HYPMO PROJECT
Hyperoodon movements in the Northeast Atlantic

UNIVERSITY OF ICELAND

HYPMO-23
Cruise Report

Prepared by:
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27 May – 20 June 2023

The HYPMO-23 cruise was funded by the Icelandic Centre for Research RANNÍS with additional support from the University of Iceland and University of St Andrews.

EXECUTIVE SUMMARY

The project HYPMO (*Hyperoodon* movements in the Northeast Atlantic; https://hypmo.org) is a multiyear research project investigating northern bottlenose whale (NBW) movement ecology to aid assessments of human impacts, including underwater noise. HYPMO-23 constituted its first dedicated research cruise in the deep waters of the Iceland Sea and Norwegian Sea—an area considered prime habitat for this poorly understood species. The research cruise was conducted within the Icelandic exclusive economic zone, from 27 May to 20 June.

Schooner Hildur was found to be an excellent research platform given the nature of the operation and science and ship's crew of 8 persons total. NBWs were frequently encountered in the Dreki Area—the core operational area which includes part of the Jan Mayen Ridge and several sea mounts. We had visual survey effort for 19 hours/day and NBWs were seen at least once on 12 days. The NBW was the most sighed marine mammal species with 94 out of 173 sightings. Its groups consisted of 1 to 7 individuals with a mean of 3 individuals. Photographs were collected during 77 NBW encounters for dorsal fin matching and age-sex classification. In addition, we collected 19 near-surface acoustic recordings of 18 individual groups with a vertical array and three drone videos at 4k resolution with Lidar altitude measurements. One biopsy sample was collected but several were lost after getting stuck, suggesting the tips used were inappropriate for the species. Four SPOT satellite tags in LIMPET configuration were deployed, all with good placement in the dorsal fin. LIMPET tag deployments were made using the Dan-Inject system from a zodiac without engine running; tagging from Hildur was found to be ineffective. Pole tagging with CATS suction-cup tags was not attempted. Several recommendations for future research are made in this report.

INTRODUCTION

The HYPMO research project was funded by the RANNÍS Icelandic Research Fund and Infrastructure Fund, with additional support from the University of Iceland and University of St Andrews in the form of fellowships and equipment. Part of the methodology used during the HYPMO-23 cruise was established during several research campaigns to Jan Mayen led by the University of St Andrews in 2013 to 2016.

This cruise report provides a brief overview of the outcomes of HYPMO-23; further details are available upon request to the authors. The logistical components and research procedures are described in the cruise plan appended to the report.

CRUISE TASKS

Primary tasks had a higher priority than the secondary tasks. We tried to accomplish as many of the secondary tasks as possible, but they were given a lower priority if they interfered with our ability to accomplish the primary tasks.

Primary tasks:

1. Deploy LIMPET satellite tags to record horizontal movements and dive behaviour
2. Collect identification photographs of tagged and non-tagged individuals
3. Collect visual observations on group size/composition and behaviour

Secondary tasks:

4. Make acoustic recordings of whales at the surface using a vertical array
5. Biopsy sampling of skin and blubber of whales for genetic and stable isotope analysis
6. Collect drone footage for photogrammetry and indicators of anthropogenic interactions
7. Deploy CATS tags to collect high-resolution sound and movement information

Green: Achieved during the cruise (to varying degrees).
Red: Not achieved. Note: SPLASH10 tags were not deployed so no dive behaviour recorded.

CHRONOLOGICAL SUMMARY

Table 1: Weather and activity log. Days with northern bottlenose whale sightings in grey. Sea state and fog presence are provided for before and after noon.

