining the ship will do so on the mainland. Some individuals may depart from King George Island to the mainland, but in order to comply with our covid protocols we will avoid flying anyone into King George Island to join the ship from there unless absolutely necessary. In this situation a full risk assessment will be conducted by our Duty of Care team.

Expedition Personnel

Full name	**Role**	**Affiliation**	**Previous Antarctic, Arctic or cold weather experience? Y/N**	**If yes for previous column please provide details**
Fernando Romo Martin	Captain	Greenpeace International	Y	Captain on one previous Antarctic trip and two previous Arctic trips. Chief mate on many more polar expeditions.
Daniel Rizzotti	Ice Pilot	Greenpeace International	Y	Captain on numerous Arctic and Antarctic expeditions, ice pilot on two previous Greenpeace Antarctic expeditions.
Will McCallum	Expedition Lead	Greenpeace UK	Y	Expedition lead on two previous Antarctic expeditions
Laura Meller	Expedition Lead	Greenpeace Nordic	Y	Expedition lead on one previous Arctic expedition
John Hocevar	Lead Scientist (VME)	Greenpeace USA	Y	Scientist on 2018 expedition with VME work.
TBC	Polar Guide	PolarX	Y	Polar guides for over 20 years, including on two previous Greenpeace Antarctic trips and many Arctic expeditions

Greenpeace Scientific Personnel

Dr Laura Meller is an ocean policy advisor with Greenpeace Nordic. She was the expedition leader for Greenpeace's scientific expedition to the Arctic sea ice edge in 2020, and coordinated the scientific programme for a similar expedition to Western Indian Ocean. Her research at the University of Helsinki focused on biodiversity conservation in times of climate change, underlining the importance of data for sound conservation and management decisions amidst uncertainty. She is currently a member of the societal engagement group advising the Blue-Action project, a major international research project investigating the effect of a changing Arctic on weather and climate. Dr Meller's CV is included as Annex B1.

As the Oceans Campaign Director for Greenpeace USA, John Hocevar oversees the organization's work to keep our oceans healthy for future generations. Since joining Greenpeace in 2004, Hocevar has spearheaded numerous projects, including efforts to phase out single use plastic, improve the sustainability of seafood sold in supermarkets and establish a network of ocean sanctuaries. An experienced submarine pilot and SCUBA diver, Hocevar has collaborated with scientists from dozens of institutions on research projects from the Arctic to the Antarctic. He served on the US delegation to CCAMLR from 2011 to 2014. John Hocevar's CV is included as Annex B2.

Additional information on Greenpeace scientific personnel, along with supporting information is presented in Annex B.

Ships Crew

In addition to the Greenpeace staff, Polar guide, external scientists and Captains we will have 15 Greenpeace crew. The expected crew list is outlined below. Please note, that as the COVID-19 pandemic continues to evolve, this may also impact the crew we are able to bring onboard and therefore this list may change, however our all crew will be specialists in their field.

Position	**Name**	**Nationality**	**Affiliation**
1st Mate	Adrian Aruza	Panama	Greenpeace International
2nd Mate	Simona Stoeva	Bulgaria	Greenpeace International
3rd Mate	Quinten Boiton	France	Greenpeace International
Chief Engineer	Dave Mcvitt	Irish	Greenpeace International
2nd Engineer	Nasko Atansov	Bulgerian	Greenpeace International
Electrical Engineer	Ivan Yordenov	Bulgerian	Greenpeace International
Outboard Mechanic	Phil Dunn	Canadian	Greenpeace International
Radio Operator	Rosy Vilela	Spanish	Greenpeace International

Cook	Ignacio Fernandez	Chilean	Greenpeace International
Bosun	Ana Paula	Brazil	Greenpeace International
Medic	Alan Strove	USA	Greenpeace International
Deckhand	Clement Barbet	France	Greenpeace International
Deckhand	Solange Vargos	Argentina	Greenpeace International
Deckhand	David Hernandez	Spanish	Greenpeace International
Deckhand	Samantha Rodriguez	Mexican	Greenpeace International

Description of Proposed Activities

This expedition will focus on two key scientific activities. In January we will focus on submersible dives for Vulnerable Marine Ecosystem identification (VME). After a small personnel change in early February, we will then focus on surveying penguin colonies. Alongside this work we will conduct Passive Acoustic Monitoring (PAM) as and when time and conditions permit. The PAM work will be conducted from the ship during transits between sites for the VME and penguin surveys. Greenpeace will document all these activities with photographs and videos. This will help us to provide communication material to aid the public campaign to create Marine Protected Areas in Antarctica.

Submersible Dive for VME Identification

In Greenpeace's 2018 Antarctic expedition we undertook a number of submersible dives to identify VMEs, these dives led to the successful adoption of four such sites in the CCAMLR meeting the same year. However, our original dive plan involved a number of dives in the Weddell Sea that were not possible due to ice conditions. It is Greenpeace's hope to return to these locations in 2022 and undertake the dives that were not possible in 2018 and thereby help identify additional vulnerable ecosystems that may be at risk and ensure that they are protected.

Research and CITES permits will be arranged independently by our collaborator scientist as with Greenpeace's 2018 expedition through the US State Department.

Background

Identification of VME and VME Risk Areas in the Southern Ocean is important to the management of bottom fishing activities in the CCAMLR Convention area. This was brought about largely by the requirements of United Nations General Assembly (UNGA) Sustainable Fisheries Resolution (61/105) aimed at avoiding significant adverse impacts of bottom fishing activities on VMEs in high seas areas, which led to the adoption by the CCAMLR Commission of Conservation Measure 22-06 (Bottom Fishing in the Convention Area) and CM 22-07 (Interim

measure for bottom fishing activities subject to CM 22-06 encountering potential VMEs in the Convention Area). When the CAMLR Commission revised Conservation Measure 22-06 (2008), a Notification of Encounter of Vulnerable Marine Ecosystems was included (Annex 22-06/B) as part of the Conservation Measure. This notification is required to be completed when evidence of VMEs are encountered and not otherwise reported under CM 22-07.

The Annex 22-06/B notification allows for VMEs to be reported when encountered through fishery-independent research activities. Encounters can be reported via several methods, including in-situ photographic observation. The notification requires that the habitat-forming organisms and other VME-indicator taxa or habitat feature be provided for each VME that is notified. Fishery-independent Antarctic research surveys provide powerful platforms with great potential to detect and report encounters of VMEs in the CCAMLR Convention Area. As notifications are reported to the CCAMLR Secretariat and included in the CCAMLR VME registry, the ability of CCAMLR to manage and minimize risk to VMEs in both present and potential future fisheries in the Convention Area is greatly improved.

Our scientific partner's previous experience and research in Antarctica includes the successful registration of 76 % of the VMEs currently listed in CCAMLR's VME registry (Fig. 1) under CM 22-06.

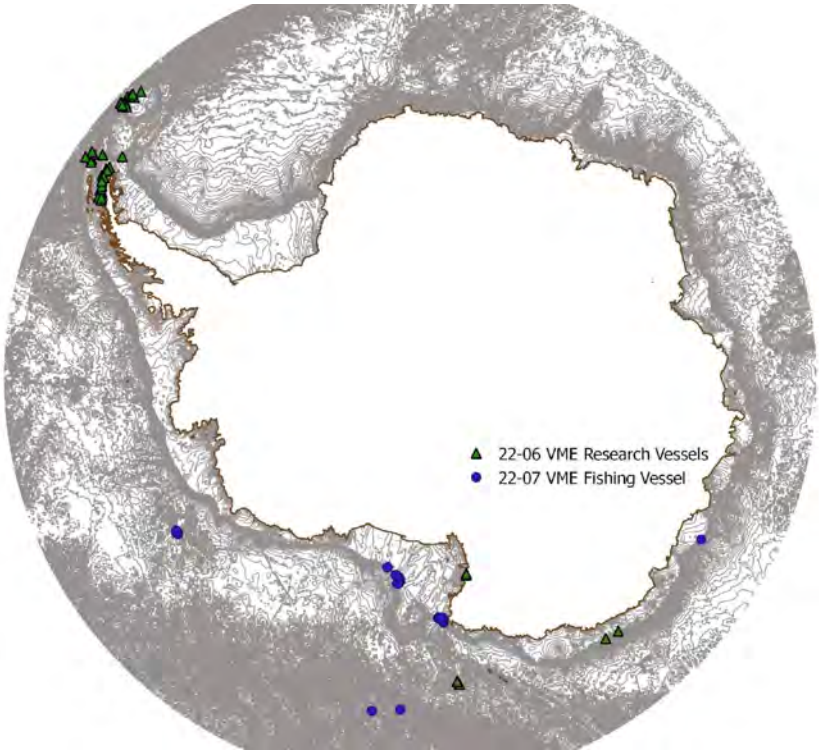

Figure 1: Locations of all registered VMEs. Blue circles are VMEs reported by fishing vessels and their observers and are referred to as VME Risk Areas. Green triangles denote VMEs reported by research vessels.

Plan Overview

Following a relatively shallow 'training' dive in the region near Elephant Island, Phase 1 will focus within the MPA planning Domain 3; the Weddell Sea region (Fig. 2). As there are no

registered VMEs in Domain 3, this region is a priority. Please note that the lines drawn in Figure 2 delineating Domain 1 from 3 and the proposed General Protection Zone (GPZ) from the proposed No Protection Zone (NPZ) are approximated in this figure (see also fig. 1 in Appendix II). The demarcation between the two planning domains is at 64.0 °S and the demarcation between the proposed GPZ and NPZ is at 65.25 °S. From the South Shetlands we will steam down and attempt a dive in the NPZ with the idea of pushing southward the NPZ border in future Weddell Sea proposals. From there, we will survey the historical Larsen A region. As Germany has never reported a VME, their Special Protection Zone (SPZ) (Fig.2 herein) is not well supported. If ice conditions allow, it will be important to conduct a dive in this SPZ. In anticipation of the various ice conditions we may encounter, we have proposed more dive stations in the region of Larsen A than we could possibly conduct for this area. The ultimate intent is to provide evidence for the need to expand the SPZ northwards and eastwards. Dive sites north of Larsen A and within the GPZ are also designed with the hope that the SPZ can be greatly enlarged.

If these dives are successfully completed in a shorter time period, or if ice conditions do not allow, then dives could be conducted in Domain 1. For example, Brash Island among the Danger Islands is home to a large colony of Chinstrap and Adélie penguins. Figure 1 in Appendix III shows that the seas surrounding the Danger Islands were not indicated as a Priority Area (dark blue) by the original Domain 1 MPA mode. Locating a VME near these islands may expand the modelled Priority Areas to afford greater protection to this significant penguin colony.

Alternatively, conditions dependent, the expedition could survey the northern Bransfield Strait region. The model used in the Peninsula MPA proposal identifies this area as a Priority Area, however, the steep bathymetry is not conducive to trawling; meaning the southern shelves of the South Shetlands have rarely been sampled, if at all. Hence, there is a greater potential for the discovery of new species. For the same reason (and if ocean conditions permit), a station beyond the flat, trawl-able northern shelves of these islands is proposed in Drake Passage.

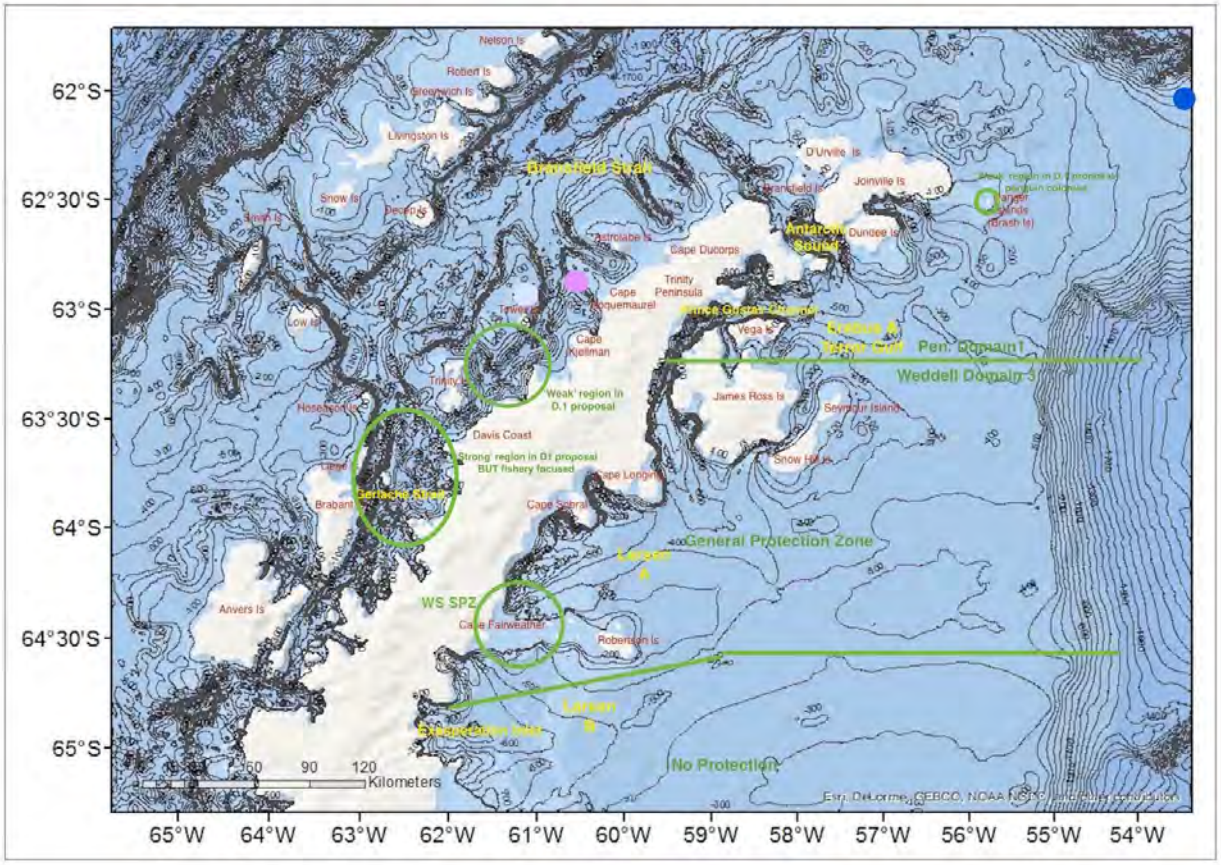

Figure 2: Antarctic Peninsula. Highlighted are topographical features (red lettering) and oceanographic features (yellow lettering). Green circles denote regions of interest (see text) and the green lines are approximate demarcations between Domain 1 and 3, and between the General Protection Zone (GPZ) and the No Protection zone (NPZ) as presented in the MPA proposal for Domain 3. The purple dot is the location of enormous hexactinellid glass sponges and is a registered VME. The blue dot is also a registered VME of interest (see text for details).

From there, we could head into the Gerlache Strait (Fig. 2). Not only is the seabed here not trawl-friendly - increasing the likelihood of new species and impressive imagery - the krill fishery, over recent years, has increasingly focused their efforts here. Then, heading north again along the Peninsula we will dive off the Davis Coast, a region not well supported by the MPA proposal's model (fig.1 in Appendix III).

Towards the northern tip of the Peninsula, chosen dive sites target steep, rarely explored, terrain. If conditions allow, we will passage through the Antarctic Sound and at the shelf edge east of Joinville and Danger Islands. Figure 3 is an image we captured at this shelf edge (blue dot in Fig. 2) and the site is registered as a VME as a result (see also Appendix IV). As lovely images at this station exist, a dive at this VME site is not necessary. However, because of the weakness in the Peninsula MPA proposal in this area, we have proposed dives at similar bathymetry along the same shelf edge in order to afford this area greater protection. Phase B of the expedition concludes with a return crossing of Drake Passage.

Figure 3: US AMLR 2009 Station 101, east of Joinville Island (max. depth: 637 m). A) Abundant red-brown hexactinellid (glass) sponge species not previously observed by us; rich stylasterid coral assemblage; other VME-IT also include diverse primnoid gorgonians, hydroids, basket stars and demosponges.

Identifying VMEs

We will use the guide produced at the CCAMLR VME workshop of what constitutes a VME and which organisms are indicative of one. This guide is designed to enable a layperson or fisheries observer to identify VME indicator taxa. The functional roles of VME indicator taxa were listed as including, inter alia, that they "(i) significantly contribute to the creation of complex 3-D structure; ii) create a complex surface by clustering in high densities; (iii) change the structure of the substratum; (iv) provide substrata for other organisms." An additional intrinsic factor contributing to vulnerability to disturbance is rarity or uniqueness. We will be looking for benthos that form large complex structures that in turn support other benthic invertebrates. It is a relatively straight-forward process for these types of communities to be identified, notified and registered as VMEs.

However, the benthic community of the Southern Ocean is characteristically mosaic (where a single species will dominate a small area), which makes our job all the more difficult as it can be hit and miss even with coordinates visited previously. In some instances, a VME indicator taxon can occur in relatively barren terrain but nonetheless at a density that far exceeds that found elsewhere and can be designated a VME. Figure 4 is an example of a mono-dominant, non-complex and 2-D structured VME, where in situ photographs were enough for VME designation even in the absence of density data comparisons (also see Appendix IV). Another example, where in situ imagery was not available, is found in Appendix VI. In this case, the beautiful sea pen, Umbellula carpenteri (Fig. 5), came up in the trawl in numbers (not huge numbers, but) far exceeding normal. We were able to plot the density of Umbellula at all stations to illustrate the unusual abundance. In cases where we come across a mosaic mono-dominated patch of seabed, it would be prudent to conduct a transect-like dive, whereby we would choose a direction and follow a straight trajectory for a distance. We can extract and calculate density

from the video data and compare it to data from our other video transects as well as from our extensive database of recorded weights and numbers of VME indicator taxa from fish survey trawls at hundreds of stations in this region.

Something else to keep an eye out for that would deem an area vulnerable to bottom fishing are nesting icefish. Some icefish excavate shallow depressions in soft sediment and brood their young, exhibiting parental care (Fig. 6).

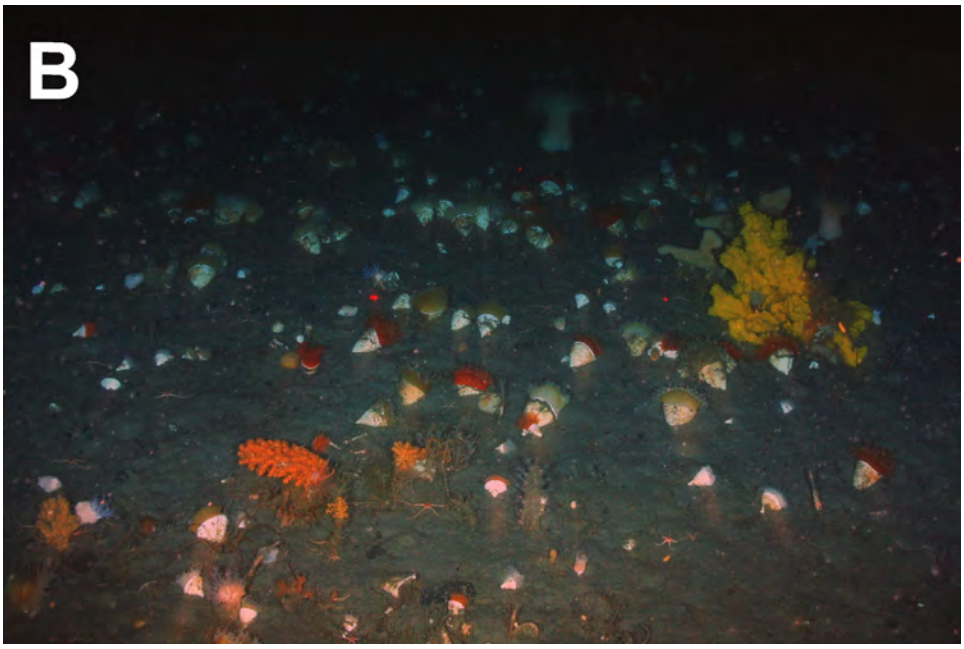

Figure 4: US AMLR Station 6, north of Inaccessible Islands, South Orkney Islands (max. depth: 218 m). B) Small- to medium-sized demosponges, large anemones, pennatulacean sea pens and primnoid gorgonians can be seen among the exceptionally abundant scleractinian corals.

Figure 5: Sea pen, *Umbellula carpenteri* (Cnidaria: Pennatulacea) collected in aberrant abundance at US AMLR 2009 Station 13, north of Inaccessible Islands, South Orkney Islands (max. depth: 218 m). Image is of specimen in a tank on board.

