

APPLICATION FOR CONSENT TO CONDUCT MARINE SCIENTIFIC RESEARCH

1. General Information

1.1 Cruise name and/or number:	F2025-019-RS152512 REKA
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1.2 Sponsoring institution(s):		
Name	Address	Name Of Director
National Geographic - Lindblad Expeditions	2505 2nd Ave. Suite 300 Seattle, WA 98121 USA science@expeditions.com +1 858 349 8231	Ashley Knight
Woods Hole Oceanographic Institution	266 Woods Hole Rd. Woods Hole, MA 02543 USA bvanmooy@whoi.edu +1 508 289 2322	Benjamin Van Mooy (Deputy Director for Research)

1.3 Scientist in charge of the project:	
Name:	Catherine Walker
Country:	United States
Affiliation:	Woods Hole Oceanographic Institution
Address:	266 Woods Hole Rd. Woods Hole, MA 02543 United States
Telephone:	9782046106
Email:	cwalker@whoi.edu

1.4 Entity(ies) /Participant(s) from coastal State involved in the planning of the project:	
Name:	See Section 6.2
Country:	
Affiliation:	
Address:	
Telephone:	
Fax:	
Email:	
Website (for CV and photo):	

1.5 Submitting officer:	
Name:	Ashley Knight
Affiliation:	Lindblad Expeditions
Address:	United States
Telephone:	858-349-8231
Fax:	
Email:	ashleyk@expeditions.com

2. Description of Project

2.1 Nature and objectives of the project:
Perhaps surprising to those outside of glaciology, there are very few observations of actual ice cliff heights, much less studies linking cliff heights to cliff morphology, damage (crevassing) and surrounding ocean properties. While possible to measure cliffs using satellites, these measurements are often interrupted by clouds, resolution issues, and misaligned orbits. Glacier stability measurements and ground-truthing elevation for NASA's ICESat-2 satellite are the objectives of this project. We will be measuring glacier cliffs and ice-edge heights (elevations) using handheld lidar (laser ranging) instruments and creating 3D photogrammetry from structure-from-motion (SfM) imagery. We will also opportunistically use lidar on a drone over glacier edges and icebergs. This work will be completed from onboard the ship, and occasionally from a Zodiac, at any target within a ~2 km range. These are not location-specific, so can be collected anywhere, and are not dependent on repeat visits to same location. The goal is to build a database of ice cliff (ice edge and iceberg) elevations to compare against satellite measurements in the same region.

2.2 Relevant previous or future research projects:
These observations will have an immediate and far-reaching impact on our current understanding of ice sheet stability, as we do not have sufficient measurements of glacier cliffs to understand how glacier stability varies with environmental setting or stress regime. We are on our way to establishing this crucial dataset through this work. We have previously published theoretical work on this topic (e.g., Bassis and Walker (2012), Upper and lower limits on the stability of calving glaciers from the yield strength envelope of ice, doi:10.1098/rspa.2011.0422) and recently used satellite data to gather actual heights (Walker et al. (2024), Observational Constraints on Marine-Terminating Glacier Cliffs along the east Antarctic Peninsula, AGU 2024), but have yet to complete this work in Greenland. This will be a valuable ground-truthing campaign for the ICESat-2 satellite, whose mission is to measure ice elevations but its orbit tracks are poorly aligned with most glacier orientations in Greenland (optimized for Antarctica). This work would be the first of its kind to provide in situ measurements of cliffs to enable corrections to Greenland measurements using ICESat-2.

2.3 Previous publications relating to the project:
Related to this work: (1) Upper and lower limits on the stability of calving glaciers from the yield strength envelope of ice, Proceedings of the Royal Society A Math, Phys. Eng. Sci., 468 (2140), doi:10.1098/rspa.2011.0422 (2) Walker, C. C. and A. S. Gardner (2019). Evolution of ice shelf rifts: Implications for formation mechanics and morphological controls, Earth and Planetary Science Letters, 526, 115764, doi:10.1016/j.epsl.2019.115764 (3) Walker, C. C., M. K. Becker, and H. A. Fricker (2021). A high resolution, three-dimensional view of the D-28 calving event from Amery Ice Shelf with ICESat-2 and satellite imagery. Geophysical Research Letters, 48, e2020GL091200. doi:10.1029/2020GL091200 (4) Fluegel, B. and C. C. Walker (2024): The Two-Decade Evolution of Antarctica's Hektor Glacier and its 2022 Rapid Retreat from Satellite Observations. Geophysical Research Letters, 51, e2024GL110592, 10.1029/2024GL110592