Date	Sea state	Fog	Notes
27-May			First day of installation
28-May			Installation and training trip in Skjálfandi Bay
29-May	-/2	-	Sailed to Grimsey in afternoon
30-May	-/3	-	Left Grimsey for deep waters in afternoon
31-May	4/2	-	Rough ride with water leakage. Arrival to Raufarhöfn at night.
01-Jun			Fixed towed array, CATS tag prep and training. Tarred the deck
02-Jun	-/2.5	-	Generator replaced. Departure for NE area in afternoon
03-Jun	2/2	-	First full day of effort. Distant NBW sighting at night
04-Jun	2.5/2	-	Many encounters around ‘southern alps’ in the Dreki Area, SW of the Jan Mayen Ridge (JMR)
05-Jun	3/3	x/x	Sailed up and down the canal and back to southern alps
06-Jun	1/1	-	Many encounters but not much seeking behaviour. Tagging from zodiac
07-Jun	3/3	-	Many good encounters S of JMR but wind+swell too high for zodiac. Tags and biopsies lost. Drone but without GPS
08-Jun	2/2	-	Sailing W to avoid weather - no sighings. Detour due to pack ice at night
09-Jun	2/1.5	-	Several groups near Kolbeinsey Ridge in afternoon. Tagging but evasive.
10-Jun	5/-	-	Sailed to Raufarhöfn to avoid storm
11-Jun			Left Raufarhöfn for NE area in the evening
12-Jun	1/1	-	Surveyed shelf edge and transit. Many sperm whale clicks but no visual

13-Jun	1/1	-/x	Great NBW encounters. Towed array in propellor. Drone videos collected. Biopsy attempts w tether unsuccessful.
14-Jun	1/2	-/x	OK encounters in morning but foggy. Many calves. Crossed over to JMR
15-Jun	1/0.5	x/-	Surveyed W side of JMR. Vertical array to find whales in fog
16-Jun	2.5/2	x/x	JMR. Tagging and biopsy from zodiac w paddles and towline
17-Jun	2.5/2	x/x	Many encounters at sea mounts S of JMR, incl all-male groups. Less attraction
18-Jun	0.5/1	-/x	Great encounters in the central area. 4 tags deployed. 1 biopsy lost
19-Jun	2/-	x/	Sailed to Husavik. Data back-ups.
20-Jun			De-installation and packing