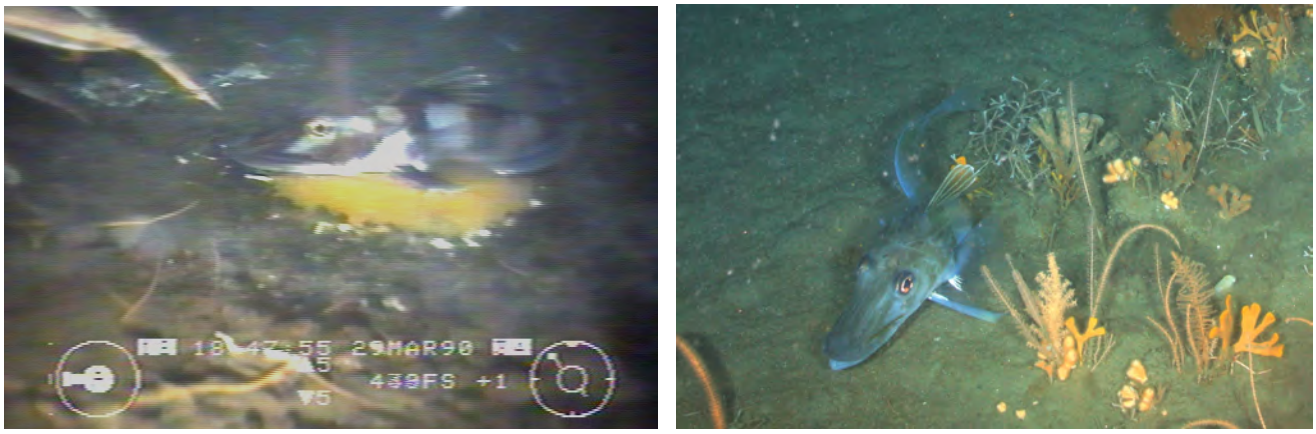

Figure 6: Nesting icefish

Dive Profile

Despite the fact that density data is not strictly necessary in order to register a VME (previously our partner has registered VMEs on images alone, as has Australia), conducting a transect at each station by default would be pragmatic. Once at the seabed we will conduct a 30 min video transect at a standard and steady speed in a straight trajectory. Transects can be lengthened as required. The remainder of the available time at the seafloor will be spent taking pretty photographs of VME indicator taxa and collecting samples for identification.

Itinerary

Dive plan: coordinates are plotted in Fig. 7 as red dots.

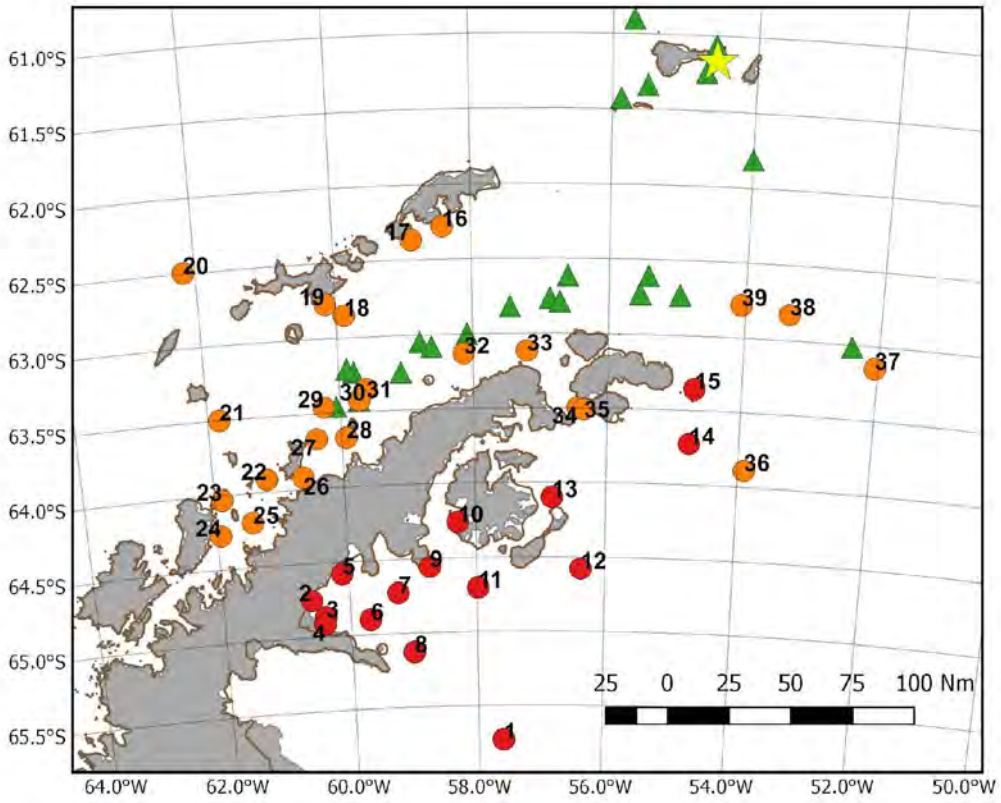

Figure 7: Greenpeace Antarctic Expedition 2022 Dive Plan: Yellow star denotes Practice Dive location. Red dots represent proposed priority dive sites; Orange dots indicate proposed alternative dive sites. CCAMLR registered VMEs are represented by green triangles.

Days 1–3 Transit to South Shetlands

Day 4 Practice dive between Elephant and Clarence Islands

Station #	Approx. Depth	Coordinates
PD	325 m	61.1685 °S; 54.5608 W

This station did not meet the biomass threshold for a VME, however, it was very high in diversity, including the presence of black coral (CITES listed).

Days 5–8 Transit into Weddell Sea

Days 9–11 Larsen A historical region

Station #	Approx. Depth	Coordinates
1	300	65.7291 °S; 57.6010 °W
2	350	64.7507 °S; 60.6064 °W
3	400	64.8665 °S; 60.4001 °W
4	300	64.9158 °S; 60.4156 °W
5	550	64.5815 °S; 60.1066 °W
6	350	65.8987 °S; 59.6924 °W
7	550	64.7259 °S; 59.2397 °W
8	250	65.1289 °S; 59.0152 °W
9	400	64.5578 °S; 58.7316 °W

10	400	64.2618 °S; 58.2802 °W

There are more stations here than are possible to dive in 3 days. However, ice conditions are likely to make many of these inaccessible. Station #1 is in the No Protection Zone. Stations #2-4 look to fall in the Special Protection Zone (however, the boundaries are not made specific in the German proposal) and Stations #5-13 are in the General Protection Zone.

Day 12 Around James Ross Island

Station #	Approx. Depth	Coordinates
11	450	64.7044 °S; 57.9811 °W
12	350	64.5790 °S; 56.3727 °W
13	350	64.1000 °S; 56.8261 °W

Both stations are north of Larsen A but still within the GPZ of Domain 3

Day 13 Around Danger Islands

Station #	Approx. Depth	Coordinates
14	200	63.7252 °S; 54.7533 °W
15	150	63.3554 °S; 54.7024 °W

Intention of these stations is to strengthen the model for the proposed Domain 1 General Protection Zone to afford a large colony of penguins better protection.

Day 14 End

Alternative dive sites: Coordinates are plotted in Fig. 7 as orange dots

South of King George Island

Station #	Approx. Depth	Coordinates
16	550	62.2811 °S; 58.4155 °W
17	200	62.3662 °S; 58.8646 °W

South of Livingston Island

Station #	Approx. Depth	Coordinates
18	400	62.8534 °S; 59.8806 °W
19	550	62.7730 °S; 60.1473 °W

Drake Passage and southeast of Low Island

Station #	Approx. Depth	Coordinates
20	400	62.4972 °S; 62.1715 °W
21	550	63.4985 °S; 61.8249 °W

Gerlache Strait

Station #	Approx. Depth	Coordinates
22	200	63.9173 °S; 61.1768 °W
23	350	64.0343 °S; 61.8812 °W

24	450	64.2724 °S; 61.9440 °W
25	300	64.2009 °S; 61.4398 °W

An area with interesting bathymetry, and where the krill fishery has been largely focused in recent years.

Off Davis Coast

Station #	Approx. Depth	Coordinates
26	200	63.9208 °S; 60.6185 °W
27	600	63.6679 °S; 60.3792 °W
28	500	63.6701 °S; 59.9325 °W
29	250	63.4581 °S; 60.2495 °W

A weak spot in the modelled Peninsula proposal.

Off Cape Roquemaurel

Station #	Approx. Depth	Coordinates
30	330	63.247 °S; 59.0757 °W
31		63.369 °S; 59.729 °W

Registered VME at station #30. Enormous hexactinellid sponges, *Anoxycalyx joubini*, encountered here (2006 AMLR Station #12). Goal is to capture video/photo evidence of the enormous volcanic glass sponges that we trawled in 2006.

Canyon features off northernmost tip of Peninsula

Station #	Approx. Depth	Coordinates
32	100	63.1326 °S; 58.1364 °W
33	600	63.1173 °S; 57.2014 °W

Antarctic Sound

Station #	Approx. Depth	Coordinates
34	300	63.4960 °S; 56.4428 °W
35	200	63.5086 °S; 56.3481 °W

Rarely sampled

Shelf edge east of Joinville and Danger Islands

Station #	Approx. Depth	Coordinates
36	600	63.8883 °S; 53.9013 °W
37	600	63.1477 °S; 52.0481 °W
38	550	62.8288 °S; 53.3530 °W
39	300	62.7831 °S; 54.0637 °W

Weakly modelled area in Domain 1 proposal. Beautiful burgundy glass sponges and lots of stylasterid corals at nearby 2009 AMLR Station #101.

All coordinates are plotted over 100 m isobaths in Figs. 8a-d.

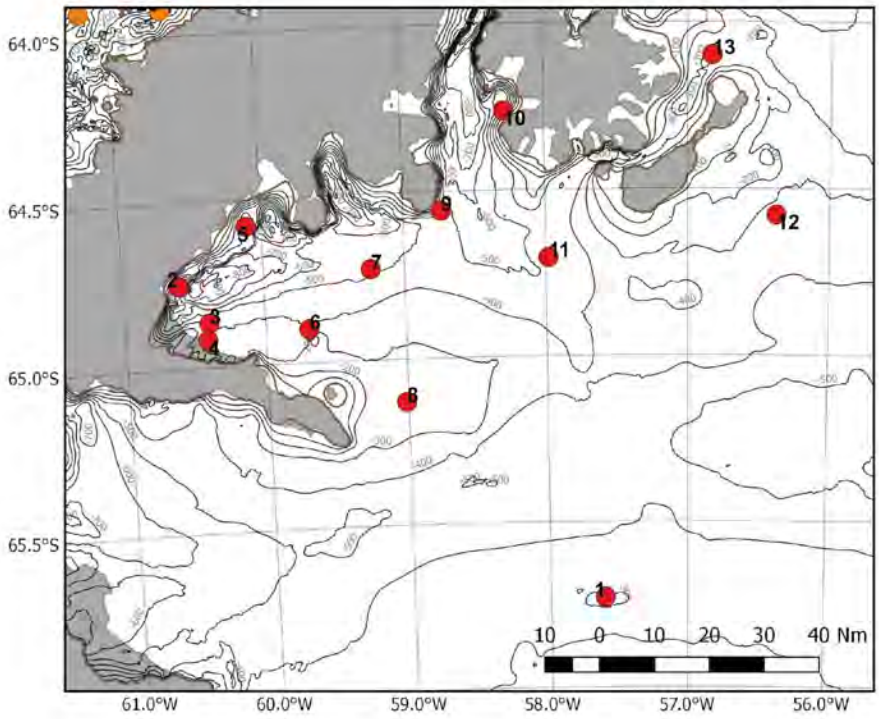

Figure 8a: Weddell Sea, Larsen A stations: Yellow star denotes Practice Dive location. Red dots represent proposed Phase A dive sites; Station 1 is in the No Protection Zone of the Weddell Sea MPA proposal. All others are within the General Protection Zone. (Orange dots indicate proposed Phase B dive sites.). The demarcation between the GPZ and the NPZ is at 65.25 °S.

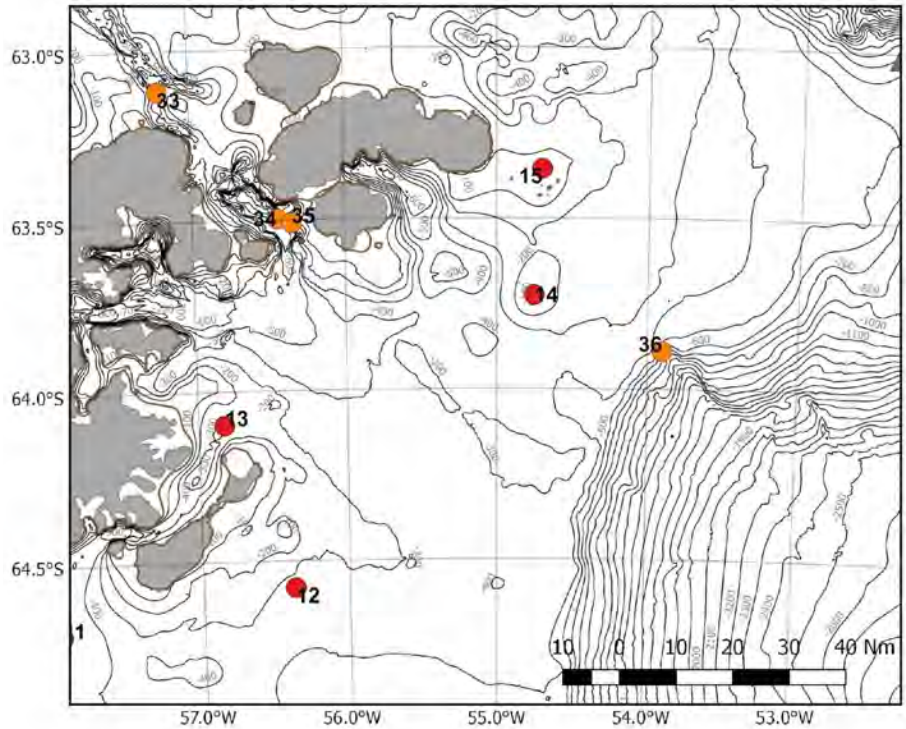

Figure 8b: Weddell Sea, James Ross and Danger Islands: Red dots represent proposed Phase A dive sites; Stations 12 and 13 are in the Weddell Sea General Protection Zone.of the Weddell Sea MPA proposal. Stations 14 and 15 are in Domain 1. The demarcation between Domain 1 and Domain 3 is 64.0 °S.

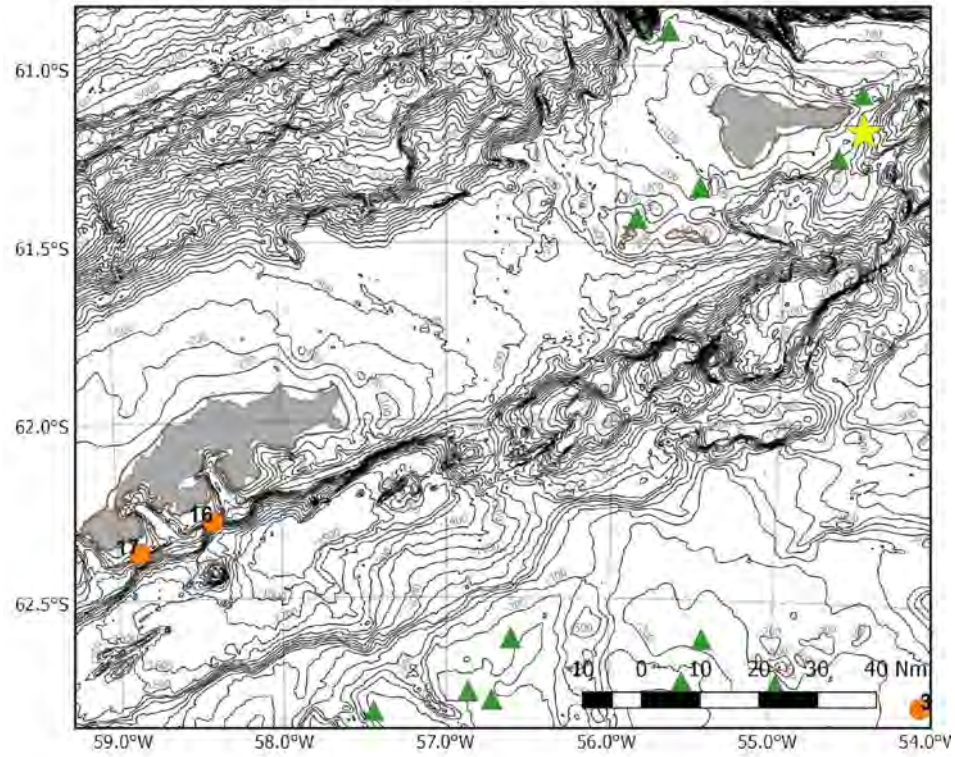

Figure 8c: King George Island Sites: Orange dots indicate the first 2 proposed Phase B dive sites. Yellow star denotes Practice Dive location at Elephant Island. Green triangles denotes registered VMEs.

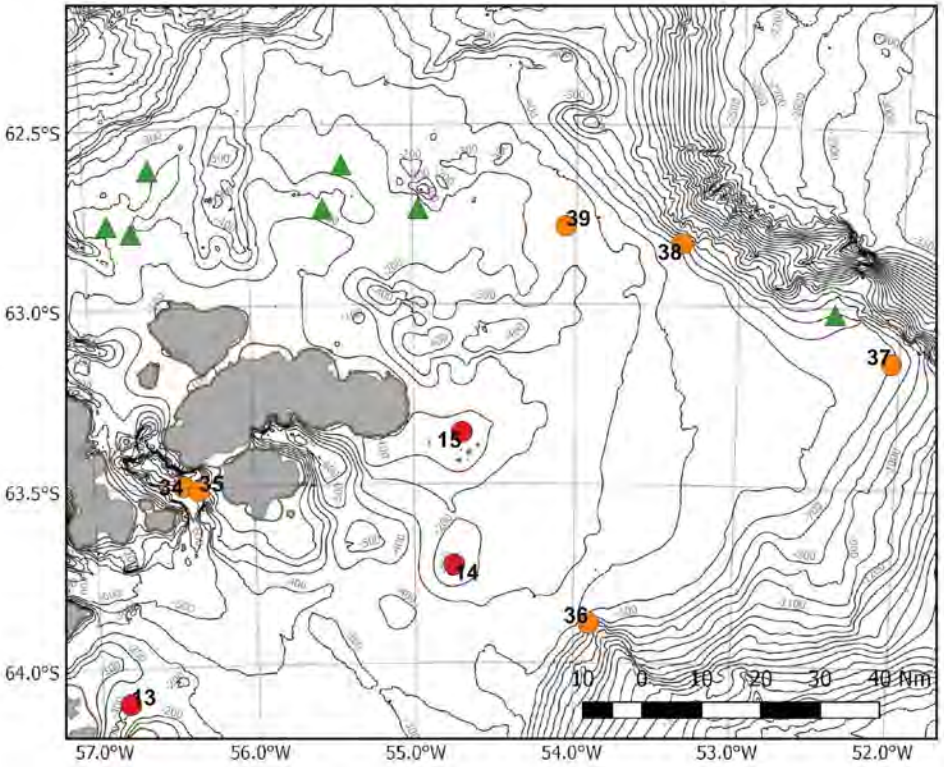

Figure 8d: Joinville Island Sites: Orange dots indicate the proposed Phase B dive sites. (Red dots denote Phase A sites). Green triangles denote registered VMEs.

VME Data Analysis

The fieldwork and preliminary assessments of the data will be conducted on board by the Lead Scientist with support from Dr. Susanne Lockhart from Southern Benthics. Please find a letter of intent from Dr Lockhart in Annex C1. We are in further conversations with a number of collaborators and are confident that the combination of expertise available on board as well as through a network of specialists ready to support the work from their facilities will yield valuable and sound evidence of the benthic organisms at the diving locations. An Antarctic Expedition Scientific Advisory Council, consisting of 15 experts from climate research, benthic ecology and taxonomic specialists of various species groups, supported the scientific work during and after the Greenpeace expedition in 2018 and we are working towards a similar arrangement. See Annex B4 for a list of the advisory council from 2018.

In 2018, successful field work resulted in CCAMLR designating four new VMEs based on data collected during the Greenpeace expedition, as well as a peer reviewed scientific article accepted for publication in Frontiers in Marine Science (Annex B3).

Penguin Surveys, Domains 1 and 3

The penguin surveys will build on the work from our 2020 expedition, and will form the focus of the second half of our expedition, from early February to early March. We will be working with the same scientists from our 2020 expedition, Dr Heather Lynch, of Stony Brook University and Dr Tom Hart, of Oxford University. All penguin surveys will be undertaken under scientific research permits arranged by the relevant institutions. Greenpeace is seeking to facilitate this research by providing access and logistic support to the survey locations by means of the ship.

A primary objective of the expedition is to support a comprehensive survey of penguins, to contribute critical knowledge on the impact and role of climate change and krill fisheries as population drivers of these iconic species. Surveys to assess changes in population numbers as well as timing of reproduction and reproductive success are the key variables of interest. Changes in species distributions and phenology - ie. timing of key events in an annual cycle, such as migration and breeding - are well documented responses to climate change across species groups; however limited field data makes it challenging to document and assess such impacts on Antarctic penguin populations.