3. Geographical Areas

3.1 Indicate geographical areas in which the project is to be conducted (with reference in latitude and longitude, including coordinates of cruise track/ way points):
(1) Iceland, including these locations: (a) Iceland - Isafjörður - 66.0750° N, 23.1248° W (b) Iceland - Vigur(Isafjarðururp) - 66.0555° N, 22.8289° W (c) Iceland - Geirhofs fjordur(Arnafjörður) - 65.6667° N, 23.3667° W (d) Iceland - Dynjandi - 65.7326° N, 23.1986° W (2) Greenland, including these locations: (a) Greenland - Skjoldungen Fjord - 63°19'N 41°30'W (b) Greenland - Prins Christian Sund - 60.1500° N, 43.8833° W (c) Greenland - Tasermuit Fjord - Klosterdalen - 60°16'N 44°47'W (d) Greenland - Qaqortoq - 60.7190° N, 46.0353° W (e) Greenland - Eriksfjord - 60.9827° N, 45.5612° W (h) Greenland - Eternity Fjord - 65.9378° N, 52.6454° W (i) Greenland - Sisimiut - 66.9394° N, 53.6632° W (j) Greenland - Ilulissat - 69.2198° N, 51.0986° W (k) Greenland - Disko Island - 69.8265° N, 53.4334° W (l) Greenland - Uummannaq - 70.6767° N, 52.1313° W (m) Greenland - Qilakitsoq - 70° 36' 18.59" N, -52° 10' 33.00" W
3.2 Attach chart(s) at an appropriate scale (1 page, high-resolution) showing the geographical areas of the intended work and, as far as practicable, the location and depth of sampling stations, the tracks of survey lines, and the locations of installations and equipment.
Chart provided - see Section 10.1.

4. Methods and Means to be Used

4.1 Particulars of Vessel:	
Name:	National Geographic Resolution
Type/Class:	Ship : R/V
Nationality (Flag state):	Bahamas
Identification Number/Lloyds #/MMSI #:	311 000 893
Owner:	Lindblad Maritime Enterprises
Operator:	Lindblad Expeditions
Overall length:	118m
Maximum draught:	5.7m
Displacement/Gross tonnage:	12,786.0
Propulsion:	2x ABB Azipods

Cruising:	10
Maximum speed:	
Call sign:	
INMARSAT number and method and capability of communication (including emergency frequencies):	
Name of master:	Heidi Norling & Martin Grasser
Number of crew:	116
Number of scientists on board:	2

4.2 Other craft in the project, including its use:
None.

4.3 Particulars of methods and scientific instruments:		
Types of samples and measurements	Methods to be used	Instruments to be used
Imagery and lidar (laser altimeter and rangefinding) profiles (remotely sensed).	- Creation of 3D mosaic images from photography (structure-from-motion (SfM) imagery) - Measurement of glacier cliff heights using lidar (eye-safe)	DLSR and mirrorless cameras, handheld lidar and laser rangefinder, lidar/imaging drone where applicable

4.4 Indicate nature and quantity of substances to be released into the marine environment:
No

4.5 Indicate whether drilling will be carried out. If yes, please specify:
No

4.6 Indicate whether explosives will be used. If yes, please specify type and trade name, chemical content, depth of trade class and stowage, size, depth of detonation, frequency of detonation, and position in latitude and longitude:
No

4.7 Indicate whether protected species be studied. If yes, please specify:
No

4.8 Indicate whether scientific acoustic equipment will be used.:
No

4.9 Indicate whether fishing/trawling will be used.:
No

5. Installations and Equipment

5.1 Details of installations and equipment (including dates of laying, servicing, method and anticipated timeframe for recovery, locations and depth, and measurements):
No