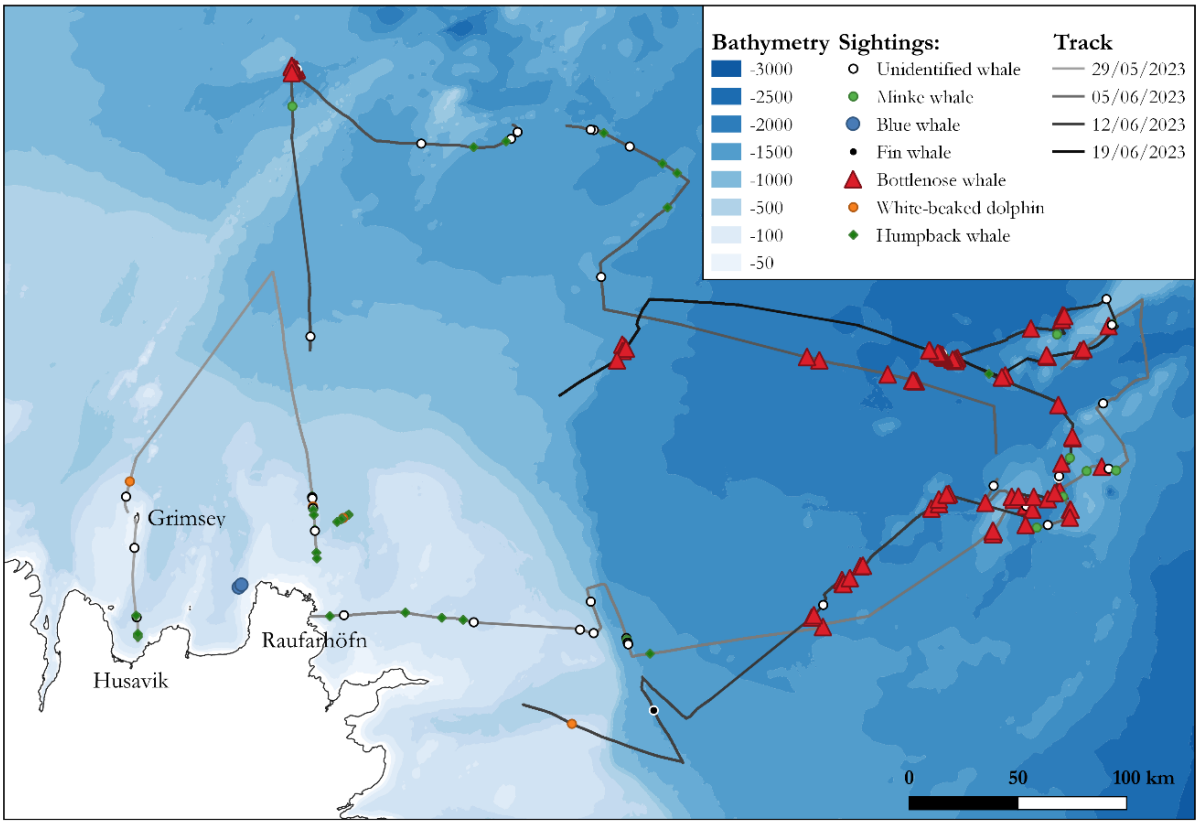
DATA COLLECTED

Visual monitoring effort

Two or three marine mammal observers monitored for whales on most days between 5am and midnight, in sea states up to 4 or 5 Beaufort (Fig. 1). When whales were found, more observers would generally be on deck. A total of 173 sightings, of which 94 of NBW groups, 50 resightings of NBW groups, and 253 effort forms were submitted in IFAW Logger. Best estimates of NBW group sizes ranged from 1 to 7, with a mean of 3 individuals.

Acoustic monitoring effort

A two-element towed hydrophone array was used for acoustic monitoring whenever possible. Acoustic recordings from the array were collected and analysed in real-time in PAMGuard at 192kHz sample rate from June 04 to 07 and from June 12 to 13, comprising a total of 212GB of data. The NBW click detector and classifier was set up to emit an alarm whenever clicks were detected to allow for 'in the field'-detections without the need for a PAM operator. Initially the detector did not function as planned but from June 12th onwards it was working properly. On June 13th, the towed array was lost when the vessel was accidentally reversed after being stopped, causing the towed array cable to entangle in the ship's propeller.



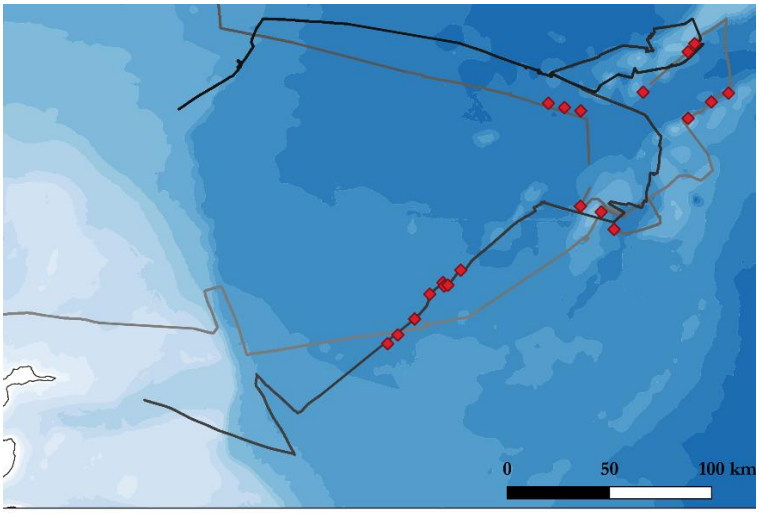


Figure 1: Track of research vessel Hildur during periods of visual effort, with a gradient from light grey to black indicating time, overlaid with (above) visual detections of all cetaceans (i.e. sightings, no resightings) or (left) acoustic detections of NBWs based on a run of the SPICE detector. Detector settings DT=8 dB SNR, and at least 200 click detections per 1-h time bin.

Photo ID

Every close encounter with NBWs was documented by taking pictures with at least one photo ID camera (model Canon EOS 5D or 7D, with a 100-400 mm lens). A total of 20,907 pictures (147 GB) were taken. Photo ID work focused on documenting the melon, left and right side of the dorsal fin, and any striking body markings of the whales encountered for individual identification and age-sex class determination. Photographs were taken during 77 individual NBW encounters (i.e. sightings).