We will be working with a highly experienced Antarctic penguin research team, focusing surveying efforts on Heroina, Brown Bluff, Vortex Island, Red Island, Devil Island, Cockburn Island and Seymour Island. Secondary sites of Half Moon Island, Aitcho Islands and the Western Antarctic Peninsula will be visited should weather impede surveys on primary focus sites, to ensure expertise and opportunity is maximised. Surveying techniques will take the form of land surveys performed directly by researchers in colonies and drone surveys (as used by the same team in 2015 Adelie Penguin Survey of Danger Islands, published in ‘Nature’ journal).

The research team will comprise two highly experienced and specialist researchers to undertake ground surveys as well as operate from the ships and RHIBs for UAV surveying. The

variety of survey methods on each island will depend on conditions and time ashore, including one or more of the following methods:

- Manually counting individual nests
- Counting individual nests in panoramic photos taken from the ground or the vessel
- Counting individual penguins from photographs captured by UAV
- Sample collection and observational data collection undertaken by hand/with close range binocular assistance.

The combination of these methods allows for efficient data collection with opportunities for cross-validation of survey methods.

Collaborators

We will be working once again with Dr Heather Lynch from Stony Brook University, USA and Dr Tom Hart, Research Fellow, Department of Zoology, University of Oxford. A letter of intent from Dr Hart is included as Annex C2. Once we have confirmed permits for this work we will sign a Memorandum of Understanding, similar to the attached document from our 2020 work (Annex C3).

The Lynch Lab at Stony Brook University is focused on applying quantitative methods to Antarctic conservation biology. Central to the lab's research activities are their efforts to understand the dynamics of ecological change in Antarctica and its genesis in environmental and anthropogenic drivers. They are particularly interested in the distribution and abundance of Antarctic seabirds and using a combination of direct field censuses and satellite imagery, we can try and understand the extent to which recent changes are related to climate change, fishing, or tourism. As a means of sharing these data with key stakeholder groups, they have created an online application for penguin population data called the Mapping Application for Penguin Populations and Projected Dynamics (MAPPPD), which provides an up-to-date assessment on the status of the four Antarctic penguin species that can be used for scientific research, for the planning of Antarctic activities, for the management of Antarctic fisheries, and for the design of protected areas.

Of the field data that they collect through direct in-the-field surveys, around three-quarters is collected using ships of opportunity, typically IAATO-member Antarctic cruise ships, that host 2-3 researchers on board who census animals at landings and complete at-sea surveys. In addition to counting animals, they conduct a variety of other research projects including, but not limited to, analyses of penguin behavior using acoustics, video recorders, and guano sampling for stress hormones and studies of genetic relatedness using blood sampling. In recent years, advances in unmanned aerial vehicles (UAV) have made it possible to supplement manual ground counts of penguins with UAV-based surveys, which allow for more efficient coverage of large colonies and more precise computer-based counts of individuals. UAV imagery also provides a three-dimensional rendering of the habitat that facilitates further analysis of micro-habitat preferences and behavior.

The Lynch Lab's research, being vessel based and unavoidably subject to uncertain itineraries, is optimized for flexibility, and their research plan will be adapted to the timing and geographic

coverage of the vessels used as research platforms. Expeditions later in the austral summer usually focus on chick counts, which provides a measure of the size of the breeding population. The lab's research has been and is currently funded by a large number of sponsors, including the US National Science Foundation, NASA, the Pew Foundation, and National Geographic.

Itinerary

The penguin surveys form the focus of our second 'leg' of this expedition, following the personnel change in early February. It is expected this work will be carried out between 5th February and 2nd March 2022.

The team will visit up to 10 sites on land to conduct surveys of penguin populations. The sites we plan to visit are shown in Figure 9 and detailed in the table below. We have eight priority locations (marked with red dots in Figure 9 and detailed further in Figure 10). The nature of these sites, being hard to reach, means that many have not been surveyed onland for many years, if at all. This voyage offers a unique opportunity to gain access to these sites for the scientists, however accessing these sites will be very dependent on weather and sea ice conditions. We will monitor conditions closely throughout our voyage, and if conditions do not allow us to visit our selected sites we have provided a list of alternative sites (marked as orange dots in Figure 9 and detailed further in Figure 11) that lie along the West of the Antarctic Peninsula as well as sites on Half Moon Island, Aitcho Island and Deception Island.

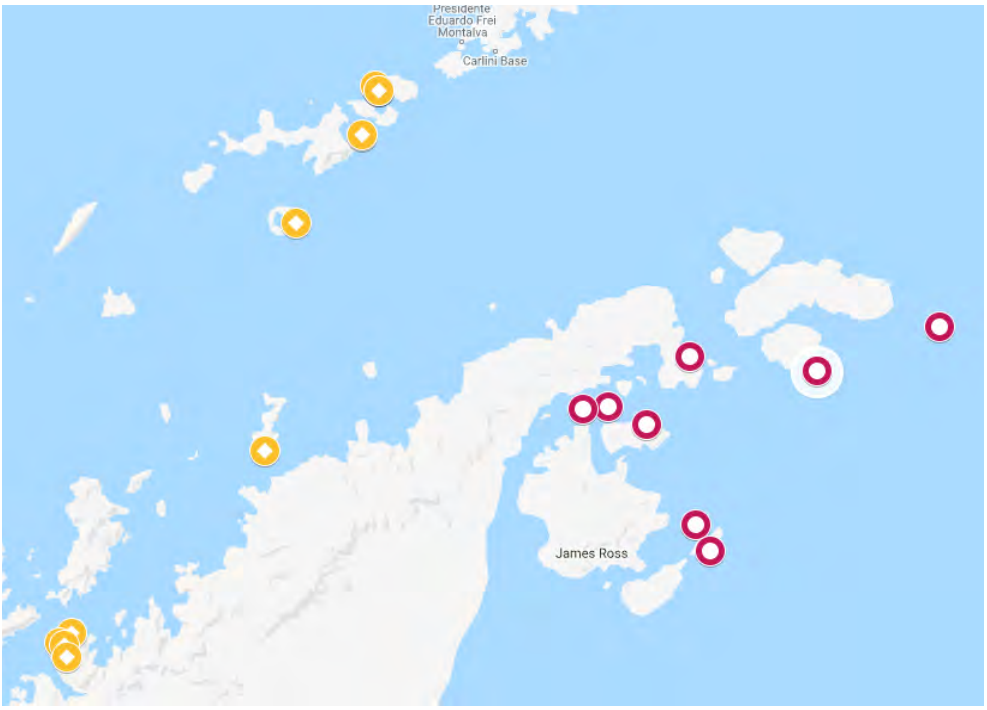

Figure 9: Proposed penguin survey sites. Red dots indicate identified priority sites. Orange dots indicate back-up options if the original sites can not be reached.

Our expected itinerary is:

Day	Site name, Island	Latitude	Longitude	Activity
1	-			Transit to Weddell Sea
2	Brown Bluff	-63.52	-56.893	Adélie penguin population survey
3	-			Transit
4	Devil Island	-63.7992	-57.2889	Adélie penguin population survey - last surveyed in 2011
5	-			Transit
6	Vortex Island	-63.7257	-57.6415	Adélie penguin population survey - last surveyed on the ground in 2008
7	Red Island	-63.7356	-57.88	Adélie penguin population survey - possibly never surveyed on the ground
8	-			Transit
9	Cockburn Island	-64.2005	-56.8412	Adélie penguin population survey - not surveyed on ground since at least 1979
10	-			Transit
11	Penguin Point, Seymour Island	-64.3061	-56.7114	Adélie penguin population survey - last surveyed in 2009
12-13	-			Transit
14	Heroina	-63.3944	-54.6083	Adélie penguin population survey
15	-			Transit
16	Paulett	-63.577	-55.733	Chinstrap penguin population survey
				End

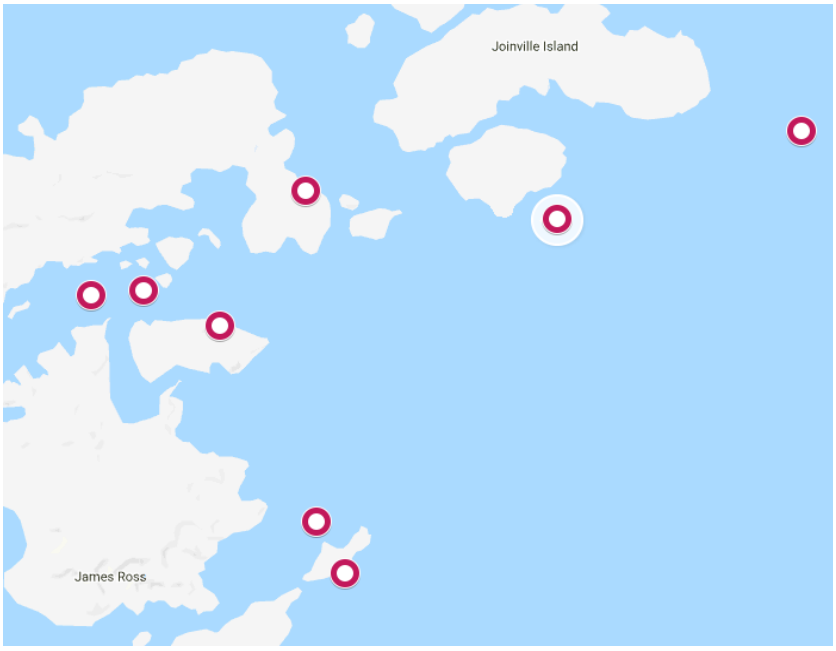

Figure 10: Identified priority penguin survey sites. 5 sites in Domain 1, 2 sites in Domain 3

If weather or sea ice prevents us visiting the sites listed above, we would divert to a selection of the sites listed below (and shown in Figure 11). The sites we divert to will be dictated by sea ice and weather conditions as well as time available.

Site name, Island	**Latitude**	**Longitude**	**Activity**
Half Moon	-62.596	-59.898	Chinstrap penguin population survey
Aitcho Barrientos	-62.406	-59.74	Chinstrap penguin population survey
Aitcho Barrientos	-62.4078	-59.747	Gentoo penguin population survey
Aitcho Barrientos	-62.4057	-59.7451	Gentoo penguin population survey
Aitcho Emiline	-62.3852	-59.7738	Chinstrap penguin population survey
Bailey Head, Deception Island	-62.964	-60.504	Chinstrap penguin population survey
Mikkelson Harbour, Trinity Island	-63.902	-60.79	Gentoo penguin population survey
Oren Harbour	-64.631	-62.555	Chinstrap penguin population survey
Georges Point	-64.67	-62.669	Gentoo penguin population

			survey
Cuverville	-64.682	-62.621	Gentoo penguin population survey
Danco Island	-64.728	-62.597	Gentoo penguin population survey

Figure 11: Alternative penguin survey sites if priority sites cannot be reached. All sites are in Domain 1.

Landings

Landings for manual population counts and observations will involve six people who will carry out data collection, documentation, guiding and logistic support. Of these, two will be scientists, and four will be Greenpeace for guiding, logistics support and documentation. This group of six may, on suitable occasions, be accompanied by up to four highly experienced crew, additional camera people, and guests in order to collect footage and video material of the wildlife and the research. This brings the maximum size of any landing group to ten people. The material collected will be used to communicate the urgency for protection of the seas around Antarctica

and to call for action on climate change. The materials will also be made available to Greenpeace partners and Natural History museums as well as media outlets. Greenpeace is not an IAATO member but will carry IAATO certified guides on our vessels and will, as in 2018 and 2020, reach out to IAATO centrally to coordinate activities between IAATO member vessels and the Greenpeace ships. As in 2018 and 2020, when we were invited to visit some of the bases, we will be operating near a number of scientific bases and may need to anchor nearby.

If we need to anchor at King George Island to use the airstrip for collecting or dropping off crew and guests. We will follow the procedure for operations related to the DAP flights to and from King George Island. We will make sure we have all pertinent maps, codes of conduct and permissions to visit, as well as adhere to all COVID-19 protocols.

Places of interest also include the north end of Adelaide Island to the north end of the Trinity Peninsula, Smith Island, and the South Orkney Islands for the purpose of photography. Other activities that we will be pursuing are:

- observing wildlife
- photographing and filming our surroundings
- charting and logging areas that we visit for aid to small boat navigation
- hiking or crossing land to access some of the points we wish to photograph

All of the activities above involve transport aboard our vessel MY Arctic Sunrise. See ANNEX 1 for Certificate of Registry. To access the shore, to attach shorelines or land people, an inflatable RHIB is used. The RHIB will have an outboard engine when circumstances dictate, or will be rowed by crew so as to minimize noise and pollution. The MY Arctic Sunrise has three big RHIBs and four smaller ones. The ship also carries a ‘Man Over Board’ (MOB) boat. See ANNEX 2 and 3 for full information on the RHIBs on board the ship.

Landings will be chosen away from wildlife nesting sites and areas of high vegetation. Land trips are planned as day trips and will not involve use of vehicles on land. For any landings the shore party of no more than 10 persons will be limited to work within the immediate area of the landing sites with the intention of staying ashore only long enough to acquire the desired survey results or photographs. The shore party will travel as one group.

When navigating in ice conditions, it is often necessary to seek safe havens to await weather or ice conditions to improve. Due to much of the Antarctic waters being uncharted, an inflatable RHIB with outboard will be used to survey possible anchorage sites in advance, allowing the vessel to follow a safe course into the anchorage. This extra precaution is essential to avoid hitting uncharted rocks or reefs, hence avoiding any marine emergencies or fuel spills.

While observing wildlife, filming or photography ashore, all distances from wildlife as recommended in the New Zealand Code of Conduct, and all available visitor site guidelines and Marine Wildlife watching guidelines published by IAATO as well as Ron Naveen’s “The Oceanites Site Guide to the Antarctic Peninsula” will be carried ashore for reference.

UAV Surveys

UAV surveys will be performed with a DJI Phantom 3 quadcopter using its stock 1.2 Megapixel camera. The UAV is flown either manually or automatically using the mission planning software Map Pilot App to generate image coverage of each island with at least 70% overlap between images. Following best practice, a minimum height above ground of 25 m will be set for all flights to avoid disturbance to wildlife, and a maximum height above ground of 45 m selected to maintain image quality for penguin identification. The geotagged imagery collected with the UAV is post-processed using the commercial photogrammetry software Photoscan (Agisoft LLC, St. Petersburg, Russia) which will generate full, georeferenced orthomosaics, a top-down view of the island – in which each pixel corresponds to a fixed physical dimension – of the surveyed islands and their penguin colonies.

Additional Scientific Work: Hydrophones

MY Arctic Sunrise will transit the Antarctic Sound and western Weddell sea towing a hydrophone array collecting valuable data on cetaceans when conditions allow. This work will take place on transits between sites for VME identification and penguin surveys and as such forms a secondary focus for our expedition. The hydrophones will be deployed as and when time and conditions allow.

Apex predators, such as cetaceans, are invaluable indicator species that highlight areas of the open ocean and coastal regions that are important hotspots for biodiversity. Many species are highly vocal. Passive acoustic monitoring, using a towed hydrophone, provides a robust, cost effective and automated method for determining cetacean occurrence and distribution as well as the location of ocean biodiversity hotspots. Species-specific vocalisations from cetaceans can be detected during ship transits and dedicated systematic surveys using relatively simple and affordable equipment. New, powerful and freely available open source software that combines both GPS locations and data from acoustic encounters provide real-time detection information during campaigns and a valuable archive for later re-analysis.

The objective of the activity is to provide a map of cetacean encounters to highlight areas of higher top predator density in the open ocean and to provide data on ocean noise and on the occurrence and distribution of powerful anthropogenic noise sources.

An approximately 400m long towed hydrophone array would be deployed from the vessel once at sea using either a dedicated reel positioned on the poop deck or by hand at low speed. Signals from the array are processed by an amplifier / conditioner unit. These can be monitored by ear or using detection and logging software running on a standard laptop. The laptop would also collect a complete acoustic record within a coordinated database.

The effectiveness of acoustic monitoring is affected by background noise. For a towed system, survey vessel noise is a significant component of this. Generally, vessels are reasonably quiet at speeds which provide the best fuel efficiency and it’s likely that effective acoustic monitoring will be achieved at the vessel’s normal transit speed. An exercise will be undertaken during early

trials to measure background noise at different speeds so that effectiveness at different speeds can be assessed.

Passive acoustic monitoring for cetaceans: Standard protocols for surveying for cetaceans will be used whilst transiting and during areas of opportunistic survey work. The system involves a 400 m towed hydrophone array deployed from the stern of the vessel and cabled to a laptop on the bridge with PAMguard software.

Deck crew on board the Arctic Sunrise will deploy and operate the towed hydrophone and Passive Acoustic Monitoring equipment with support from other Greenpeace staff. Deck crew on board Greenpeace ships have gained extensive recent experience deploying the towed hydrophone array and operating the Passive Acoustic Monitoring devices during 2019 in Southern Atlantic, 2020 in the Antarctic and Arctic Ocean, and in 2021 in the Indian Ocean. Greenpeace Research Laboratories will analyse the data in collaboration with University of St Andrews, UK. In combination with similar data collected during transits across the world, the data will make a valuable contribution to the global knowledge base of cetacean distributions and temporal dynamics.

Assessments and Likely Impacts

Greenpeace have conducted previous expeditions to Antarctica and are familiar with the obligations under the treaty, in particular their responsibilities in relation to waste disposal, marine pollution and avoidance of harmful interference with fauna and flora. Crew and other guests will follow the captain's instructions and will be made familiar with their obligations under the treaty. A compilation of information will be binded and made available for reference onboard. In a worst case scenario the ship MY Arctic Sunrise could founder or discharge fuel or other wastes into the environment. In an offshore scenario the contaminants may likely disperse reasonably quickly but in the event of this occurring close to shore the impacts could be more severe; affecting wildlife contaminating the surrounding environment. The likelihood of this event is extremely low and, combined with the fact that the vessel is an ice-strengthened steel construction, the chance of rupture and discharge of hazardous chemicals, even in extreme circumstances, is low. See the section below for mitigation measures and ANNEX 4 for MY Arctic Sunrise Ship’s Particulars.

The use of inflatable boats will be kept only to those necessary to carry out the activities and will be rowed, where feasible, when approaching landing sites. Outboard motors emit emissions, which will contribute to the overall atmospheric pollution but as the use of these will be restricted to necessity, the impacts will be minor. It is also possible that some engine residues may be emitted in the general running of the vessels' motors.

Anchoring is avoided where possible, thus avoiding disturbance to the fragile sea floor. All of the planned activities will be in accordance to:

- The Antarctic (Environmental Protection) Act 1994 - Recommendation XVII-1- Tourism and Non-Governmental Activities
- The Management Plan for the Antarctic Specially Managed Areas on King George Island (ASMAs)
- The Management Plans of all Antarctic Specially Protected Areas within or nearby to the areas that we will be sailing
- Visitor Site Guides published by IAATO
- The Antarctic New Zealand Code of Conduct
- International Maritime Organisation (IMO) polar code
- International Whaling Commission (IWC) guidelines on avoiding collisions/ship strikes with whales
- Plus a number of other publications noted in annexes

Impacts of the Submersible Dives for VME Identification

The submersible will be operated from our ship, MY Arctic Sunrise, by highly trained crew members. The submersibles will be piloted by experienced pilots with 2 people onboard for each dive. The dives will take photographs and videos of the seabed.

A manned submersible enables us to document Antarctic seafloor habitats with less impact than any other means. In contrast with dredges or trawls, which damage portions of the seabed while removing living organisms along with part of the substrate, we will use photography and video as our primary form of data. This non-invasive approach enables us to quantitatively survey the benthic environment without impact to the seafloor.

A backup submersible will be on board and kept on deck in case it is needed for a rescue operation. Greenpeace has safely used these submersibles in Antarctica in 2018, in the Arctic, off the coast of Brazil, in the Gulf of Mexico, and twice in the Bering Sea. Between our own experience and the expertise of Nuytco, the company that builds and operates the submersibles, we are confident that we can meet our scientific and educational objectives safely and in the most environmentally conservative means possible.

Impacts of Penguin Survey Work

Landings will be chosen away from wildlife nesting sites and areas of high vegetation. Land trips are planned as day trips and will not involve use of vehicles on land. For any landings the shore party of no more than 10 persons will be limited to work within the immediate area of the landing sites with the intention of staying ashore only long enough to acquire the desired survey results or photographs. The shore party will travel as one group. For all landings the shore party will be limited to work within the immediate area of the landing sites and will travel no further than 30mins walk from the landing site with the intention of staying ashore only long enough to acquire the desired survey results or photographs. An emergency kit will be carried with the shore team in the event bad weather or ice conditions force a night ashore. Any food scraps or garbage generated by the shore team will be returned to the ship. Likely impacts of land based activities may include:

- inadvertent trampling of moss, grasses or lichen (every effort is made to land on rocky areas or snow ramps).
- disturbing wildlife with engine or outboard noise
- exhaust emissions from vessel engine or outboard engines
- being forced by ice conditions to change itinerary and seek alternative anchorages, possibly areas that have not been visited before by a small vessel
- exhaust emissions from emergency cookstoves carried by shore parties as part of the emergency kit
- human waste left in the field on the glaciers in the event of being impractical or unsafe to carry out (positions will be marked with a GPS point)

The ship will be the base for meals and accommodation with the exception if the team is forced to stay on land due to weather or time constraints. All solid human waste will be bagged where practical and returned to the ship and handled. Any rubbish or food scraps will be returned to the vessel and handled onboard.