6. Dates

6.1 Estimated overall project start and end dates:
Project Start Date: 7/20/2025
Project End Date: 8/5/2025

6.2 Coastal State-specific details:	
Coastal Area	Iceland
Estimated Entry Date:	7/20/2025
Estimated Departure Date:	7/24/2025
Estimated Research Start Date:	7/21/2025
Estimated Research End Date:	7/24/2025
Explanation of multiple entries:	N/A
Research will be performed:	within 12 nm
Extent to which Iceland will be enabled to participate or to be represented in the research project:	We are participating as passengers on a tourist vessel, and we will welcome any and all coastal state participation in our project that is enabled by the ship. Our methods are simple and easily adopted by non-specialists. We do not have any native Greenland participants on our small science team, however.
Name, affiliation and contact information for all participants from Iceland:	N/A
Coastal Area	Greenland
Estimated Entry Date:	7/25/2025
Estimated Departure Date:	8/5/2025
Estimated Research Start Date:	7/25/2025
Estimated Research End Date:	8/4/2025
Explanation of multiple entries:	N/A
Research will be performed:	within 12 nm
Extent to which Greenland will be enabled to participate or to be represented in the research project:	We are participating as passengers on a tourist vessel, and we will welcome any and all coastal state participation in our project that is enabled by the ship. Our methods are simple and easily adopted by non-specialists. We do not have any native Greenland participants on our small science team, however.
Name, affiliation and contact information for all participants from Greenland:	N/A

7. Port Calls

7.1 List of Port Calls				
Port	Arrival Date	End Date	Special Logistical Requirements	Shipping Agent
Reykjavik	7/20/2025	7/20/2025	None	NA
Isafjordur - hofn	7/22/2025	7/22/2025	None	NA
Qaqortoq (Julianehaab)	7/27/2025	7/27/2025	None	NA
Eskifjordur - hofn	7/28/2025	7/28/2025	None	NA
Holsteinsborg Sisimiut	7/31/2025	7/31/2025	None	NA
Ilulissat (Jakobshavn)	8/1/2025	8/1/2025	None	NA

8. Participation of the representative of the coastal State

8.1 Modalities of the participation of the representative of the coastal State in the research project:
See Section 6.2
8.2 Proposed dates and ports for embarkation/disembarkation:
See Section 6.2

9. Access to Data, Samples and Research Results

9.1 Expected dates of submission to coastal State of preliminary report, which should include the expected dates of submission of the data and research results:
No more than 3 months from the end date of the research as provided in Section 6.1.
9.2 Anticipated dates of submission to the coastal State of the final report:

No more than 2 years from the end date of the research as provided in Section 6.1.
9.3 Proposed means for access by coastal State to data (including format) and samples:
Data will be provided through official channels at no cost to the coastal State(s). Samples will be provided upon request.
9.4 Proposed means to provide coastal State with assessment of data, samples and research results:
Assessment of data, samples and research results will be provided at no cost to the coastal State(s).
9.5 Proposed means to provide assistance in assessment or interpretation of data, samples and research results:
Assistance in further assessment or interpretation will be provided upon request.
9.6 Proposed means of making results internationally available:
We plan to publish results in an Open Access journal; before publication, results and measurements will be available on the Chief Scientist's institutional website, which is internationally accessible.

10. List of Supporting Documentation

10.1 List of attachments, such as additional forms required by the coastal State, etc.:			
Attachment Type	Description	Attachment	Submission Date
Proposed Cruise Track	Greenland	CruiseTrack_NGResolution_Plan_2025JulyAug.pdf	2/19/2025 7:29 AM
Supplemental Material	Hosting letter for project by existing expedition to Iceland/Greenland.	Hosting Letter for VSs - Walker.pdf	2/19/2025 7:32 AM
Proposed Cruise Track	Cruise Track	NG-LEX REKA Cruise Track 2025.pdf	2/20/2025 5:09 PM

Executed: 2/28/2025 8:45:16 PM (Coordinated Universal Time)

14 February 2025

Dear Catherine Walker,

We look forward to hosting you onboard our tourism vessel *M/V National Geographic Resolution* from 20 July to 05 August 2025 as we travel from Reykjavik, Iceland to Nuuk, Greenland. As we take guests/passengers on our itinerary [Iceland and Greenland: Edge of the Arctic](#), we will, when possible, support you to collect imagery of glaciers and sea ice using 3D SfM and LiDAR cameras – both stationary and as drones – as part of your research project *Ice at the Edge: Walls of Change*.