Vertical array recordings

The vertical array of 2 hydrophones (depths 35 m and 40 m) was deployed when groups of NBWs were sighted close to the research vessel. A total of 19 acoustic recordings of 18 individual groups were collected (60 GB of stereo data; 192 kHz), each with photo ID and notes on behaviour, group size and group composition during the recordings. No clicks were heard during two recordings (IDs 17-18) when the array was being used to find whales in fog.

Table 2: Summary of acoustic recordings with the two-hydrophone vertical array.

ID	UTC Time (dd/mm/yy hh:mm)			Latitude	Longitude	Filename (yymmdd_#)	Group size (best est.)
1	04/06/2023	08:08	Start	67°41.651'	009°25.888'	230604_0076	2
	04/06/2023	08:24	End			230604_0076	2
2	04/06/2023	12:26	Start	67°51.465'	009°20.383'	230604_0077	5
	04/06/2023	12:42	End	67°51.475'	009°20.248'	230604_0077	5
3	05/06/2023	06:40	Start	67°48.467'	009°36.413	230605_0078	2
	05/06/2023	06:55	End			230605_0078	
4	07/06/2023	13:53	Start	68°12.274'	010°48.482'	230607_0079	7
	07/06/2023	14:05	End	68°12.293'	010°48.320'	230607_0079	
5	07/06/2023	16:10	Start	68°12.502'	010°48.777'	230607_0080	2
	07/06/2023	16:29	End	68°12.659'	010°48.579'	230607_0080	
6	07/06/2023	22:21	Start	68°10.054'	011°51.611'	230607_0081	5
	07/06/2023	22:49	End	68°10.177'	011°81.567'	230607_0081	
7	09/06/2023	17:40	Start	68°30.354'	018°33.473'	230609_0082	4
	09/06/2023	17:45	End			230609_0082	
8	09/06/2023	17:48	Start	68°30.356'	010°33.487'	230609_0083	4
	09/06/2023		End			230609_0083	
9	13/06/2023	05:55	Start	67°09.299'	010°59.044'	230613_0084	2
	13/06/2023	06:15	End	67°09.515'	010°58.635'	230613_0084	
10	13/06/2023	10:20	Start	67°18.780'	010°48.440'	230613_0085	1
	13/06/2023	10:40	End	67°18.775'	010°47.859'	230613_0085	
11	13/06/2023	12:23	Start	67°24.362'	010°40.806'	230613_0086	4
	13/06/2023	12:39	End	67°24.425'	010°40.672'	230613_0086	7
12	13/06/2023	21:23	Start	67°47.736'	010°02.218	230613_0087	6
	13/06/2023	21:54	End	67°47.915'	010°02.643'	230613_0087	6
13	14/06/2023	08:08	Start	67°52.422'	009°18.054'	230614_0088	3
	14/06/2023	08:24	End	67°52.546'	009°17.838'	230614_0088	4
14	14/06/2023	10:17	Start	67°53.464'	009°05.789'	230614_0089	4
	14/06/2023	10:42	End	67°53.724'	009°05.398'	230614_0089	
15	15/06/2023	05:37	Start	68°21.207'	010°24.481'	230615_0090	4
	15/06/2023	05:53	End	68°21.319'	010°24.663'	230615_0090	4
16	15/06/2023	12:46	Start	68°33.482'	009°43.399'	230615_0091	3
	15/06/2023	13:01	End	68°33.539'	009°43.221'	230615_0091	
19	15/06/2023	22:14	Start	68°39.715'	009°24.976	230615_0094	3
	15/06/2023	22:29	End	68°39.960'	009°25.320'	230615_0094	
20	17/06/2023	05:58	Start	68°20.238'	009°50.411'	230617_0100	2
	17/06/2023	06:14	End	68°20.367'	009°50.340'	230617_0100	
21	17/06/2023	06:59	Start	68°19.557'	009°52.117'	230617_0101	3
	17/06/2023	07:19	End	68°19.585'	009°52.167'	230617_0101	

Limpet satellite tags

Four whales were tagged with satellite-transmitting SPOT6 tags from the 5-m zodiac. The boat was always without engine on and was maneuvered around the whales using paddles only. The whales with SPOT ids 2 and 4 were not seen again after tag-on, while the groups with SPOT ids 1 and 3 were resighted and the whales were seen together on a few occasions (Fig 2). The tagged whales showed only minor short-term behavioural reactions (response scores 1 and 2) to the tagging event.