Likely specific impacts from UAV surveys may include disturbing wildlife with noise. This impact will be mitigated by following IAATO guidelines and best practices with regards to ensuring enough distance is kept at all times. In a worst case, unforeseeable weather events or technical failure may lead to the UAV to fall down during flight. In the event of a UAV falling, every effort will be made to retrieve it or its parts. The risk of loss of UAV will be mitigated as far as possible by only operating the UAVs by qualified pilots who carry their own permits for such operations according to protocols agreed with the Captain; only allowing UAV operations in favourable weather conditions.

Impacts of the Hydrophone Work

As this activity takes place during ship's transits between locations of other activities - ie. VME identification and penguin population surveys - there are no likely added impacts for the Antarctic environment. In a worst case scenario, presence of ice or unforeseeable weather events could break the towed hydrophone array. To prevent this as far as possible, the towed hydrophone array will not be deployed while navigating in ice, and it will only be deployed in favourable weather conditions.

Impacts from the Voyage to the Antarctic Peninsula

Greenpeace acknowledges that regardless of our relatively small-scale operations and our dedication to achieving our goals in the most ecological means possible, our presence in Antarctica does have an impact.

Through diligent planning, awareness and actions, we hope to demonstrate that we are capable of making an expedition to the Antarctic Peninsula and outlying islands with minimal impact. In order to minimize any impact, we will carry onboard various publications concerning Antarctica, such as IAATO guidelines, and ensure all crew are aware of responsibilities laid out in them.

Impacts from our Vessels

The largest possible impact from the expedition would be a fuel spill from any of our vessels due to an incident. MY Arctic Sunrise will retain all waste oil onboard for later disposal where it can be appropriately handled. No animals, live plants, soil or poultry (live or dressed) will be transported to the Antarctic Peninsula. Likely impacts from the ship can be:

- disturbing wildlife with engine or outboard noise
- exhaust emissions from vessel engine or outboard engines
- being forced by bad weather and ice conditions to change itinerary and seek alternative shelter closer to the Antarctic peninsula
- anchorages, possible areas that have not been visited before by a small vessel
- noise pollution via the outboard engine or vessel engine
- diesel fuel emissions during motoring and heating
- noise pollution from the engine and outboard motor operation
- kerosene (Jet A1) emissions when operating the outboard engine
- disrupting the seabed when anchoring, (when possible we will moor into the ice shelf, sea ice or drift to avoid use the anchor)

Mitigation of Impacts from the Expedition

MY Arctic Sunrise

The likelihood of a fuel spill from any of our vessels is small as precaution is taken, the ship is ice classed and we have an experienced captain and crew.

Fuel onboard the vessel:

	LSMGO (Low Sulfur Marine GasOil)	**Gasoline**	**Jet A1 fuel**	**Daily use of LSMGO**
MY Arctic Sunrise	400,000 liters / 344 Mtons	100 liters	10,000 liters	5,000 ltrs/day

MY Arctic Sunrise burns up to max 5,000 ltrs /day LSMGO, which includes motoring and heating but the amount of emissions is low especially in comparison to larger vessels.

Greenpeace makes every effort to prevent accidental fuel spills through careful attention to fuel management and handling. Re-fuelling of the inflatable boats will be completed onboard the MY Arctic Sunrise where any spillage can be contained on board, thus avoiding any contamination of the ocean.

Wildlife Distances

All procedures for wildlife distances as recommended by the IAATO ‘Marine Wildlife Watching Guidelines Part 1 & 2’ and the IAATO ‘Guidelines for Visitors to the Antarctic’. These will be

available for review by all crew members. While wildlife observation is a natural activity of the trip, the team are very aware of the impacts of unnecessary intrusions into wildlife habitat. Where possible, the ship will:

- proceed at no wake/idle speed within 300 meters
- not proceed through a pod of cetaceans or seals
- understand that we may exceed idle/wake speed to outdistance cetaceans but must increase speed gradually
- maneuver the vessel to keep out of the path of any whales and maintain a minimum of 50m distance (and increase this distance to 200m for Baleen or Sperm whales with calf).
- cease viewing if a sperm whale abruptly changes its orientation or starts to make short dives (1-5 minutes) without showing tail flukes

When inflatable boats or other tenders are being employed for transfer from the ship to shore, the boats or tenders will slow down to avoid disturbance to the animals and will not approach animals during navigation to and from the landing site. On land, the group will avoid disturbing wildlife, especially breeding birds, following the guideline publications noted above. Greenpeace have operated in some of the most fragile ecosystems in the world (Antarctica, Patagonia, Canadian and US Arctic as well as Svalbard and Greenland) and have always respected the avoidance of unnecessary impact on wildlife.

Human Waste Disposal

Please see ANNEX 5 for International Sewage Prevention Certificate for MY Arctic Sunrise.

Rubbish

All rubbish will be kept on board and disposed of upon our return to Punta Arenas or next continental port where waste can be handled in a responsible manner. Greenpeace always strive to minimize our waste footprint through careful and responsible purchasing and waste management onboard.

We always sail with a garbologist onboard (one dedicated crew member that keeps the waste management under control). Food waste will be stored on board and then discharged into the Drake Passage, in Punta Arenas or north of 60 degrees in accordance with maritime pollution (MARPOL) regulations. See ANNEX 6 for our Garbage Management Plans for MY Arctic Sunrise.

Science Program

All scientific activities shall be performed in accordance with the Scientific Committee on Antarctic Research (SCAR) Environmental Code of Conduct for Terrestrial Scientific Field Research in Antarctica. Collection or removal of anything not brought into the area by the permit holder shall only be in accordance with a permit and will be limited to the minimum necessary to meet scientific or management needs. 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 such items will 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. Penguin survey research team shall be operating under US NSF permit, and conducted under the approval of Stony Brook University's Institutional Animal Care and Use Committee (237420), Woods Hole Oceanographic Institution's Institutional Animal Care and Use Committee (18958), and following ethical review by the University of Oxford.

Intensity

The expedition is mobile, with no permanent structures on land. The ship expedition's goal is also to get in and get out of the desired locations as quickly as possible. We aim to be continuously on the move, anchoring only when necessary. The style of voyage is such that impact and intensity is kept to the absolute minimum.

Cumulative Impacts

At more popular landing sites on the Peninsula there is the potential for cumulative impact over a number of years. Potential areas for cumulative impact to which we might contribute include:

- by-products from boat operations such as engine exhaust and fumes adding to the overall atmosphere loading. MY Arctic Sunrise uses LSMGO fuel (Low Sulfur Marine Gas Oil) or IFO (Intermediate Fuel Oil) with minimum sulfur content
- disturbance to any bird or sea life in the region by the activity of the boat
- possible spillage or accidents involving hydrocarbon products that would contaminate the ice or ocean
- a build up of liquid human waste, which is disposed of at any camp in snow pits, is possible as biodegradation occurs slowly in the cold environment.

Apart from a major contaminating spillage somewhere on the Antarctic Peninsula, the cumulative effects are hard to monitor other than visually and at their present level are undetectable. It is the goal of the expedition to minimize environmental impacts wherever possible.

The potential cumulative impacts on transit and activity sites have been determined as the following:

- food and human wastes deposits
- damage to flora through foot traffic
- disturbance of fauna and flora
- fuel spillage
- accidental abandonment of non-biodegradable material
- atmospheric pollution
- noise pollution

Having identified these potential impacts, the expedition has put the following procedure in place to minimize or avoid them wherever possible:

- removal of food and solid human wastes from land
- avoidance of exposed flora and fauna
- maintaining adequate distance from fauna
- managing re-fuelling of inflatable boats on board the MY Arctic Sunrise and strict care when handling fuels
- carrying fuel spill trays and absorbent kits for the emergency cookstoves and return any contaminated materials to the vessel for disposal in the landfill in Punta Arenas
- carefully checking that materials taken off the boat are returned
- minimizing use of motor transport, use oars or paddles wherever feasible
- choose alternative landings or locations to avoid disturbing animals
- stop the activity and resume at a more appropriate time

Monitoring

Each land team member will be responsible for, and aware of, their own impacts at all times. The captain, expedition leaders onboard and camp manager will monitor compliance to regulations and the impact of the party on the environment. An evaluation of any observed impacts on the environment will be made by Greenpeace in the post expedition report to the Dutch Ministry of Foreign Affairs.

Exotic Organisms & Antarctica

Greenpeace supplies the vessel from the Netherlands and Chile. All fresh fruit and vegetable products will be wiped down before packing aboard. Greenpeace have a new policy on meat and fish and as of August 2019 the vessels will be mostly vegetarian with a maximum of one meal of fish or meat a week. Meat onboard will be treated in accordance with biosecurity regulations. Any meat for the camp will be vacuum sealed, dried, frozen or canned. No fresh poultry products are carried aboard with the exception of eggs.

All byproducts of fresh foods are kept as compost onboard and disposed of in the Drake Passage, outside of Antarctica (i.e. north of latitude 60 degrees south) and in line with MARPOL regulations, or when returning to South America. Processed and dried foods from The Netherlands and Chile, which are pre-packaged, are used for the emergency kits on land, thereby providing a reasonable degree of care to exclude exotic organisms.

Equipment Checks for Foreign Organisms and Contaminants

Prior to boarding, Greenpeace will check all equipment for foreign organisms and soils that may present a hazard to the environment in Antarctica and ensure the offending material/ organisms are removed and the items cleaned or sterilized before departure from Punta Arenas. Also, within the Antarctic Peninsula, expedition members will clean their equipment and boots before re-boarding the ship in order to avoid transporting soils and contaminants between sites within Antarctica.

A biosecurity protocol (ANNEX 7.1-7.3) has been developed and will be implemented onboard. This includes treatment of clothes, RHIBs, equipment etc. with the right fungicides between landings. All joining crew and guests will receive training in biosecurity upon joining the ship.

Antarctic Specially Protected Areas (ASPAs)

We have no intention of entering any Antarctic Specially Protected Areas (ASPAs). All our sites for VME identification and penguin surveys fall outside of ASPAs. A printed list of ASPA sites will be kept on hand for reference. All sites that we may be sailing near will be noted and circled on our navigational charts. Cross-reference for site guidelines, boundaries, locations and conduct will be kept on board and reviewed if forced to anchor near any of these sites. Deception Island and Admiralty Bay on King George Island are specially managed areas (ASMA) containing a number of ASPAs and Historic Sites Monuments (HSM). All information will be printed and available onboard with regard to exact locations of the sites as is the ATS '*Deception Island Management Package, Code of Conduct, Alert Scheme & Escape Strategy and Conservation Strategy for Historic Site and Monument No. 71, Whalers Bay*' and the '*Management Plan for Antarctic Specially Managed Area No 1 – Admiralty Bay, King George Island*'.

ASPAs, ASMAs, HSMs, CEMP Sites and Seal Reserves

Although none of our identified sites for VME or penguin surveys fall within ASPAs, ASMAs, HSMs, CEMP sites, or seal reserves noted below are the Specially Protected Areas (ASPAs), Managed Areas (ASMAs), Historic Sites and Monuments (HSMs) we may find ourselves near during our voyage. We do not anticipate operating near CEMP sites (Convention on the Conservation of Antarctic Marine Living Resources Ecosystem Monitoring Programme) or Seal Reserves. A complete list of all of these sites, including maps will be carried onboard and made available for reference.

Antarctic Specially Protected Areas (ASPAs)

ASPA No 140. Parts of Deception Island, South Shetland Islands
ASPA No 145. Port Foster, Deception Island, South Shetland Islands
ASPA No 148. Mount Flora, Hope Bay, Antarctic Peninsula

Antarctic Specially Managed Areas (ASMAs)

ASMA No 1. Admiralty Bay, King George Islands
ASMA No. 4. Deception Island

Historic Sites and Monuments (HSMs)

HSM No 38. Nordenskjöld hut - snow hill Island (Weddell Sea)
HSM No 39. Hope Bay hut (Hope Bay- Antarctic sound)
HSM No 60. Seymour IslandHSM No 71. Whalers Bay - Deception Island

All maps and notes will be kept onboard delineating the areas as well as Code of Conduct and management plans. Due to the unpredictable nature of sailing in Antarctic waters, adverse

weather and ice conditions may force us to choose anchorages and routes outside of our intended itinerary noted above. Any deviation from intended plans will be detailed in the Post Expedition Report.

Transport and Logistical Support

The MY Arctic Sunrise

Name of Ship	MY Arctic Sunrise
Gross Tonnage	1017
Year Built	1975
Type	Sea-going Motor Yacht - MY (Former Research Vessel)
Flag	Netherlands
IMO Number	7382902
Port of Registry	Amsterdam, Netherlands

Essential communication and navigation equipment is on board including:

- RADAR
- Ice Radar
- Dual ECDIS (Electronic Chart Display and Information System)
- BA Paper charts
- Dual Echo Sounder
- Gyro Compass
- GPS Compass
- Magnetic Compass
- Global Positioning Systems (GPS)
- V-Sat (Internet and communication)
- Iridium system (communication and Internet)
- Photo Satellite Receiver (SkyEye) for meteorological forecasting
- HF radio and VHF radios

The vessel is certified for area A4 (Maximum IMO category for communication). See ANNEX 8.1 - 8.4 for more details on the communication equipment onboard.

Inflatables

See ANNEX 3 for details and particulars of the inflatables (RHIBs) carried onboard.

Drones

Drones will be onboard to conduct the described science as well as for navigational purposes for the vessels. PolarX (prev JRP AS) and IAATO guides also have a commercial permit for drone operations from the Norwegian Civil Aviation Authority and have experience of flying

drones in polar regions. The expedition will follow the ATCM guidelines and The COMNAP RPAS Handbook at all times. The scientists will bring their own drones and permits from relevant national authorities. The scientists have conducted drone surveys in the Antarctic previously. All drones in the expedition will fall in the small bracket weighing less or just above 2kg.

Self-Sufficiency

The expedition will be fully self-contained with equipment and provisions suitable for these types of activities. The expedition party is made up of very experienced individuals covering the following skills:

- Captains with extensive experience from Antarctica and other ice covered waters and officers with ice navigation training.
- Highly experienced high latitude crew often operating in difficult and dangerous conditions (Arctic, Svalbard, Antarctica, Greenland etc.) including RHIB operator with high latitude, open ocean and ice laden landings and Antarctic cruise ship experience. We will share the full crew list once confirmed.
- Medic with polar experience and advanced first aid training
- Expedition leader with polar experience
- IAATO certified guides
- Scientists with Southern Ocean expertise
- Rigging and rope safety
- Mountaineering and glacier travel
- Wildlife management
- Biosecurity specialist

As we have often sailed in remote and isolated areas, Greenpeace has always operated with the idea that we must only rely upon ourselves in the event of an emergency. Everyone sailing aboard will know and understand that there is no Search and Rescue service in Antarctic waters and we cannot rely upon any scientific base, scientific ship, tourist ship or any other operators in the area other than ones we have arranged in advance.

- All available charts and pilots are onboard, including drawings and notes made from previous visits and information from other sailing vessels that have visited some of the uncharted areas.
- All food, fuel and equipment is carried onboard. Extra food and fuel is carried in the event of delays due to weather or ice conditions.
- The ship has a doctor and a hospital on board.

Extra precautionary measures taken when sailing in isolated areas. These include:

- All persons sailing with us must produce a medical certificate from their doctor stating they are capable of participating in a voyage to Antarctica on a small vessel

- All persons participating in any other activities (climbing, kayaking, skiing etc.) are highly experienced in their field.
- Everyone must wear floatation suits or dry suits when in the inflatable boats going to and from the ship to the shore
- Any parties visiting the shore must carry emergency equipment including food, shelter, medical kit, spare radio, batteries etc. The floater suits will be left cached on shore as an extra security measure.
- A regular radio schedule will be followed between shore parties and the ship
- No one will be allowed onto the glaciers without proper equipment or knowledge.
- Emergency scenarios will be discussed with all crew and plans for rescue and evacuation for each situation noted
- Up to date weather forecasts will be obtained daily and used to plan activities and travels within the Peninsula waters and the Weddell Sea
- Communication will be kept with other ships operating in the region and exchanges made regarding local weather and ice conditions
- A “Reciprocal Emergency Rescue & Aid Agreement” will be made with a number of other vessels operating within the Antarctic Peninsula waters and contact will be kept with these vessels in the event we may need assistance

Medical Evacuation

The team accepts that the expedition is being run in a very remote part of the Antarctic continent and consequently there are limited or no search and rescue facilities. The expedition will operate in as safe and conservative manner as possible and still achieve the anticipated outcomes of the expedition. The MY Arctic Sunrise will hold regular radio schedules with other vessels in the region and we understand that in the event of a medical evacuation it may be necessary to abandon the proposed itinerary to return to port in South America.

Insurance

Everyone aboard will carry personal insurance for liability, health and medical evacuations, which will be validated before departure to Antarctica. Greenpeace covers hospitals, physicians, medicine and medical evacuation 100%. The insurance has no restrictions on hazardous sports or occupations. The insurance details for MY Arctic Sunrise can be found in ANNEX 11.1 - 11.3, with additional information relating to evidence of insurance and environmental emergencies cover in Annex D.

Contingency Plans

Health and Safety

Operation	Incident	Incident prevention	Detection	Response
Ship board	Fire	Close adherence to Standard Operating Procedures (SOP's) and scheduled maintenance. Attention to high risk areas Galley and Eng rm. All crew have received STCW' 2010 Fire prevention and fighting training, as identified in SMSM Additional non crew persons advised on fire risk avoidance in safety briefing. Designated smoking area	24hr watchkeeper, with deck/ engine room monitoring + automatic detection system	Implement appropriate provisions SCP-06 (ANNEX 12. 3) and SCP-07 (ANNEX 12.4) from 'Shipboard Contingency Plan' (ANNEX 12.2) in accordance to SOLAS chapter IX as amended, under the vessels 'Safety Management System Manual' (SMSM) ANNEX 12.1. If required,under Captains command initiate Abandon Ship procedures (following SPC-11 procedures ANNEX 12.5)
	Grounding/ Stranding/ collision/ flooding	24hr Navigational watch of suitably qualified officer of the watch and ratings deckhand. Full use of all electronic navigational tools including, satellite ice charts and Olex navigation system to provide maximum data when operating in areas of limited data. In uncharted waters and ice conditions follow provisions of SPC-23 (ANNEX 12.9 Approach and Operation in Uncharted Areas) Drones with HD camera stream to ship's radar also available onboard for ice navigation. If at anchorage and anchors dragging, follow procedures SPC 20 - (ANNEX 12.10)	24hr Watch, all alarms tested and operational, use of all navigational tools	Implement SCP-05 (ANNEX 12.6) Grounding/Strandin g/ or SCP-10 (ANNEX 12.7) Collision or SPC-13 (ANNEX 12.8) Flooding procedures from SMSM as appropriate. If required,under Captains command initiate Abandon Ship procedures following SPC-11 procedures (ANNEX 12.5) Follow reporting procedures contained within SMSM
	MOB	Falling overboard strictly	24hr Watch,	Implement Man

		forbidden, care for sea sick persons, restricted deck access in heavy weather	regular checks on person locations, especially if apparent absence	overboard SCP-08 (ANNEX 12.11) or MOB SCP-09 (ANNEX 12.12) as appropriate upon situation, from SMSM
	Injury/illness	Only suitable trained and qualified persons engaged in deck operations, with areas otherwise restricted. Full safety round provided to all persons	All operations to be conducted in teams, pairs of general supervision. Guests to be supported by experienced crew	Onboard advanced first aid, medic to respond, with ship's hospital and shore support if required via Radio, or nearest suitably provisioned base station. Follow provisions in SCP-14 (ANNEX 12.13) SMSM
	Medivac	Follow SOPs and Best Working Practices. All persons be fit and proper in health, to have STCW 2010 seafarers medical certificate	24hr watch, careful monitoring for persons health, physical and mental well being	Alter operational schedule immediately to prioritise medivac. Coordinate medivac with nearest suitably provisioned shore side support, Stabilize condition onboard if possible, route ship to nearest suitable shore support for transfer
Boat Ops	Lost boat	All boats fitted with location tracker, monitored by ship. Spare radio, highly experienced boat operators. Regular radio schedule on position and status	24hr bridge watch and radio communications. Boat operations always 2 boats and crews, with GPS, and nav station on at least 1 of the boats	If loss of communications, engine failure or event, implement SAR with 2 boats, and ship as suitable, following SAR bridge protocol. All RHIBs have safety kit, including range of flares to display distress and location. Bridge team to Initiate SOLAS emergency procedures if deemed necessary