As a part of this “Platform of Opportunity” we will supply you with a cabin and meals onboard, and (where applicable) seats on some private, group, LEX-arranged charter flights to arrive/depart port cities for embarkation/disembarkation to the vessel. We will endeavor to support you in your imagery collection endeavors from the ship, Zodiacs deployed from the ship, and while walking ashore with the guests, provided you have acquired the appropriate access, research, and sampling permits required by local authorities and other bodies as needed.

You are responsible for your own research permits, collection permits, sample transport permits and arrangements, as well as any large equipment transport (beyond what can be provided on charter flights).

Thank you,
Ashley Knight



National Geographic-Lindblad Expeditions
Science Operations Manager
ashleyk@expeditions.com

Subject: Visiting Science aboard the NG-LEX Fleet in Greenland
Date: Tuesday, February 18, 2025 at 8:36:24 PM Chile Summer Time
From: Lindblad Science
To: Catherine Walker
CC: Sven Andes, Kylie Spado
Attachments: image001.jpg, Hosting Letter for VSs - Walker.pdf

I wanted to share with you a couple important things regarding Greenland research and permitting.

I've also included the working itinerary here, as well as the letter - both of which you will need for permitting. Please include this letter in the DOS RATS application (which is due 6 months prior to embarkation - which is 20 Feb 2025).

First, when you are applying for your research permits, please know that you will not be able to sample in "remote" Greenland. These areas are denoted in grey on [this map](#) and require exhaustive permitting to access for tourism expeditions (and especially for tourism vessels supporting science) and we cannot support science in these areas. We have focused the voyage we offered you based on the fact that this itinerary remains mostly in the green areas on the map. For these areas, [only "regular" Greenland research permitting](#) is needed.

Also, we want to **very strongly encourage** you to join the [Arctic Hub](#), a Greenland collaborative effort to bring together scientists doing research in Greenland. They have an online gathering called [Arctic Hub Connect](#) in late February that will likely be very beneficial to your research. Unfortunately, it is at very inconvenient times for US-based teams, but we still encourage you to join, perhaps join late, or request a recording.

Please reach out with any questions.

Thank you
Ashley

20-Jul	REYKJAVIK, ICELAND	B
21-Jul	Ship Cruising past Latrabjarg	P
	Flatey	A
22-Jul	Isafjörður	B
	Vigur(Isafjarðurup)	A
23-Jul	Geirrhjofsfiordur(Arnafjörður)	A
	Dynjandi(Arnafjörður)	A
24-Jul	Crossing the Denmark Strait	P
25-Jul	Skjoldungen Fjord, E Greenland	A
26-Jul	Prins Christian Sund, Greenland(entrance)	P
	Tasermuit Fjord - Klosterdalen	B
27-Jul	Qaqortokulooq, Greenland (Hvalsey ruins)	DP
	Qaqortoq, Greenland	A
	Eriksfjord, Greenland (site of Brattahlid)	A
28-Jul	Eriksfjord, Greenland (site of Brattahlid)	DP
29-Jul	Exploring southern fjords	DP

29-Jul	Exploring southern fjords	DP
30-Jul	Eternity Fjord - distance to face of glacier	DP
31-Jul	Sisimiut	B
1-Aug	Ilulissat	B/A
2-Aug	Disko Island Exploration - Tuapaat	DP
3-Aug	Uummannaq	A
	Qilakitsoq	DP
4-Aug	Itilleq(Arctic Circle)	DP
5-Aug	Nuuk, GREENLAND	A



**LINDBLAD
EXPEDITIONS**

Ashley Knight/Expedition Science Committee
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Pioneering Responsible Exploration

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NG-LEX REKA Cruise track July/Aug 2025