A custom Matlab application was run on the Toughbook laptop on the deck of Hildur. This program recorded the NMEA messages received by the CLS Goniometer and directional antenna and visualised the bearings (re ship's heading) of all received ARGOS messages. The antenna system received what appeared to be accurate bearings from all three tags that were transmitting (SPOT1 / 206608; SPOT3 / 206610; and SPOT4 / 206607). As of yet, signals have not been received from SPOT2.

Table 3: Satellite tag deployments during HYPMO-23.

ID	**Date** (UTC)	**Closest dist.** (m)	**Appr. aspect** (clock)	**Behav. context**	**Resp. score**	**Position**	**Placement**	**Age-sex class**
SPOT1	18/06/2023 12:37	7	3	slow travel	1	67.9606 -13.9589	RS dorsal	Adult female size
SPOT2	18/06/2023 12:40	7	3	slow travel	1	67.9611 -13.9601	RS dorsal	Adult female size
SPOT3	18/06/2023 13:03	9	9	logging	2	67.9605 -13.9588	LS dorsal	Adult female size
SPOT4	18/06/2023 18:53	8	3	slow travel	1	67.8968 -13.9476	LS dorsal	Adult female size

Figure 2: Whales with SPOT1 (left) and SPOT3 (on the right) swimming together.

Biopsy sampling

One biopsy sample of skin and blubber was retrieved. The biopsy dart was launched from the zodiac using the Dan-Inject system on 17 June at 13:36 (N68 21.110, W020 25.587). The sampled NBW had a large nick near the tip of the dorsal fin. Skin and blubber were separated and frozen or stored in ethanol (skin).

Six other biopsy darts got stuck in the whales and were subsequently lost. Three darts got stuck on 04 and 07 June, after which the retention teeth inside the tip were flattened. A system with the dart on a tether was also trialled but the tether (coiled fishing line in a tube) slowed down the arrow too much, making it too susceptible to wind. The successful biopsy was taken with the open tip and at a steep angle. However, two other darts got stuck, on 17 June (right angle shot on back of adult male) and 18 June (lower pressure of 6 bar and with steep angle to the whale). In both cases the whale was seen without the arrow on the next surfacing bout.

Drone photogrammetry

Three drone flights were conducted, all with LIDAR data logger to measure altitude (operator: Patrick Kagerer). The first flight started around 22:30 on the 7th of June, lasted approximately 8 minutes, but did not fly directly over the whales, though some surfacing events were recorded. The second flight started around 12:55 on the 13th of June, lasted approximately 10 minutes, flew over a group of four whales and recorded images that can be used for photogrammetry (Fig. 3). The third flight started around 13:24 on the 13th of June, lasted approximately 13 minutes, flew over a group of three whales and also recorded images that can be used for photogrammetry.

Due to repeated failure of the drone's GPS, the ability to operate it was reduced to only excellent weather conditions, i.e. no wind and very good visibility.