	Capsize	Avoid operating in poor conditions. Highly experienced teams, with knowledge of beach landings and operating around Ice. Follow provisions with Polar Module (ANNEX 13.2) of in house boat driving SOP's. All persons wear appropriate PPE	2nd boat on hand, working with 2 boats provides safety support and ability to maintain visual observation on each boat	Attend to incident with 2nd boat on location. Prepare additional boats and ship to respond as required. Safety of person paramount
	Boat landings/ damage	Experienced boat drivers, suitable landing sites, suitable conditions. With most appropriate boats. Do not land persons in deteriorating conditions. Range of landing techniques to use depending on conditions- see Polar Module of in house boat driving SOP's (ANNEX 13.2)	2 boats working in tandem	2nd boat on scene to support in case of incident, equipped with anchor and tow line general safety equipment
	Fuel spill	Refuelling only undertaken on board Ship following strict SOP's. All boats maintained to a high standard	Visual observation/ watch from boat crew	If spill during refuelling onboard ship, follow procedures SCP-19 (ANNEX 12.14). If leak apparent in operation, shut down engine, close seavalves. Immediately retrieve boat back onboard ship and implement SCP-19
	Shore party stranded ashore due to bad weather conditions	All shore trips team leader to undertake checklist (ANNEX - 13.1) prior to departure to ensure suitably prepared. All shore parties to carry emergency equipment kit (ANNEX - 13.2), to ensure persons can be safely ashore for 48hr period if required	Ship to shore communication following communication plan (ANNEX - 8.2)	Seek a suitable location, away from dangers, to wait until boat pick up is possible. Use emergency equipment kit to provide shelter, keep hydrated and fed. Maintain communication schedule with ship. Team leader/guide to monitor shore team individuals for signs of exposure

				and act early to keep all party in good health

Environmental

Operation	Incident	Incident prevention	Detection	Response
Shipboard	Fire	Strict adherence to all SOP's in fire prevention.	24hr watch, and operational alarm system	SCP-06 and SCP-07
	Grounding	24hr Navigational watch of suitably qualified officer of the watch and ratings deckhand. Full use of all electronic navigational tools including, satellite ice charts and Olex navigation system to provide maximum data when operating in areas of limited data (unchartered waters) and ice conditions. Drones with HD camera stream to ship's radar available for ice navigation.	24hr Watch, all alarms tested and operational, use of all navigational tools	Implement SCP-05 Grounding/Stranding or SCP-10 Collision or SPC-13 Flooding procedures from SMSM. If required,under Captain's command initiate Abandon Ship procedures (following SPC-11 procedures) Follow reporting procedures contained within SMSM
	Oil spill	All refuelling of RHIB's by trained crew, following SOP's, with oil spill prevention provisions undertaken (all scuppers bunded etc) and oil spill response equipment prepared.	Vigilant deck rounds every hour, and additional supervision during refuelling	Follow procedures in SCP-19
Boat Ops	Fuel spill	Refueling of boat only undertaken onboard ship	Supervised refuelling by Outboard Mechanic	Follow procedures in SCP-19
	Invasive species introduction	Ensure all persons and ships personal receive and follow biosecurity protocol and guide, with additional briefings onboard. Onboard biosecurity protocol implemented as standard operating procedure prior to visiting	Vigilance and monitoring of all persons, with Ships Officer designated as onboard biosecurity officer. And camp manager/guide as camp and field	Initiate additional trapping, baiting as required, report all incidents to NL Ministry, with all relevant information. Lead by biosecurity officers

		Antarctic	party biosecurity officer	

Annexes

ANNEX A	**Greenpeace COVID Protocols**
A1	COVID-19 - Guidelines for ship operations
A2	Campaign teams & externals _ Joining the ships during COVID-19
A3	SOP_Travelling during COVID-19
A4	DoC Webinars Using our Greenpeace Ships in Covid Times
A5	Circular letter OPE 01-20
A6	Circular letter OPE 02-20
ANNEX B	**Greenpeace Scientific Personnel and Supporting Information**
B1	Dr Laura Meller CV
B2	John Hocevar CV
B3	Lockhard & Hocevar. Frontiers in Marine Science - Author's Proof
B4	Antarctic Expedition 2018 Scientific Advisory Council
ANNEX C	**Letters of Intent**
C1	Letter of Intent - Dr Lockhart
C2	Letter of Intent - Dr Hart
C3	Example MoU with Dr H Lynch from 2020 Expedition
ANNEX D	**Insurance**
D1	Evidence of Insurance_Arctic Sunrise
D2	Environmental Emergencies cover_Arctic Sunrise

ANNEX 1	Certificate of Registry - MY Arctic Sunrise
ANNEX 2	Evidence of Insurance - RHIBS
ANNEX 3	RHIBs Specifications
ANNEX 4	Ship’s Particulars - MY Arctic Sunrise
ANNEX 5	International Sewage Pollution Preventions Cert - MY Arctic Sunrise
ANNEX 6	Garbage Management Plan - MY Arctic Sunrise
ANNEX 7.1	Greenpeace Biosecurity Handbook
ANNEX 7.2	Biosecurity protocols for embarking crew
ANNEX 7.3	Ships biosecurity protocols
ANNEX 7.4	Antarctic Biosecurity SOPS
ANNEX 8.1	Bridge Navigation Communication - MY Arctic Sunrise

ANNEX 8.2	Shore Party Communications
ANNEX 9	Report on Survey of GMDSS Radio Installations - MY Arctic Sunrise
ANNEX 10	Protection & Indemnity Insurance Policy - MY Arctic Sunrise
ANNEX 11.1	MY Arctic Sunrise Evidence of Insurance
ANNEX 11.2	MYAS-Marine Package Insurance for PHO IRI til 14 Oct 2022
ANNEX 11.3	MYAS insurance blue card for bunker liability cert till 02 2022
ANNEX 12.1	Safety Management System Manual
ANNEX 12.2	SCP 06 Fire in engine room
ANNEX 12.3	SCP 01 Main Propulsion failure
ANNEX 12.4	SCP 07 Fire in accommodation
ANNEX 12.5	SCP 11 Abandon ship
ANNEX 12.6	SCP 05 Grounding stranding
ANNEX 12.7	SCP 10 Collision
ANNEX 12.8	SCP 13 Flooding
ANNEX 12.9	SCP 23 Approach and Operation in Uncharted Areas
ANNEX 12.10	SCP 20 Dragging of anchors
ANNEX 12.11	SCP 08 Man overboard (immediate discovery)
ANNEX 12.12	SCP 09 Man overboard (unknown time)
ANNEX 12.13	SCP 14 Personal injury or illness
ANNEX 12.14	SCP 19 Oil spill
ANNEX 13.1	Antarctic Shore Party Checklist
ANNEX 13.2	Polar Operations RHIB Training

Appendix 3

U.S. Department of State

ADVANCE NOTIFICATION FORM

TOURIST AND OTHER NON-GOVERNMENTAL ACTIVITIES IN THE ANTARCTIC TREATY AREA

OMB APPROVAL NO. 1405-0181
EXPIRES: 10/31/2021
ESTIMATED BURDEN: 10.5 HOURS

This information is requested in furtherance of U.S. obligations under Article VII(5)(a) of the Antarctic Treaty of 1959, and consistent with Antarctic Treaty Consultative Meeting Recommendation XVIII-1 and Resolution XIX-3. Information below should be submitted no later than three months prior to intended travel to the Antarctic Treaty Area. Responses will facilitate a determination of U.S. jurisdiction over the activity and permit timely dissemination to Parties to the Treaty of expedition details. Certain expedition information may be posted on the National Science Foundation's and the Antarctic Treaty Secretariat's Web sites in order to facilitate notification of and access by all Parties to the Treaty. All U.S. nationals organizing expeditions to Antarctica in the United States, or proceeding to Antarctica from the United States, should submit this form to the U.S. Department of State as indicated below . In addition to disclosure to other Parties to the Treaty, the information provided may be shared with the U.S. Environmental Protection Agency to ensure compliance with 40 CFR *(Code of Federal Regulations)* Part 8, Environmental Impact Assessment *(EIA)* of Nongovernmental Activities in Antarctica, as well as with other relevant U.S. agencies. The information also may be shared with appropriate domestic or foreign entities for law enforcement, search and rescue, or administrative purposes.

Include attachments for responses that require more space than the form provides. If an organizer is planning more than one expedition, details specific to each individual expedition should be provided as attachments to this form. Each organizer should prepare only one Advance Notification form.

The completed form should be submitted to the Antarctic Advisor, Office of Ocean and Polar Affairs, Bureau of Oceans, Environment and Science, U.S. Department of State, 2201 C Street NW, Washington DC 20520.

NOTE: For the purposes of this form, "expeditions to Antarctica" include activities south of Sixty degrees South Latitude, excluding commercial fishing voyages. Crew includes an expedition's captain and officers, helicopter pilots, and deck, engine, and hotel/catering staff. Expedition staff include guides, lecturers, and small boat drivers who are not otherwise counted as crew. Passengers include other persons accompanying the expedition, but exclude national representatives or observers.

A. Expedition Organizer

1. Name of Expedition Organizer *(Company, entity, or person(s) as appropriate)*	2. Expedition Organizer's Contact Person
Heather Joan Lynch	Heather Joan Lynch
3. Mailing Address *(Please also provide physical address if using a post office box)*	4. Nationality of Expedition Organizer
163 IACS Building, Stony Brook, NY 11794	USA
5. Principal Place of Business *(Home office)*	6. Total Number of Expedition Staff per Excursion
Institute for Advanced Computational Science, Stony Brook University	2
7. International Phone	8. International Fax
1-631-632-2384	1-631-632-7626

9. Explain activities undertaken by the organizer, including, for example, acquiring the use of vessels or aircraft, hiring expedition staff, or planning itineraries.

Heather Lynch will be responsible for: 1) Obtaining permits; 2) Coordinating research staff; 3) Cruise planning (in consultation with Greenpeace International); and 4) Determining scientific objectives.

10. Explain if the organizer maintains substantial ties to a country or countries other than the United States; for example, a U.S. national who habitually resides in another country, or a company which is the subsidiary of an entity incorporated in or with other substantial ties to another country.

None.

11. Explain whether any organizing activities will be or are being performed by a party or parties other than the named expedition organizer; *e.g.*, a sub-charter. Identify the nationality of individuals or commercial entities to whom the expedition organizer has delegated specified organizational responsibilities.

Our scientific activities will occur within an expedition organized and operated by Greenpeace International, which is being permitted through the Netherlands.

12. Describe where the organizing activities conducted prior to the expedition will be or are being performed.

All organizing activities will take place at Stony Brook University in Stony Brook, NY.

13. Specify the place(s) from which the expedition(s) will depart immediately prior to entering the Treaty Area.

The expedition will depart from Punta Arenas, Chile.

B. Details of Transport and Equipment to be Used for the Tour/Expedition

Complete these panels only once if all Tours/Expeditions planned do not vary in their use of transport or equipment; where these vary, complete the panel for every Tour or Expedition.

B1. Vessel/Aircraft Used for Transport To/From Antarctica

14. Vessel/Aircraft Registered Name	15. Vessel/Aircraft Type
MY Arctic Sunrise	Sea-going motor yacht

16. Country of Registration	17. Vessel/Aircraft Passenger Carrying Capacity	18. Vessel Ice Rating and Classification Society *(If applicable)*
Netherlands	36	Polar Class PC6

19. *(Check one)*	20. Vessel/Aircraft Fuel Capacity	21. Vessel/Aircraft Fuel Type
☐ Ship ☒ Yacht ☐ Aircraft ☐ Other _____	430 m3	Low sulfer MGO (LSMGO)

22. Intended Use of Vessel/Aircraft
Transportation to Antarctic Peninsula

23. Vessel/Aircraft Call Sign	24. Radio Frequency*(ies)* Monitored	25. INMARSAT Number*(s)*/Fax*(es)*	26. E-mail Address*(es)*
PE6851	GMDSS A1, A2, A3, A4	+870-773-063-361	ro1.myas@greenpeace.org

27. Captain's/Commander's Name*(s)*	28. Total Number of Crew
Fernando Romo Martin	21

B2. Equipment to be Used Within Antarctica

29. Number and Types of Aircraft to be Used

Number	Type	Use
2	DJI Mavic Air 2	Aerial censusing of penguin colonies

30. Number and Types of Other Vessels or Vehicles to be Used *(e.g., small boats, snowmobiles)*

Number	Type	Use
2	PUMAR MI585A	landings on shore

C. Contingency Planning

31. Type and Amount of Insurance Coverage, including Name*(s)* of Insurer*(s)*

All personnel will have Medical Evacuation and Repatriation Insurance coverage 1,000,000 min. purchased prior to expedition (e.g., Allianz or similar) and $50,000 emergency medical. Michael Wethington will also carry GeoBlue coverage for non-routine international medical at 90% of expenses; United HealthCare Global coverage for medical evacuation, Unlimited; and New York Workman's Compensation for unlimited medical and 2/3 wages.

32. Arrangements for self-sufficiency and contingency plans including for medical evacuations and search and rescue in the event of an emergency.

Extra food and fuel is carried in the event of delays due to weather or ice conditions. The ship has a doctor and a hospital on board. A "Reciprocal Emergency Rescue & Aid Agreement" will be made with a number of other vessels operating within the Antarctic Peninsula waters and contact will be kept with these vessels in the event we may need assistance. All of the personnel will have medical evalcuation insurance and our primary means of evacuation is own vessel to Frei Station (King George Island) for air medivac. Casualty may also be transferred to an IAATO member cruise ship for more rapid evacuation to the Falklands/South America.

D. Expedition Details

NOTE: If more than one expedition is planned, please provide the information below in an attachment referring to each individual expedition. If more than one vessel will be used in carrying multiple expeditions, please organize the submission of information on individual expeditions under the name of the specific vessel that will carry those expeditions.

33. Planned Port of Embarkation	34. Planned Date of Embarkation *(mm-dd-yyyy)*
Punta Arenas, Chile	1/7/2022
35. Planned Port of Disembarkation	36. Planned Date of Disembarkation *(mm-dd-yyyy)*
Punta Arenas, Chile	2/7/2022
37. Planned Cruise/Flight Number or Voyage Name	38. Estimated Number of Passengers to be Carried per Excursion
MY Arctic Sunrise	2

39. Activities to be Undertaken and Purpose

This permit is intended to cover a scientific survey of penguin colonies along the Antarctic Peninsula with a specific focus on the Weddell Sea region. In addition to providing key information on the dynamics of penguin colonies in the Weddell Sea, this expedition will provide a comprehensive basemap of penguin distribution and abundance that will inform the planning for and development of a Marine Protected Area in the region.

Our surveys will be completed using direct manual counts and the use of unmanned aerial vehicles. We anticipate no significant disturbance caused by either direct manual counting or by UAV survey.

40. Proposed itinerary with dates and places to be visited. Include a proposed itinerary for all expeditions that will proceed south of 60 degrees South Latitude, even if there is no intention for individuals to disembark onto land.

7 Jan: Depart Punta Arenas, Chile
8-10 Jan: At sea
11 Jan - 14 Jan: Dundee Island, Eden Rocks, and Paulet Island
15 Jan - 23 Jan: Cockburn Island and Penguin Point (Seymour Island), Devil Island, Red Island, and Vortex Island
24 Jan - 1 Feb: Danger Islands (Scud Rock, Earle, Platter, Dixey Rock, Heroina, Comb and Darwin Islands)
2 Feb - 6 Feb: At sea with possible stops for surveys in the South Shetland Islands
7 Feb: Arrive Punta Arenas

Certification

Heather J Lynch
Signature of Tour/Expedition Organizer

10/15/2021
Date *(mm-dd-yyyy)*

Appendix 4

Heather Joan Lynch

112 South Street / Port Jefferson, NY 11777
phone: 631-632-9508 e-mail: heather.lynch@stonybrook.edu
(Updated October 13, 2021)

Education

Harvard University Cambridge, MA Jan. 2003-Nov. 2006
Ph.D. Organismic and Evolutionary Biology
Thesis: Spatiotemporal dynamics of insect-fire interactions

Harvard University Cambridge, MA March 2004
A.M. Physics

Princeton University Princeton, NJ May 2000
A.B. Physics (*summa cum laude*) with certificate in Materials Science Engineering

Employment

IACS Endowed Chair for Ecology & Evolution 2019 –
Professor (Ecology & Evolution) 2020 –

Associate Professor (Ecology & Evolution) Stony Brook University 2016 – 2020
Joint Faculty of the Institute for Advanced Computational Science 2017 –

Affiliated Faculty of the Interdepartment Doctoral Program in Anthropological Sciences (2020 –)
Affiliated Faculty of the Institute for AI-Driven Discovery and Innovation (2018 –)
Affiliated Faculty in the Department of Applied Math and Statistics (2018 –)
Affiliated Faculty of the Institute for Advanced Computational Science (2014 –)
Affiliated Faculty of the School of Marine and Atmospheric Sciences (2013 –)

Data Science Advisor, ProPublica (2018 –)

Assistant Professor (Ecology & Evolution) Stony Brook University Aug. 2011 – 2016

Research Associate (Applied Math and Statistics) University of California, Santa Cruz Dec. 2010 – July 2011

Assistant Research Scientist (Biology) University of Maryland, College Park Feb. 2008 – July 2011
Senior Research Fellow Oceanites, Inc.

Postdoctoral Research Associate (Biology) University of Maryland, College Park Nov. 2006 – Feb. 2008

Grants & Awards

2021-2022: (PI) NASA SmallSat "Using spatial statistics to infer species identification in a deep-learning-based pan-Antarctic survey of pack-ice seals in Worldview imagery" ($137,098)

2021-2024: (PI) NASA Biodiversity "Identifying population tipping points through imagery super-resolution" ($728,339)

2020-2021: (PI) Stony Brook Office for the Vice President of Research Seed Award "Moving beyond mark-capture: Advanced Bayesian inference for inferring demographic rates from unmarked individuals" ($55,000)

2020-2023: (co-PI) NASA Interdisciplinary Research in Earth Sciences "Antarctic marine predators in a dynamic climate" (Total budget: 1,478,914; Stony Brook University budget $411,573)

2020-2023: (PI) NASA Interdisciplinary Research in Earth Sciences "Sea ice dynamics as driving mechanism for range expansion and colony establishment in gentoo penguins (*Pygoscelis papua*)" ($134,806)

2019-2020: (PI) Pew Foundation "Chinstrap status assessment, 2019-2020" ($48,200)

2019-2020: (co-PI) State University of New York Conversations in the Disciplines "Interpretable Artificial Intelligence: Across the Disciplines" ($2,600) (co-PIs: Jeffrey Heinz [Lead], Il Memming Park, Christian Luhmann, Stony Brook University)

2019: (PI) National Geographic AI for Earth "Coupling AI with predictive modeling for real-time tracking of Antarctic penguin populations" ($95,696) (co-PI: Dimitris Samaras, Stony Brook University)

2018: (PI) Alfred P. Sloan Foundation "The Ecological Forecasting Initiative: An Interdisciplinary Conference" ($50,000) (Additional PIs: Michael Dietze, Boston University)

2017-2020: (PI) NSF EarthCube "Collaborative Research: ICEBERG: Imagery Cyberinfrastructure and Extensible Building-Blocks to Enhance Research in the Geosciences" (Total budget: $1,815,860; Stony Brook University budget $632,179) (Lead PI: Heather Lynch; Additional PIs: Shantenu Jha [Rutgers], Vena Chu [UC Santa Barbara], Mark Salvatore [Northern Arizona University], Michael Willis [UC Boulder])

2016-2020: (co-PI) NSF NRT-DESE "Interdisciplinary Graduate Training to Understand and Inform Decision Processes Using Advanced Spatial Data Analysis and Visualization" ($2,993,930) (Lead PI: Robert Harrison; Additional PIs: Minghua Zhang, Arie E. Kaufman, Liliana Davalos Alvarez)

2015-2017: (PI) NSF EarthCube "Collaborative Research: Research Coordination Network for High-Performance Distributed Computing in the Polar Sciences" (Total budget $300,000; Stony Brook University budget $27,326) (Lead PI: Shantenu Jha [Rutgers]; Additional PIs: Lynn Yarmey [Colorado] and Jaroslaw Nabrzyski [Notre Dame])

2015-2016: (PI) Brookhaven National Lab/Stony Brook University SEED Grant 2015: "Three-dimensional structure and function for ecological monitoring using unmanned-aerial systems and computer vision" (Total budget $41,561; Stony Brook University budget $33,552) (Co-I: Shawn Serbin, Brookhaven National Lab)

2015-2018: (PI) NASA ROSES Program Element A.36 Earth Science Applications Phase II award (No. NNX14AC32G): "Bayesian Data-Model Synthesis for Biological Conservation in Antarctica" (Total budget $630,651; Stony Brook University budget $395,475) (Co-I: Mathew Schwaller NASA Goddard)

2014-2017: (PI) NSF Office of Polar Programs (No. 1341440): "Phytoplankton Phenology in the Antarctic: Drivers, Patterns, and Implications for the Adélie Penguin" (Collaborative proposal with Woods Hole Oceanographic Institution, University of Alaska Fairbanks, and the National Snow and Ice Data Center; Total budget $938,950; Stony Brook University budget $108,017)

2014-2016: (Collaborator) Dalio Explore Fund: The Danger Islands Expedition: A Multi-scale Study of Remote Penguin Supercolonies ($419,804)

2014: Block scholarship from the National Outdoor Leadership School to support four Ph.D. students taking a summer course in glacier mountaineering ($8,000)

2014: (PI) NASA ROSES Program Element A.36 Earth Science Applications Phase I award (No. NNX14AC32G): "Bayesian Data-Model Synthesis for Biological Conservation in Antarctica" (Total budget $170,605; Stony Brook University budget $113,120) (Co-I: Mathew Schwaller NASA Goddard)

2013-2018: (PI) NSF CAREER Award in Office of Polar Programs & Geography and Spatial Sciences (No. 1255058): "The use of quantitative geography to predict population tipping points for colonial seabirds" ($782,840)

2013: (PI) UK Foreign and Commonwealth Office British Antarctic Territory for "Improving estimates of penguin abundance and trends in the British Antarctic Territory for the benefit of conservation and fisheries management" ($41,317)

2012: Travel award to attend the 2012 Scientific Committee for Antarctic Research (SCAR) Open Science Conference in Portland, Oregon ($1,000)

2008-2013: (Co-PI) NSF Award in Office of Polar Programs (No. 0739515) for "Multispecies, Multiscale Investigations of Longterm Changes in Penguin and Seabird Populations on the Antarctic Peninsula" ($476,608)

2010: (PI) Mia J. Tegner Memorial Research Grant in Marine Environmental Sciences ($10,000)

Honors & Distinctions

2020 AAAS Leshner Leader Institute Public Engagement Fellow
2019 Blavatnik Laureate for Young Scientists in the category of Life Sciences, administered by the New York Academy of Sciences ($250,000 unrestricted prize)
2014 Ecological Society of America Early Career Fellow
2006 Certificate of Distinction in Teaching (Harvard University)
2005 Interdisciplinary Graduate Education and Research Training Fellow (Biomechanics)
2005 Howard T. Fisher Prize for Excellence in GIS
2000 American Physical Society Leroy Apker Award for "A Kondo Box: Coulomb Blockade and the Kondo Effect in Iron-doped Copper Nanoparticles" (awarded to the best undergraduate physics thesis from a Ph.D. granting institution in the United States)
2000 Allen Goodrich Shenstone Prize for outstanding work in experimental physics/Princeton University
2000 Lucent Technologies Graduate Research Program for Women Fellowship (accepted; 2000-2004)
2000 National Science Foundation Graduate Research Fellowship
2000 National Defense Science and Engineering Graduate Fellowship
2000 Phi Beta Kappa
2000 Sigma Xi

Press Coverage and Media Appearances

Film

- "The Penguin Counters" (2017)

Television

- Nature's Strangest Mysteries: Solved (Season 1, Episode 3) *Animal Planet* (May 18, 2019)
- BBC News interview (April 25, 2019)
- "Antarctic penguins have existed for 60 million years. Can they survive climate change?" *PBS Newshour* (April 3, 2019)
- CBS News interview (March 8, 2018)
- CTV News interview (March 5, 2018)
- "Counting penguins: What penguins in Antarctica might be telling us about climate change" *NBC's Sunday Night with Meghan Kelly* (June 25, 2017)

Online

- National Geographic Kids Book Quest (Summer 2021)
- Data Science Mixer Podcast (September 7, 2021)

Radio

- "Antarctica needs humans to protect it. It also need humans to stay away. What's a potential visitor to do?" *WPRI's The World* (June 11, 2018)
- "Should tourists go to Antarctica?" *WHYY's The Pulse* (February 22, 2018)
- *BBC5* radio interview (November 2, 2016)

Print (partial list; more complete list of links at www.lynchlab.com/press)

- An interview with Heather Lynch *Birding* (October 12, 2021)
- Why penguins may help us predict the impact of climate change *Financial Times* (February 27, 2020)
- Some Antarctic penguin colonies have declined by more than 75% in 50 years *CNN* (February 11, 2020)
- Chinstrap penguin numbers may have fallen by more than half on Antarctic island *National Geographic* (February 11, 2020)
- Climate change is decimating the chinstrap penguins of Antarctica *Time* (February 10, 2020)
- Alarm over collapse of chinstrap penguin numbers *The Guardian* (February 10, 2020)
- Penguins at risk in Antarctica *CBS Morning News* (January 16, 2020)
- Climate Change? "Meh," Say Gentoo Penguins *Scientific American* (July 25, 2019)
- Interview *New York Times* Kids section (April 28, 2019)
- "Holy Tuxedo! It's a Penguin-palooza!" *Discover Magazine* (December 2018) [Featured as one of the top science stories of 2018]
- "The Big Meltdown" *National Geographic* (November 2018) [Provided extensive scientific guidance for the story, as well as data used in the article's maps and graphics.]
- "Counting penguins isn't black and white" *Wall Street Journal* (November 3, 2018)
- "There's a penguin colony so large you can see it from space" *New York Post* (March 5, 2018)
- "A Supercolony of Penguins Has Been Found Near Antarctica" *New York Times* (March 5, 2018)
- "Secret Penguin Supercolony Discovered on Danger Islands" *Popular Mechanics* (March 3, 2018)
- "The Secret Is Out: Scientists Spot Penguin 'Super-Colony' in Antarctica" *Wall Street Journal* (March 3, 2018)
- "Penguin supercolony spotted from space" *BBC* (March 3, 2018)
- "Penguin City" *National Geographic Kids* (January 2017)
- "Antarctica's penguins could be decimated by climate change" *Washington Post* (June 30, 2016)

- "As Antarctic ice shrinks from climate change, will Adélie penguins disappear?" *Christian Science Monitor* (June 29, 2016)
- "Should tourists be banned from Antarctica?" *BBC News* (January 11, 2015)
- "One, Two, 3.79 million: How many penguins are there?" *Audubon Magazine* (August 21, 2014)
- "Adélie penguin census shows seabirds are thriving" *Wall Street Journal* (July 10, 2014)
- "Why some penguins thrive in climate change" *ABCNews* (July 7, 2014)
- "Emperor penguins may be moving due to climate change, study finds" *CBSNews* (June 24, 2014)
- "Breeding penguins vanishing from Antarctic island" *NBCNews* (September 4, 2012)
- "March of the tourists" *Mother Jones* (July/August 2008)

Expert Workshops & Working Groups

EarthCube Early Career Strategic Visioning Workshop (Carnegie Institution for Science, Washington, D.C., October 16-17, 2012)

Working Group (John Wesley Powell Center for Analysis and Synthesis, Fort Collins, CO, July 2012 – July 2014) / Topic: Modeling species response to environmental change: development of integrated, scalable Bayesian models of population persistence

Expert Workshop (National Socio-Environmental Synthesis Center, Annapolis, MD, July 2012) / Topic: Visualization Technologies to Support Research on Human - Environment Interactions

Expert Workshop (Galapagos Islands, June 2012) / Topic: Leveraging citizen science for conservation and management of the Galapagos Islands

Expert Workshop (Dessau, Germany, May 2012) / Topic: Census of penguins by remote sensing

Professional Service

Member of the IUCN Penguin Specialist Group (2020-)

Co-Organizer of the Ecological Forecasting Initiative 2019 Conference (May 13-15, 2019 in Washington, DC)

NASA Biological Diversity and Ecological Forecasting Working Group (2018-2020)

Organized Software Carpentry and HPC course for Polar 2018 Conference (Davos, Switzerland, June 16-18, 2018)

NASA Ames Research Center Non-Advocate Review Panel (2018)

Organized Software Carpentry course and Polar Science Hackathon (Stony Brook University, August 1-4, 2017)

Organized the Polar Science Hackathon at XSEDE17 (Miami, Florida, July 18-21, 2016)

Organized the Polar+Cyberinfrastructure Expert Workshop (Polar Geospatial Center, St. Paul, Minnesota, June 2-3, 2016)

Editorial Board for Scientific Reports (2016-2017)

Delegate for the Antarctic and Southern Ocean Coalition (ASOC) at the XXXVII Antarctic Treaty Consultative Meeting in Brasilia, Brazil (April 2014).

Faculty member, Population Ecology Section, Faculty of 1000 (2011-2015)

Book review consultant for the Quarterly Review of Biology (2011-2015)

Science and Operations Committee (2018- ongoing) of the University of Minnesota's Polar Geospatial Center (Committee Chair)
Science and Operations Committee (2011-2013) of the University of Minnesota's Polar Geospatial Center

Steering Group of the Commission for the Conservation of Antarctic Marine Living Resources' (CCAMLR) Krill Predator Workshop held June 16-20, 2008 in Hobart, Australia.

Reviewer for American Naturalist, Animal Conservation, Auk, Biological Conservation, Biodiversity and Conservation, CCAMLR Science, Diversity, Diversity and Distributions, Ecography, Ecological Applications, Ecology, Ecology & Evolution, Environmental Management, Global Change Biology, Journal of Field Ornithology, Landscape Ecology, Limnology and Oceanography, Marine Biodiversity Records, Marine Ecology Progress Series, Marine Policy, Methods in Ecology and Evolution, Nature Climate Change, PLoS ONE, Polar Biology, Polar Research, Population Ecology, Quarternary Science Reviews, Remote Sensing of Environment, and the Wilson Journal of Ornithology.

Proposal reviewer for the National Science Foundation's Office of Polar Programs in 2011, 2013, 2015, and 2018.

Proposal reviewer for the Deutsche Forschungsgemeinschaft (German Research Foundation) in 2013.

Proposal reviewer for the Einstein International Postdoctoral Fellowship for Junior Research groups (Germany) in 2019.

University Service

College of Arts and Sciences Departmental Self-Assessment Review Panel (Spring 2018)

Research Computing Committee (Spring 2018)

Ad hoc committee to streamline PTC processes (Spring 2018)

Streamlining Research Productivity (Procurement sub-committee) (Spring 2017)

AA/EEO Committee (Fall 2016)

Member of the Coordinating Committee for the School of Marine and Atmospheric Sciences' (SoMAS) M.A. in Marine and Conservation Policy (2013-2015).

Outreach, Public Lectures, and Community Service

Public presentation and panel discussion: National Geographic Explorer's Festival 2019 (June 11, 2019)

Judge for the North Fork TV Festival Script Competition (2019,2020)

Public lecture: "How many Adélie penguins are there? And other mysteries solved by satellites". Cary Institute for Ecosystem Studies (February 8, 2019)

Public lecture: "How many Adélie penguins are there? And other mysteries solved by satellites". Stony Brook University Library STEM Speaker Series (September 18, 2018)

Public lecture: "The who, how, what, and where of life as a penguin: How studying both captive and wild populations of penguins in redefining normal". Linnean Society of New York (April 11, 2017)

Public lecture: "Antarctic penguins: What we know, how we know it, and what the future might hold". Aquarium of the Pacific (March 17, 2015)

Panel member: "Exploring Antarctica". Bruce Museum, Greenwich, CT (January 11, 2015)

Public lecture: "Penguins on the move". Jefferson's Ferry Retirement Community (January 6, 2015)

Public lecture: "Vocal communication among gentoo penguins and its role in new colony formation". Kansas City Zoo (November 21, 2013)

Co-taught a workshop on "Grant Writing" for the Association of Polar Early Career Scientists (APECS) Bristol, UK (August 31, 2013)

Seminar for the Simons Fellows summer students, Stony Brook University (July 30, 2013 & July 15, 2014)

Keynote speaker: Student research symposium Bellport High School, Brookhaven, NY (June 4, 2013)

Co-organizer of Polar Climate Change Research: A Workshop for Educators, a 1 day workshop for middle and high school science educators on polar science and technology. Wang Center, Stony Brook University (April 11, 2012)

Public lecture: "Penguins: Sentinels of climate change". Stony Brook University Living World Lecture Series (March 23, 2012)

Teaching Experience

Biometry (BEE 552)	Spring 2012-2018, 2020-21
Statistics and Data Analysis (BIO 211)	Fall 2013
Graduate seminar (BEE 693)	Spring 2014
Bayesian Statistics and Data Analysis (BEE 569)	Fall 2014, 2017, 2020
Seminar of Decision support (MAR 534)	Spring 2020, 2021
Antarctica's Heroic Age of Exploration (SSO 102)	Spring 2017

Mentoring & Advising

Ph.D. students advised (13):

(1) Paula Casanovas (co-advised by Dr. William Fagan, graduated April 2013)
Title: "Novel approaches to studying biodiversity in remote areas: Distribution of lichens and penguins across the Antarctic Peninsula"

(2) Philip McDowall (graduated May 2018)
Title: "Spatial dynamics of *Pygoscelis* penguin coloniality"
(3) Casey Youngflesh (graduated December 2018)
Title: "Ecological change in the Southern Ocean – Insights from Antarctic seabirds"
(4) Catherine Foley (graduated May 2019)
Title: "Long-term human impacts on sub-Antarctic ecosystems and mesopredator abundance"
(5) Maureen Lynch (graduated May 2019)
Title: "Gentoo penguin behavioral ecology: Vocalizations, aggression, and stress within the colony"
(6) Michael Schrimpf (graduated May 2020)
Title: "The distribution and community ecology of breeding birds on the Antarctic Peninsula"
(7) Alex Borowicz (co-advised by Dr. Lesley Thorne; graduated May 2021)
Title: "Eco-social and remote sensing: Applications across a new era of ecological data"
(8) Bento Goncalves
(9) Rachael Herman
(10) Emma Talis (Applied Math and Statistics)
(11) Michael Wethington
(12) Kate Blackwell
(13) Carole Hall (Applied Math and Statistics)
(14) Clare Flynn

M.S. students advised (1):
(1) Noah Strycker (SoMAS; graduated 2021)

Ph.D. student committees (24):
(1) Michael McCann (E&E; graduated 2015)
(2) Antonin Machac (E&E; graduated 2015)
(3) Emily Rollinson (E&E; graduated 2016)
(4) Benjamin Weinstein (E&E; graduated 2016)
(5) Cecilia O'Leary (SoMAS; graduated 2018)
(6) Sam Urmy (SoMAS; graduated 2017)
(7) Jesse Wolfhagan (Anthropological Sciences; graduated 2019)
(8) Bilgecan Sen (E&E; graduated 2020)
(9) Yousef El-Laham (Electrical and Computer Engineering; graduated 2021)
(10) Lisa Prowant (E&E; graduated 2021)
(11) Kristjan Mets (E&E)
(12) Jannet Vu (E&E)
(13) Julia Stepanuk (E&E)
(14) Kenneth Davidson (E&E)
(15) Anna Thonis (E&E)
(16) Ayman Al-Saadi (Rutgers Electrical and Computer Engineering)
(17) John Winans (Anthropological Sciences)
(18) Ariek Norford (E&E)
(19) Yijie Tian (E&E)
(20) Kayley Abell-Hart (Biomedical Informatics)
(21) Jacob Feder (Anthropological Sciences)
(22) Zahraa Krayem (Electrical and Computer Engineering)
(23) Kayley Abell-Hart (Biomedical Informatics)
(24) Kim Lato (SoMAS)

Additional thesis committees: Breann Ross (Hofstra University; MS thesis committee), Ayman Al-Saadi (Rutgers University; MS thesis committee)

Ecology & Evolution M.A. students advised (4)

High school students advised (7):
(1) Ryan Burke (Earl L. Vandermeulen High School; attended Brown University) Summer 2013: "Using camera trap methods to study the reproductive success of penguins"
(2) Will Engellenner (Smithtown East High School; attended Northwestern University) Summer 2013: "A 15-year longitudinal study of the impact of marine ecotourism on Antarctic penguin populations"
(3) Caroline Biondo (Earl L. Vandermeulen High School; attended the University of Virginia) Summer 2014: "Are stone stealing dynamics in a penguin colony consistent with predictions from game theory?"
(4) Erin Burke (Earl L. Vandermeulen High School; attended Claremont McKenna College) Summer 2016: "Seabird life-history trade-offs and climate change resilience"
(5) Reid Biondo (Earl L. Vandermeulen High School; currently attending the University of Virginia) Summer 2016 and 2017: "King- penguin population dynamics"
(6) Andrea Dahl (Olathe North, Kansas City; currently attending Stanford University) Summer 2016: "Behavioral acoustics of gentoo penguins in captivity"
(7) Sandeepna Eranki (Smithtown East High School; currently attending Carnegie Mellon University) Summer 2018: "Egg laying contagion among Gentoo penguins"

Additional Academic Experience/Training

2014: National Socio-Environmental Synthesis Center (SESYNC) Summer Computational Institute

2006: Summer Institute at Duke University's Center on Global Change: Uncertainty and Variability in Ecological Inference, Forecasting, and Decision Making

2005: ENR-423: Regional Ecosystem Management: Science, Policy and Law
- Seminar course taught by William Clark and Jody Freeman at the J.F.K. School of Public Policy

2005: Park City Mathematics Institute graduate summer school in Mathematical Biology

Publications & Lectures

★ Indicates a Ph.D. student under my supervision, ✖ Indicates a postdoc or staff researcher under my supervision at the time of the research

In Prep/Review

★Borowicz, A., **H.J. Lynch**, R. Naveen, and L. Thorne. Spatial & temporal use patterns of Antarctic fur seals (*Arctocephalus gazella*) on the Antarctic Peninsula. *In prep.*

El-Laham, Y., M. Bugallo, and **H.J. Lynch**. Bayesian learning of structured demographic rates. *In review.*

★Schrimpf, M. and **H.J. Lynch**. Influence of stochastic and deterministic factors on metacommunity patterns in site-faithful avian breeding assemblages. *In prep.*

Lee, J. R., A. Terauds, J. Carwardine, J. D. Shaw, R. A. Fuller, H. P. Possingham, S. L. Chown, P. Convey, N. Gilbert, K. A. Hughes, E. McIvor, S. Robinson, Y. Ropert-Coudert, D. Bergstrom, E. M. Biersma, C. Christian, D. Cowan, Y. Frenot, S. Jenouvrier, L. Kelley, M. J. Lee, **H. Lynch**, B. Njastad, P. Ortuzar, R. Roura, E. A. Shaw, D. Stanwell-Smith, M. Tsujimoto, A. Quesada, D. H. Wall, A. Wilmotte, I. Chadès. Threat management priorities for conserving Antarctic biodiversity. *In review*.

★Herman, R., and **H.J. Lynch**. Extended early immigration is key for colony establishment in a site-faithful seabird. *In review at Ornithological Applications*.

★Talis, Emma, C. Che-Castaldo, and **H.J. Lynch**. A cautionary tale for the log-normal distribution: The search for self-consistent abundance estimates when summing across multiple spatial scales. *In prep*.

Refereed Journals

(83) Le, H., D. Samaras, and **H.J. Lynch**. 2021. A convolutional neural network architecture designed for the automated survey of seabird colonies. *In press at Remote Sensing of Ecology & Conservation*.

(82) ★Goncalves, B.G. and **H.J. Lynch**. 2021. Fine-scale sea ice extraction for high-resolution satellite imagery with weakly-supervised CNNs. *In press at Journal of Remote Sensing*.

(81) ★Youngflesh, C., Y. Li, **H.J. Lynch**, K. Delord, C. Barbraud, R. Ji, and S. Jenouvrier. 2021. Lack of synchronized breeding success in a seabird community: extreme events, niche separation, and environmental variability. *In press at Oikos*.

(80) Al-Saadi, A., I. Paraskevakos, B.C. Goncalves, **H.J. Lynch**, S. Jha, and M. Turilli. 2021. Comparing workflow application designs for high resolution satellite image analysis. *Future Generation Computer Systems* 124: 315-329.

(79) Pertierra, L.R., F. Santos-Martin, K.A. Hughes, C. Avila, J.O. Caceres, D. De Filippo, S. Gonzalez, S. Grant, **H. Lynch**, C. Marina-Montes, A. Quesada, P. Tejedo, T. Tin, J. Benayas. 2021. Ecosystems services in Antarctica: Global assessment of the current state, future challenges and managing opportunities. *Ecosystem Services* 49: 101299.

(78) ★Borowicz, A., **H.J. Lynch**, T. Estro, ★C. Foley, ★B. Goncalves, K. Herman, S.K. Adamczak, and L. Thorne. 2021. Social sensors for wildlife: Ecological opportunities in the era of camera ubiquity. *Frontiers in Marine Science* 8: 385.

(77) ★Schrimpf, M., and **H.J. Lynch**. 2021. The role of wind fetch in structuring Antarctic seabird breeding occupancy. *Ibis* 163(2): 695-705.

(76) Handley, J., M.-M. Rouyer, L. Pearmain, V. Warwick-Evans, K. Teschke, J. Hinke, **H. Lynch**, L. Emmerson, C. Southwell, G. Griffith, A. Franco, P. Trathan, M. P. Dias. 2021. Marine Important Bird and Biodiversity Areas for penguins in Antarctica, proxies for conservation action. *Frontiers in Marine Science* 7: 1190.

(75) ★Strycker, N., ★A. Borowicz, ★M. Wethington, S. Forrest, V. Shah, Y. Liu, H. Singh, **H. J. Lynch**. 2021. Fifty-year change in penguin abundance on Elephant Island, South Shetland Islands, Antarctica: Results of the 2019-20 census. *Polar Biology* 44(1): 1-12.

(74) ★Strycker, N., ★M. Wethington, ★A. Borowicz, S. Forrest, ⚑C. Witharana, T. Hart, **H. J. Lynch**. 2020. A global population assessment of the Chinstrap penguin (*Pygoscelis antarctica*). *Scientific Reports* 10: 19474.

(73) ★Herman, R., ★A. Borowicz, ★M. Lynch, P. Trathan, and **H.J. Lynch**. 2020. Update on the global abundance and distribution of Gentoo Penguins (*Pygoscelis papua*). *Polar Biology* 43: 1947-1956.

(72) ★Borowicz, A., S. Forrest, ★N. Strycker, ★M. Wethington, **H. J. Lynch**. 2020. Presence of king penguins (*Aptenodytes patagonicus*) on Elephant Island provides further evidence of range expansion. *Polar Biology* 43: 2117-2120.

(71) ★Youngflesh, C., F.M. Jones, **H.J. Lynch**, J. Arthur, Z. Rockaiova, H. Torsey, and T. Hart. 2020. Large-scale assessment of intra- and inter-annual breeding success using a remote camera network. *Remote Sensing in Ecology and Conservation* 7(1): 97-108.

(70) Iles, D.A., **H.J. Lynch**, R. Ji, C. Barbraud, K. Delord, and S. Jenouvrier. 2020. Sea ice predicts long-term trends in Adélie penguin population growth, but not annual fluctuations: results from a range-wide multi-scale analysis. *Global Change Biology* 26: 3788-3798.

(69) ★Foley, C.M., W.F. Fagan, and **H.J. Lynch**. 2020. Correcting for within-season demographic turnover to estimate the island-wide population of King Penguins (*Aptenodytes patagonicus*) on South Georgia. *Polar Biology* 43: 251-262.

(68) ★Goncalves, B., ⚑B. Spitzbart, and **H.J. Lynch**. 2020. SealNet: A fully automated pack-ice seal detection pipeline for sub-meter satellite imagery. *Remote Sensing of Environment* 239: 111617.

(67) ★Foley, C.M. and **H.J. Lynch**. 2020. Estimating the pre-exploitation population size of a historically harvested marine mammal. *Conservation Biology* 34(1): 256-265.

(66) ★Schrimpf, M., ⚑C. Che-Castaldo, and **H.J. Lynch**. 2020. Regional breeding bird assessment of the Antarctic Peninsula. *In press at Polar Biology*. https://doi.org/10.1007/s00300-019-02613-1

(65) ★Borowicz, A., ★H. Le, G. Humphries, G. Nehls, C. Höschle, V. Kosarev, and **H.J. Lynch**. 2019. Aerial-trained deep learning networks for surveying cetaceans from satellite imagery. *PLoS ONE* 14(10): e0212532.

(64)★McDowall, P., and **H.J. Lynch**. 2019. When the "selfish herd" becomes the "frozen herd": Spatial dynamics and population persistence in a colonial seabird. *Ecology* 100(10): c02823.

(63)★Lynch, M.A., ★C. Youngflesh, N.H. Agha, M.A. Ottinger, and **H.J. Lynch**. 2019. Tourism and stress hormone measures in Gentoo Penguins on the Antarctic Peninsula. *Polar Biology* 42: 1299-1306.

(62)⚑Humphries, G.R.W., ⚑C. Che-Castaldo, P. J. Bull, G. Lipstein, A. Ravia, B. Carrión, T. Bolton, A. Ganguly, **H. J. Lynch**. 2018. Predicting the future is hard and other lessons from a population time series data science competition. *Ecological Informatics* 48: 1-11.

(61) Schwaller, M.R., **H.J. Lynch**, A. Tarroux, and B. Prehn. 2018. A continent-wide search for Antarctic petrel breeding sites with satellite remote sensing. *Remote Sensing of Environment* 210: 444-451.

(60) ★Borowicz, A., ★P. McDowall, ★C. Youngflesh, T. Sayre-McCord, G. Clucas, ★R. Herman, S. Forrest, M. Rider, M. Schwaller, T. Hart, S. Jenouvrier, M.J. Polito, H. Singh, and **H.J. Lynch**. 2018. Multi-modal survey of Adélie penguin mega-colonies reveals the Danger Islands as a seabird hotspot. *Scientific Reports* 3926. [#59 for Altmetric's Top 100 Stories for 2018]

(59) ★Foley, C.M., T. Hart, and **H.J. Lynch**. 2018. King penguin populations increase on South Georgia but explanations remain elusive. *Polar Biology* 41(6): 1111-1122.

(58) ★Schrimpf, M., R. Naveen, and **H.J. Lynch**. 2018. Population status of the Antarctic Shag (*Phalacrocorax [atriceps] bransfieldensis*). *Antarctic Science* 30(3): 151-159.

(57) ★Youngflesh, C., S. Jenouvrier, J.T. Hinke, L. DuBois, J. St. Leger, W.Z. Trivelpiece, S.G. Trivelpiece, and **H.J. Lynch**. 2018. Rethinking 'normal': The role of stochasticity in the phenology of a synchronously breeding seabird. *Journal of Animal Ecology* 87(3): 682-690.

(56) ✖Che-Castaldo, C., S. Jenouvrier, ★C. Youngflesh, K. Shoemaker, ✖G. Humphries, ★P. McDowall, L. Landrum, M. Holland, Y. Li, R. Ji, **H.J. Lynch**. 2017. Pan-Antarctic analysis aggregating spatial estimates of Adélie penguin abundance reveals robust dynamics despite stochastic noise. *Nature Communications* 8: 832.

(55) ★Lynch, M.A., and **H.J. Lynch**. 2017. Variation in the ecstatic display call of the Gentoo Penguin (*Pygoscelis papua*) across regional geographic scales. *Auk* 134(4): 894-902.

(54) ★McDowall, P., and **H.J. Lynch**. 2017. The importance of topographically correct null models for analyzing ecological point processes. *Ecology* 98: 1764-1770.

(53) Chown, S.L., M.A. McGeoch, A. Terauds, C. Le Bohec, C. van Klaveren-Impagliazzo, J. Whittington, C. Brooks, S. Butchart, B.W.T Coetzee, B. Collen, P. Convey, K.J. Gaston, N. Gilbert, M. Gill, R. Höft, S. Johnston, M.C. Kennicutt II, H. Kriesell, Y. Le Maho, **H.J. Lynch**, M. Palomares, R. Puig-Marcó, P. Stoett. 2017. Antarctica and the Strategic Plan for Biodiversity 2011–2020. *PLoS Biology* 15(3): e2001656.

(52) ✖Humphries G.R.W., ✖C. Che-Castaldo, R. Naveen, M. Schwaller, ★P. McDowall, ★M Schrimpf, **H.J. Lynch**. 2017. Mapping Application for Penguin Populations and Projected Dynamics (MAPPPD): Data and tools for dynamic management and decision support. *Polar Record* 53(2): 160-166.

(51) ★Foley, C., ★M. Lynch, L. H. Thorne, and **H.J. Lynch**. 2017. Listing foreign species under the Endangered Species Act: A Primer for Conservation Biologists? *BioScience* 67(7): 627-637.

(50) ★Youngflesh, C., S. Jenouvrier, Y. Li, R. Ji, D. G. Ainley, G. Ballard, C. Barbraud, K. Delord, K. M. Dugger, L. M. Emmerson, W. R. Fraser, J. T. Hinke, P. O'B. Lyver, S. Olmastroni, C. J. Southwell, S. G. Trivelpiece, W. Z. Trivelpiece, **H. J. Lynch**. 2017. Circumpolar analysis of the Adélie Penguin reveals the importance of environmental variability in phenological mismatch. *Ecology* 98(4): 940-951.

(49) ★McDowall, P., and **H.J. Lynch**. 2017. Ultra-fine spatially-integrated mapping of habitat and occupancy using Structure-from-Motion. *PLoS ONE* 12(1): e0166773.

(48) ★Lynch, M., ★C. Foley, L. H. Thorne, and **H. J. Lynch**. 2016. Improving the use of biological data in Antarctic management. *Antarctic Science* 28(6): 425-431.

(47) Cimino, M.A., **H. J. Lynch**, V.S. Saba, and M.J. Oliver. 2016. Asymmetric response of Adélie penguins to Antarctic climate change. *Scientific Reports* 6:28785.

(46) ✖Witharana, C., and **H.J. Lynch**. 2016. An object-based image analysis approach for detecting penguin guano from very high spatial resolution satellite images. *Remote Sensing* 8(5): 375.

(45) **Lynch, H.J.**, R. White, R. Naveen, A.D. Black, M.S. Meixler, and W.F. Fagan. 2016. In stark contrast to widespread declines along the Scotia Arc, a survey of the South Sandwich Islands finds a robust seabird community. *Polar Biology* 39: 1615-1625.

(44) ✖Witharana, C., M.A. LaRue, and **H.J. Lynch**. 2016. Benchmarking of data fusion algorithms in support of earth observation based Antarctic wildlife monitoring. *ISPRS Journal of Photogrammetry and Remote Sensing* 113: 124-143.

(43) Levy, H., G. Clucas, A. Rogers, A.D. Leaché, K. Ciborowski, M. Polito, **H.J. Lynch**, M. Dunn, and T. Hart. 2016. Population structure and phylogeography of the Gentoo Penguin (*Pygoscelis papua*) across the Scotia Arc. *Ecology and Evolution* 6(6): 1834-1853.

(42) ★Bender, N., K. Crosbie, and **H.J. Lynch**. 2016. Spatial patterns of tour ship traffic in the Antarctic Peninsula region: A twenty-year re-analysis. *Antarctic Science* 28(3): 194-203.

(41) Trathan, P.N., **H.J. Lynch**, and W. Fraser. 2015. Changes in penguin distribution over the Antarctic Peninsula and Scotia Arc. Emerging Issues summary for the Antarctic Environments Portal [Peer reviewed, online only].

(40) ★Casanovas, P.V., R. Naveen, S. Forrest, J. Poncet, **H.J. Lynch**. 2015. A comprehensive coastal seabird survey maps out the front lines of ecological change on the Western Antarctic Peninsula. *Polar Biology* 38:927-940.

(39) LaRue, M., G. Kooyman, **H.J. Lynch**, and P. Fretwell. 2015. Emigration in emperor penguins: Implications for interpretation of long-term studies. *Ecography* 38:114-120.

(38) Trathan, P. N., P. García-Borboroglu, D. Boersma, C.-A. Bost, R. J. M. Crawford, G. T. Crossin, R. J. Cuthbert, P. Dann, L. S. Davis, S. De la Puente, U. Ellenberg, **H.J. Lynch**, T. Mattern, K. Pütz, P. J. Seddon, W. Trivelpiece, B. Wienecke. 2015. Pollution, habitat loss, fishing, and climate change as critical threats to penguins. *Conservation Biology* 29(1): 31-41.

(37) **Lynch, H. J.**, and M.R. Schwaller. 2014. Multi-sensor cross validation of Adélie penguin detection and abundance estimation. *PLoS ONE* 9(11): e113301.

(36) **Lynch, H.J.**, J. Thorson, O. Shelton. 2014. Dealing with under- and over-dispersed count data in life history, spatial, and community ecology. *Ecology* 95(11): 3173-3180.

(35) **Lynch, H.J.**, and M.A. LaRue. 2014. First global survey of Adélie penguin populations. *The Auk* 131(4): 457-466.

(34) ★Casanovas, P.V., **H.J. Lynch**, and W.F. Fagan. 2014. Using citizen science to estimate lichen diversity. *Biological Conservation* 171: 1-8.

(33) LaRue, M.A., **H.J. Lynch**, P. Lyver, K. Barton, D.G. Ainley, A.M. Pollard, W. Fraser, G. Ballard. 2014. Establishing a method to estimate Adélie penguin populations using remotely-sensed imagery. *Polar Biology* 37: 507-517.

(32) Zipkin. E.F., J.T. Thorson, K. See, **H. J. Lynch**, E.H.C. Grant, Y. Kanno, R.B. Chandler, B.H. Letcher, J.A. Royle. 2014. Modeling structured population dynamics using data from unmarked individuals. *Ecology* 95: 22-29.

(31) **Lynch, H.J.**, M. Rhainds, J. Calabrese, S. Cantrell, C. Cosner, and W.F. Fagan. 2014. How climate extremes - not means - define a species' geographic range boundary via a demographic tipping point. *Ecological Monographs* 84:131-149.

(30) **Lynch, H.J.**, R. Naveen, ★P.V. Casanovas. 2013. Antarctic Site Inventory breeding bird survey data 1994/95-2012/13. *Ecology (Data Paper)* 94(11): 2653.

(29) Fagan, W.F., Y. Pearson, E.A. Larsen, **H.J. Lynch**, J. Turner, H. Staver, A. Noble, S. Bewick, and E.E. Goldberg. 2013. Phylogenetic prediction of the maximum *per capita* rate of population growth. *Proceedings of the Royal Society B* 280: 20130523.

(28) ★Casanovas, P., **H.J. Lynch**, R. Naveen, and W.F. Fagan. 2013. Understanding lichen diversity on the Antarctic Peninsula using parataxonomic units as a surrogate for species richness. *Ecology (Data Paper)* 94(9): 2110-2110.

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(24) Brasso, R.L., M.J. Polito, **H.J. Lynch**, R. Naveen, and S.D. Emslie. 2012. Penguin eggshell membranes reflect homogeneity of mercury in the marine food web surrounding the Antarctic Peninsula. *Total Science of the Environment* 439: 165-171.

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(22) Grant, E.H.C., **H.J. Lynch**, R. Muneepeerakul, M. Arunachalam, I. Rodriguez-Iturbe, and W.F. Fagan. 2012. Interbasin water transfer, riverine connectivity, and spatial controls on fish biodiversity. *PLoS ONE* 7(3): e34170.

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Popular Writing and Published Correspondence

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Dietze, M., and **H.J. Lynch**. 2019. Forecasting a bright future for ecology. Guest editorial for Frontiers in Ecology and the Environment 17(1): 3.

★Youngflesh, C., and **H.J. Lynch**. 2017. Black-swan events: Population crashes or temporary emigration? *PNAS* https://doi.org/10.1073/pnas.1713621114.

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Refereed Conference Proceedings

El-Laham, Y., L. Yang, **H. Lynch**, P. Djuric, and M. Bugallo. 2020. Particle Gibbs sampling for regime-switching state-space models. ICASSP 2021 - 2021 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP).

Liu, Y., V. Shah, ★A. Borowicz, ★M. Wethington, ★N. Strycker, S. Forrest, **H. Lynch** and H. Singh. 2020. Efficient UAV and machine learning based method in penguin colony census. IEEE/OES Autonomous Underwater Vehicle Symposium, Sept. 2020.

Spitzbart, B., **H.J. Lynch**, M. Turilli, and S. Jha. 2020. ICEBERG: Imagery Cyber-infrastructure and Extensible Building blocks to Enhance Research in the Geosciences. (A Research Programmer's Perspective). PEARC 2020 Conference.

Paraskevakos, I., M. Turrili, B. C. Goncalves, **H.J. Lynch**, and S. Jha. 2019. Workflow design analysis for high resolution satellite image analysis. *IEEE e-Science Conference.*

Le, H., ★B. Goncalves, D. Samaras, and **H.J. Lynch**. 2019. Weakly labeling the Antarctic: The penguin colony case. 2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW).

Wyngaard, J., **H. Lynch**, J. Nabrzyski, A. Pope and S. Jha. 2017. Hacking at the Divide Between Polar Science and HPC: Using Hackathons as Training Tools. Pages 352-359 in 2017 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW), Lake Buena Vista, FL.

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Papers written on behalf of the United States and other countries for Antarctic Treaty Consultative Meetings

Naveen, R., and **H.J. Lynch**. 2016. Report of Oceanites, Inc., Information Paper submitted by SCAR to the XXXIX Antarctic Treaty Consultative Meeting in Santiago, Chile.

Naveen, R., ★N. Bender, and **H. Lynch**. 2016. Patterns of tourism in the Antarctic Peninsula region: A 20-year re-analysis., Information Paper submitted by the United States and IAATO to the XXXIX Antarctic Treaty Consultative Meeting in Santiago, Chile.

Naveen, R., ★C. Foley, and **H. Lynch**. 2015. A methodology to assess site sensitivity at visitor sites: Progress report, Information Paper submitted by Australia, New Zealand, Norway, the United Kingdom, and the United States to the XXXVIII Antarctic Treaty Consultative Meeting in Sofia, Bulgaria.

Naveen, R., and **H. Lynch**. 2015. Antarctic Site Inventory: Results from long-term monitoring, Information Paper submitted by New Zealand and the United States to the XXXVIII Antarctic Treaty Consultative Meeting in Sofia, Bulgaria.

Naveen, R., ★C. Foley, and **H. Lynch**. 2014. Developing a new methodology to analyze site sensitivities, Information Paper submitted by the United States to the XXXVII Antarctic Treaty Consultative Meeting in Brasilia, Brazil.

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Naveen, R., and **H. Lynch**. 2012. First direct, site-wide penguin survey at Deception Island, Antarctica suggests significant declines in breeding chinstrap penguins, Information Paper submitted by the United States to the XXXV Antarctic Treaty Consultative Meeting in Hobart, Australia.

Naveen, R., **H.J. Lynch**, and W. Fagan. 2011. Antarctic Site Inventory: 1994-2011, Information Paper submitted by the United States to the XXXIV Antarctic Treaty Consultative Meeting in Buenos Aires, Argentina.

Lynch, H.J., K. Crosbie, W.F. Fagan, R. Naveen. 2010. Spatial patterns of tour ship traffic in the Antarctic Peninsula region, Information Paper submitted by the United States to the XXXIII Antarctic Treaty Consultative Meeting in Punta del Este, Uruguay.

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Naveen, R., **H.J. Lynch**, and W. Fagan. 2009. Monitoring and assessment using hierarchical Bayesian modeling: An approach taken by the Antarctic Site Inventory, Information Paper submitted by the United States to the XXXII Antarctic Treaty Consultative Meeting in Baltimore, Maryland.

Naveen, R., **H.J. Lynch**, and W. Fagan. 2008. Antarctic Site Inventory: 1994-2008, Information Paper submitted by the United States to the XXXI Antarctic Treaty Consultative Meeting in Kiev, Ukraine.

Papers written for the Commission for the Conservation of Antarctic Marine Living Resources' Working Group on Ecosystem Monitoring and Management (CCAMLR WG-EMM)

★Strycker, N., ★M. Wethington, ★A. Borowicz, S. Forrest, T. Hart, and **H.J. Lynch**. 2020. Towards an updated chinstrap penguin population assessment. CCAMLR-IXXXX.

Naveen, R., G. Humphries, and **H.J. Lynch**. 2016. Mapping Application for Penguin Populations and Projected Dynamics (MAPPPD). CCAMLR-XXXV/BG/15.

Naveen, R., G. Humphries, and **H.J. Lynch**. 2016. Report to CCAMLR by Oceanites, Inc. CCAMLR-XXXV/BG/16.

Lynch, H.J., and M.A. LaRue. 2014. First global survey of Adélie penguin populations. CCAMLR WG-EMM-14/P05.

Lynch, H.J., and M. Schwaller. 2013. Bayesian data-model synthesis for biological conservation and management in Antarctica. CCAMLR WG-EMM-13/26.

Lynch, H.J., N. Ratcliffe, J. Passmore, E. Foster, and P.N. Trathan. 2012. Sensitivity analysis identifies high influence sites for estimates of penguin krill consumption on the Antarctic Peninsula. CCAMLR WG-EMM-12/P02.

Trathan, P.N., **H. Lynch**, C. Southwell, P.T. Fretwell, G. Watters, and N. Ratcliffe. 2012. Extending ecological monitoring to underpin the development of feedback management approaches for the Antarctic krill fishery. CCAMLR WG-EMM-12/04.

Southwell, C., J. Forcada, M. Goebel, J. Hinke, **H. Lynch**, P. Lyver, J. McKinlay, N. Ratcliffe, D. Ramm, K. Reid, C. Reiss, W. Trivelpiece, S. Trivelpiece, and P. Trathan. 2009. Update on progress in inter-sessional work from the Predator Survey workshop. CCAMLR WG-EMM-09/39.

Trivelpiece, S., W. Trivelpiece, **H. Lynch**, D. Ramm, J. McKinlay, R. Naveen, P. Trathan, and C. Southwell. 2008. Preliminary estimation of penguin breeding abundance at spatial scales of relevance to CCAMLR: Incorporating uncertainty in count data. CCAMLR WG-EMM-08/53.

Trivelpiece, S.G., W.F. Fagan, **H. J. Lynch**, W.Z. Trivelpiece, and R. Naveen. 2008. Timing of clutch initiation in Pygoscelis penguins on the Antarctic Peninsula: Towards an improved understanding of off-peak census correction factors. WG-EMM-PSW-08/15.

Invited Talks & Department Seminars

H.J. Lynch. 2021. "How many Adélie penguins are there? (and other mysteries solved by satellites)". Harvard University (February 8, 2021)

H.J. Lynch. 2020. "How many Adélie penguins are there? (and other mysteries solved by satellites)". University of Liverpool (UK) (November 10, 2020)

H.J. Lynch. 2019. "Adventures in mathematical biology inspired by a bird's eye view of penguin colonies in Antarctica". Mathematical Biology Seminar, University of Utah (March 27, 2019)

H.J. Lynch. 2019. "How many Adélie penguins are there? (and other mysteries solved by satellites)". Department of Ecology, Evolution, and Natural Resources Seminar, Rutgers University (March 7, 2019)

H.J. Lynch. 2017. "How many Adélie penguins are there? (and other mysteries solved by satellites)". Department of Natural Resources and the Environment Seminar, University of Connecticut (September 12, 2017)

H.J. Lynch. 2017. "Spatiotemporal dynamics of Antarctic penguin populations". NASA Icesat2 Team (May 22, 2017)

H.J. Lynch. 2016. "Spatiotemporal dynamics of Antarctic penguin populations". Department of Biology Seminar, Hofstra University (March 18, 2016).

H.J. Lynch. 2015. "Spatial ecology in the era of high-resolution satellite imagery: Linking pattern and process to understand population tipping points for Antarctic penguins". Ecology & Evolutionary Biology Colloquium, University of California, Santa Cruz (February 18, 2015).

H.J. Lynch. 2014. "Spatial ecology in the era of high-resolution satellite imagery: Linking pattern and process to understand population tipping points for Antarctic penguins". Ecology, Evolution, & Environmental Biology Colloquium, Columbia University (September 9, 2014).

H.J. Lynch. 2014. "Data fusion modelling approaches for tracking Adélie penguin abundance, distribution, and demography". Morss Colloquium, Woods Hole Oceanographic Institute (May 5, 2014).

H.J. Lynch. 2013. "How many Adélie penguins are there? (and other mysteries solved by satellites)". Stony Brook Southampton Lecture Series 2013 (November 1, 2013).

H.J. Lynch. 2013. "Thinking big and thinking small: How satellites are revolutionizing penguin ecology". Biology Department seminar at Woods Hole Oceanographic Institute.

H.J. Lynch. 2013. "A sea change in seabird research: How emerging geospatial technologies are radically changing the study of spatial ecology in the Antarctic". Departmental seminar at the University of Massachusetts, Amherst.

H.J. Lynch. 2013. "Climate change winners and losers: Penguin population dynamics on the Antarctic Peninsula". Departmental seminar at the School of Marine and Atmospheric Sciences, Stony Brook University.

H.J. Lynch. 2012. "Automated classification of Antarctic penguin colonies in satellite imagery". Social-Environmental Synthesis Center Workshop on Data Visualization, Annapolis, MD.

H.J. Lynch. 2010. "Climate change winners and losers: Penguin population dynamics on the Antarctic Peninsula". Departmental seminar at the University of Maryland, College Park.

H.J. Lynch. 2010. "Climate change winners and losers: Penguin population dynamics on the Antarctic Peninsula". Seminar at the University of California, Santa Cruz.

H.J. Lynch, E.H.C. Grant, R. Muneepeerakul, I. Rodriguez-Iturbe, and W.F. Fagan. 2009. "India's Inter Basin Water Transfer project: The impact of network manipulation on freshwater fish communities". Organized Oral Session 16-7 of ESA Annual Conference 2009.

H.J. Lynch. 2005. "Spatiotemporal dynamics of insect-fire interactions". Seminar at the University of Colorado, Boulder.

H. Lynch. 2001. "A Kondo box: Coulomb blockade and the Kondo effect in iron-doped copper nanoparticles". Invited Talk in Session J1 of APS March Meeting 2001.

Contributed Talks

★C. Foley and **H.J. Lynch**. 2018. "Estimating the pre-exploitation population size of Antarctic fur seals (Arctocephalus gazella) in South Georgia." Population dynamics and regulation session at Ecological Society of America Annual Meeting 2018.

★B. Goncalves, **H.J. Lynch**. 2018. "Monitoring pack-ice seals from space with deep learning." Using satellite imagery to study wildlife ecology in polar regions session at the Scientific Committee on Antarctic Research Biennial Meeting 2018.

★C. Youngflesh, S. Jenouvrier, **H.J. Lynch**. 2018. "Divergent trends, unsynchronized community dynamics and extreme years – the challenge in finding effective ecological proxies." Population dynamics and regulation session at Ecological Society of America Annual Meeting.

★C. Youngflesh, S. Jenouvrier, **H.J. Lynch**. 2018. "Divergent trends and unsynchronized dynamics – the challenge in finding effective ecological proxies." Life distribution and responses to environmental changes in Polar ecosystems session at the Scientific Committee on Antarctic Research Biennial Meeting 2018.

★M. A. Lynch, ★C. Youngflesh, N. Agha, M. A. Ottinger and **H. J. Lynch**. 2018. "Variation in hormonal stress levels in gentoo penguins (Pygoscelis papua) in relation to tourist visitation on the Antarctic Peninsula". Physiology I Contributed Oral Session of the Ecological Society of America Annual Meeting 2018.

✖C. Che-Castaldo, **H.J. Lynch**, ★C. Youngflesh, and M.R. Schwaller. 2018. "Range-wide Adelie penguin abundance from 30 years of Landsat satellite imagery". Satellite-based Remote Sensing of Wildlife Session of the Scientific Committee on Antarctic Research Biennial Meeting 2018.

H.J. Lynch. 2018. "Real-time population forecasts for Antarctic management". Ecological Society of America Annual Conference 2018.

★P. McDowall and **H.J. Lynch**. 2014. "High-resolution terrestrial habitat models for *Pygoscelis* Penguins". Diversity and Connectivity in Antarctica & Spatial Analysis of Antarctic Biodiversity Session of the Scientific Committee on Antarctic Research Biennial Meeting 2014.

H.J. Lynch. 2014. "Data fusion modelling approaches for tracking Adélie penguin abundance and distribution". Remote Sensing of the Antarctic Environment Session of the Scientific Committee on Antarctic Research Biennial Meeting 2014.

H.J. Lynch and M.A. LaRue. 2013. "Emerging geospatial technologies for studying penguin biogeography". 8th International Penguin Conference, Bristol, UK.

H.J. Lynch. 2012. "Detection, differentiation, and abundance estimation of penguin species by high-resolution satellite imagery". Birds and Marine Mammals Session of the Scientific Committee on Antarctic Research Biennial Meeting 2012.

H.J. Lynch. 2010. "Climate change winners and losers: Penguin population dynamics on the Antarctic Peninsula". 7th International Penguin Conference, Boston, MA.

H.J. Lynch. 2010. "Climate change winners and losers: Penguin population dynamics on the Antarctic Peninsula". Organized Oral Session 33 of ESA Annual Conference 2010.

H.J. Lynch and P.R. Moorcroft. 2007. "The 1988 Yellowstone fires: A geospatial examination of the impact of historical insect damage on forest fire risk". Contributed Oral Session 78-3 of ESA Annual Conference 2007.

H.J. Lynch and P.R. Moorcroft. 2006. "Mountain Pine Beetle Dynamics in a Spatially-Explicit Heterogeneous Landscape". Contributed Oral Session 91 of ESA Annual Conference 2006.

H.J. Lynch, Paul R. Moorcroft., Roy A. Renkin, and Robert L. Crabtree. 2005. "Insect-fire interactions in Yellowstone National Park". Greater Yellowstone Public Lands Conference 2005.

H,J. Lynch and P.R. Moorcroft. 2005. "Spatiotemporal Dynamics of Insect-Fire Interactions". Contributed Oral Session 130 of ESA Annual Conference 2005.

H.J. Lynch, L. DiCarlo, L.I. Childress, N.J. Craig, M.D. Lukin, C.M. Marcus, M.P. Hanson, A.C. Gossard. 2003. "Capacitive Sensing of Localized Charge in a Double Quantum Dot System". Session Y19 of APS March Meeting 2003.

H.J. Lynch, S. M. Cronenwett, C. M. Marcus, L. P. Kouwenhoven, V. Umansky. 2002. "Spin Effects and '0.7 Structure' in Quantum Point Contacts". Session F24 of APS March Meeting 2002.

H.J. Lynch, L. L. Sohn. 2000. "Spin Polarized Tunneling in an Iron-doped Copper Nanoparticle". Session P28 of APS March Meeting 2000.

C. E. Sosolik, A. C. Lavery, J. R. Hampton, **H.J. Lynch**, B.H. Cooper. 1999. "Temperature Dependent K^+ and Ca^+ Scattering from Cu(001)". Session FC33 of APS March Meeting 1999.

Appendix 5

Dr Tom Hart

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Tel: 01865 600 170, tom.hart@zoo.ox.ac.uk
Useful links: Google Scholar Profile; Polar Ecology and Conservation Group; Penguin Watch; Seabird Watch

A question-driven ecologist specialising in the Polar Regions. In particular, I seek to answer ecological questions about edge of range effects in changing environments. I have spent ten years developing semi-automated monitoring by deploying cameras in the poles. The projects are reaching maturity and are having increasing impact through publications and policy.

Current positions

04/13-present	Research Fellow, Department of Zoology, University of Oxford

Employment history

09/10-06/16	Research Fellow, Department of Zoology, University of Oxford
09/12-09/13	Fellow, Christchurch College, University of Oxford
01/08-10/11	Lecturer, Merton College, University of Oxford
03/08-10/11	Lecturer, Somerville College, University of Oxford
01/08-12/10	Post-doctoral researcher, Institute of Zoology
01/08-07/10	Departmental Lecturer, Department of Zoology, University of Oxford

Education

10/04-01/10	PhD, Imperial College London and the British Antarctic Survey "Foraging ecology of macaroni penguins (*Eudyptes chrysolophus*) around South Georgia" Supervised by Prof Tim Coulson (Imperial), Dr Phil Trathan (BAS) and Dr Alex Rogers (IoZ)
09/01-08/02	MSc in Integrative Biosciences, Department of Zoology / Hertford College, University of Oxford
09/98-06/01	BA in Biological Sciences, Somerville College, University of Oxford (2.1)

Recent funding

2021	£65,000	John Ellerman Foundation – "non-invasive seabird monitoring in the UKOTs"
2021	£20,000	Save our Seas Foundation – "penguin responses to a no tourist year in Antarctica"
2020	£85,280	Donations towards penguin conservation in the Southern Ocean
2019	£85,000	Donations towards penguin conservation in the Southern Ocean
2018	£110,000	Donations towards penguin conservation in the Southern Ocean
2017	£77,357	Donations towards penguin conservation in the Southern Ocean
2017	£74,910	John Ellerman Foundation – toward Seabird Watch project
2016	£71,763	Donations towards penguin conservation in the Southern Ocean

Current research interests

- Seabird Watch: This started as a Palearctic network of kittiwake and guillemots in a nest-based study. It is rapidly developing into an international, multispecies network. I have now brought together members of the existing UK seabird monitoring community (such as RSPB, National Trust for Scotland, BTO, Scottish Natural Heritage, Natural England, Natural Resources Wales, the Wildlife Trusts, National Trust) and academic partners and are currently applying for a 5-year Leverhulme Research Project grant.
- Penguin conservation genetics in relation to immunology: Using samples from Antarctica and the sub-Antarctic to determine the links between population structure, island biogeography and demographic history.
- Survivorship studies: I have established the largest network in Antarctica that records nest-based survival from time-lapse cameras, which we analyse using citizen science and machine learning.

Measures of esteem

- Member of the IUCN Penguin Specialist Group
- SCAR – Scientific Committee for Antarctic Research Wildlife Disease Monitoring Group
- Given evidence to Parliamentary Select Committee on remote sensing and on tourism in Antarctica.
- Consulting on the South Georgia and South Sandwich Islands (GSGSSI) Marine Protected Area, at the time the largest MPA in the world and since given evidence on the 5-year review
- Contributed substantially to the Terrestrial Protected Area designation of the South Sandwich Islands and current member of the Terrestrial Protected Area Advisory Group for GSGSSI.
- Received Vice-Chancellor's Public Engagement and Research award, 2018 Oxford University Annual report 2014/15 http://www.ox.ac.uk/sites/files/oxford/Annual%20Review%202014-15.pdf

- 2019 British Standards Institution award in the 'Trust' category for voluntarily adhering to and promoting BS8848:2014 in a new sector
- Explorer's Club flag carrying expedition for the International South Sandwich Science Expedition 2019

Teaching and current students

Current supervision:

- Chloe Kaczvinsky (1st year DPhil, primary supervisor, co-supervised by Prof Adrian Smith)
- Alice Edney (1st year DPhil, primary supervisor, co-supervised by Dr Mark Jessopp, University College Cork)
- Ignacio Juarez Martinez (2nd year DPhil, primary supervisor, co-supervised by Prof Alex Kacelnik)

In addition to these, I have supervised four DPhil students to completion as the primary supervisor and co-supervised three DPhil students. I also have managerial experience and am currently managing a Project Coordinator to assist me with the coordination of my research group and fast-growing projects.

Teaching experience:

2004-present	Tutor, specialising in statistics, marine biology, ecology and behaviour, BA in Biological Sciences, University of Oxford
2008-2011	Convenor, *Statistics and Data Handling* 1st year BA in Biological Sciences, University of Oxford.
2009-2010	Lecturer, *Quantitative Methods* 2nd year BA in Biological Sciences, University of Oxford.
2009-2019	Convenor, *Introduction to Statistics* Using R, DPhil in Zoology and Plant Sciences, University of Oxford
2012-2014	Lecturer – MSc in Marine Biology, University College Cork
2017-2018	Lecturer, *Remote Sensing in Arctic Ecology*, MSc Arctic Ecology, UNIS- The University Centre in Svalbard
2018	Lecturer, *Image based monitoring in Arctic Ecology*, MSc in Biology, Arhuus University, Denmark
2018-2020	Co-convenor, *Marine Ecology and Conservation* 2nd year BA in Biological Sciences, University of Oxford.
2017-2021	Lecturer, Remote and Semi-Remote Monitoring in Ecology and Conservation, MSc Biodiversity Change and Management, the School of Geography University of Oxford.
2020-2021	Co-convenor, *Statistics and Data Management*, Doctoral Training Centre, University of Oxford.

Impact

Sample media coverage:
Wall St Journal, TIME, The Times, The Guardian, The Telegraph, The Independent, BBC, Daily Mail, The Sun, Metro, Live Science, International Business Times, Huff Post, CNN, Buzzfeed, Sky News, Quartz

Non-academic outreach and educational content:
Penguin Watch educational packs, Geography key stage 2 classes, Capturing the world's longest sunset, Penguin CCTV, Capturing a year in the life of a penguin colony, Inside Science

REF2021 Impact case study. *Research into seabird behaviour engages the public and helps designate protected areas.* University of Oxford, Biological Sciences

Publications

1. Monteiro, T., **Hart, T.** & Kacelnik, A. (2021) Imprinting on time-structured acoustic stimuli in ducklings. *Biology Letters*, in press https://doi.org/10.1098/rsbl.2021.0381
2. **Hart, T.,** Jones, F., Black, C. E., Lintott, C. J., Youngflesh, C., Lynch, H., Davies, A., Maguire, E., Zisserman, A., Artetas, C., Barham, P., Emmerson, L., Southwell, C. & Jessopp, M. (2021) The advances and future of time-lapse imagery in animal ecology, *Ecology and Evolution, in Press*
3. Mora-Soto, A., Capsey, A., Friedlander, A., Palacios, M., Brewin, P., Golding, N., Dayton, P., Van Tussenbroek, B., Montiel, A., Goodell, W., Velasco, C., **Hart, T.**, Macaya, E., Pérez-Matus, A., Macias-Fauria, M. (2021) One of the last undisturbed marine coastal ecosystems on Earth: Spatial and temporal persistence of Darwin's sub-Antarctic giant kelp forests. *Journal of Biogeography* https://onlinelibrary.wiley.com/doi/10.1111/jbi.14221
4. Grace, MK, Akçakaya, HR, Bennett, EL et al. [100 authors] (2021) Testing a global standard for quantifying species recovery and assessing conservation impact. *Conservation Biology* https://doi.org/10.1002/cobi.13756

5. Dickens, J., Hollyman, P. R., **Hart, T.**, Clucas, G. V., Murphy, E. J., Poncet, S., Trathan, P. N. & Collins, M. A. (2021) UAV monitoring of South Georgia and the South Sandwich Islands https://doi.org/10.3389/fmars.2021.654215
6. Herman, R., Borowicz, A., Trathan, P. N., **Hart, T.** & Lynch, H. J. (2021) Update on the Global Abundance and Distribution of Gentoo Penguins (*Pygoscelis papua*). Polar Biology.
7. Samplonius, J. M. Atkinson, A. Hassall, C., Keogan, K., Thackeray, S. J., Assmann, J. J., Burgess, M.D., Johansson, J., Macphie, K. H., Pearce-Higgins, J. W., Simmonds, E. G., Varpe, Ø., Jamie C. Weir, J. C, Childs, D. Z., Cole, E. F., Duant, F., **Hart, T.**, Lewis, O. T., Pettorelli, N., Sheldon, B. C & Phillimore, A. B. (2020) Strengthening the evidence base for temperature-mediated phenological asynchrony and its impacts. *Nature Ecology and Evolution* https://doi.org/10.1038/s41559-020-01357-0
8. Liu, E. J., Wood, K., Aiuppa, A., Giudice, G., Bitetto, M., Fischer, T., McCormick, B., Plank, T. & **Hart, T.** (2020) Volcanic activity and gas emissions along the South Sandwich Arc. *Bulletin of Volcanology* https://doi.org/10.1007/s00445-020-01415-2
9. Strycker, N., Wethington, M., Borowicz, A., Forrest, S., Witharana, C., **Hart, T.** & Lynch, H. J. (2020) First global census of chinstrap penguins estimates 3.8 million breeding pairs and suggests a declining trend. *Scientific Reports* https://doi.org/10.1038/s41598-020-76479-3
10. Herman, R. W., Borowicz, A., Lynch, M, Trathan, P. N., **Hart, T.** & Lynch, H. J. (2020) Update on the global abundance and distribution of breeding Gentoo Penguins (*Pygoscelis papua*) *Polar Biology* https://doi.org/10.1007/s00300-020-02759-3
11. Levy, H., Fontenele, R. S., Harding, C., Suazo, C., Kraberger, S., Schmidlin, K., Djurhuus, A., Black, C. E., **Hart, T.**, Smith, A. L. Varsani, A. (2020) Identification and distribution of novel cressdnaviruses and circular molecules in four Penguin species in South Georgia and the Antarctic Peninsula. *Viruses* https://doi.org/10.3390/v12091029
12. Youngflesh, C., Jones, F.M., Lynch, H.J., Arthur, J., Macháčková, Z., Torsey, H.R. & **Hart, T.** (2020) Large-scale assessment of intra- and inter-annual nesting success using a remote camera network, *RSEC.* https://doi.org/10.1002/rse2.171
13. Levy, H., Fiddaman, S. R., Djurhuus, A., Black, C. E., Kraberger, S., Smith, A. L., **Hart, T.** & Varsani, A. (2020) Identification of Circovirus in a Chinstrap Penguin (*Pygoscelis antarcticus*) and Adélie Penguin (*Pygoscelis adeliae*) on the Antarctic Peninsula. *Viruses* https://doi.org/10.3390/v12080858
14. Jones, F. M., Arteta, C., Zisserman, A., Lempitsky, V., Lintott, C. J. & **Hart, T.** (2020) Processing citizen science- and machine –annotated time-lapse imagery for biologically meaningful metrics. *Scientific Data* https://doi.org/10.1038/s41597-020-0442-6
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Referees

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Appendix 6

Stony Brook Research

Stony Brook University Institutional Animal Care and Use Committee (IACUC)

DATE: July 20, 2021

TO: Heather Lynch
FROM: Jamie Fuellbier, IACUC Administrator, Office of Research Compliance
SUBJECT: Institutional Animal Care and Use Committee (IACUC) Action Taken

237420_AR001/Multispecies, Multiscale Investigations of Longterm Changes in Penguin and Seabird Populations on the Antarctic Peninsula

SUBMISSION TYPE:	Annual Review
ACTION:	APPROVED
SUBMISSION APPROVAL DATE:	7/20/2021
PROJECT EXPIRATION DATE:	**7/19/2022**
REVIEW TYPE:	Full Committee Review

The project referenced above which involves animal subjects was reviewed and approved by the Institutional Animal Care and Use Committee (IACUC) on 7/20/2021.

IMPORTANT: You must renew this project by submitting an Annual Review application to the IACUC, and obtain approval by 7/19/2022 if the study is to continue.

You must renew your activity, if it is to continue, prior to the expiration date. It is your responsibility to be aware of your expiration dates. You may receive courtesy reminder notifications and it is recommended you respond to the renewal notice in a timely manner to prevent a lapse in your study approval.

The Federal Office of Laboratory Animal Welfare (OLAW) in the Public Health Service (PHS) and this Institution require that ANY proposed changes to the project be reviewed and approved by the IACUC PRIOR to commencement of the activity.

This approval is subject to suspension if at any time the conditions and requirements of the IACUC are not met.