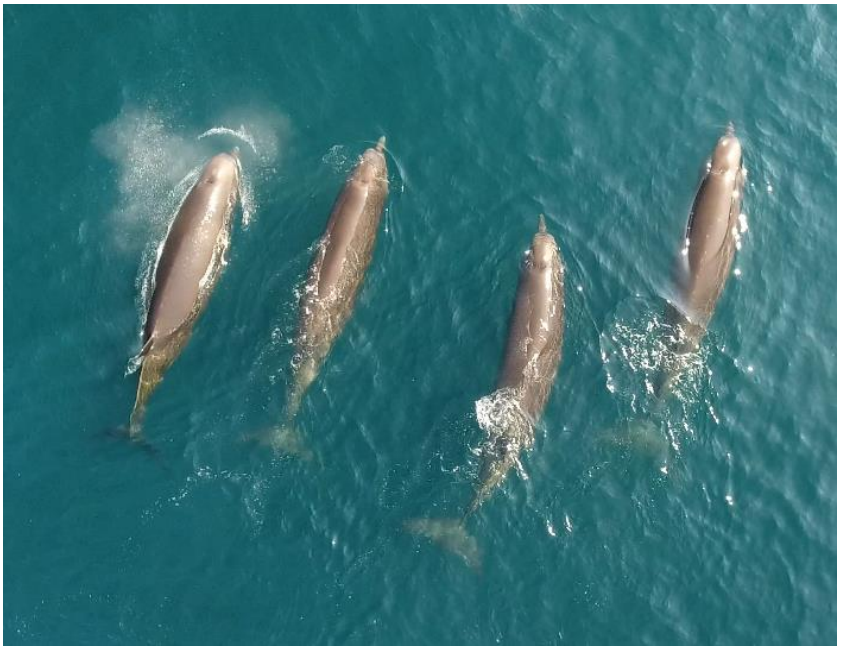


Figure 3: Still frame from 4K video taken during the second flight of the drone.

CONCLUSIONS AND RECOMMENDATIONS

- Relatively high numbers of NBWs were found, particularly in the Dreki Area. Its closer to port compared to the area closer to Jan Mayen which could be beneficial for future research on this population.
- An easily accessible crow´s nest would be beneficial for spotting groups at distances beyond 1-2 km on calm and clear days.
- Hildur's bowsprit was lower than that of Donna Wood's and seemed too low for pole tagging as the whales never swam under it. ARTS might be the best tool for suction cup tagging as whales tended to stay at least 6-8 m away from the zodiac.
- An extra (third) experienced person on the morning watch would have been better for visual monitoring and tagging/biopsy effort.
- A compass data stream into Logger would reduce confusion about sighting locations when the vessel is stopped/drifting (due to the mismatch between course-over-ground from GPS and the ship's heading at low speed). Logger requires HDT or HDM messages in NMEA0183 format. Hildur's compass could have provided heading information in Furuno's AD10 format. A simple compass at the Logger station would also be useful to keep track of sighting positions.
- Bring and use stopwatches to monitor dive durations.
- It's inconvenient to recover the towed array at the start each encounter and being stopped/drifting did not pose a risk of entanglement. However, reversing the engine once caused a serious risk to the propellor and array (which was immediately lost) and resulted in lost opportunities when the cable was being removed. A removable clamp on the throttle control lever, preventing the skipper from switching to reverse, would be a practical measure to reduce this risk.
- A good approach for tagging/biopsy from the zodiac could be:
    - Launch the zodiac as soon as the whales show some interest in the main vessel. The additional boat on the water may spark their curiosity further, as does light paddle ("tail")-slapping.
    - Tow the zodiac in areas with NBWs, with or without tagging team.
    - Do not use the outboard engine, but use paddles for propulsion and stay close to Hildur (for data collection from Hildur). Better to have one paddler, one photographer and one tagger. Might require smaller boat and/or kayak-style paddle.
    - When whales are not seen for a while, tow the zodiac incl. team back to the area where the whales were first seen (if drifted away from that area).
- The DJI Phantom drone was always losing GPS during flights, more than during in-/onshore testing. GPS is essentially a requirement although some data were collected. Launching the drone from the bow worked well.
- The custom biopsy tips provided by Dan-Inject Australasia did not function well for NBWs as they would often get stuck, even at low pressure and at steep angles. They were previously only used with blue and humpback whales. Flattening the

retention teeth helped but did not solve the issue. Tethered arrow did not work, making the trajectory unpredictable, likely due to reduced speed and wind effects on the line and arrow. A photo of the biopsied large male showed that the arrow went in too far, thus adding a larger stopper and perhaps blunting the tip could help. Or use different system.

APPENDIX A

HYPMO PROJECT
Hyperoodon movements in the Northeast Atlantic

UNIVERSITY OF ICELAND

HYPMO-23 Cruise

Cruise Plan

27 May – 20 June 2023
Paul Wensveen, Cruise Leader

The HYPMO-23 cruise is funded by the RANNÍS Icelandic Research Fund with additional support from the University of Iceland's Research Fund.

PROJECT OBJECTIVE

The HYPMO project (*Hyperoodon ampullatus* movements in the Northeast Atlantic; https://hypmo.org) is a multiyear research effort investigating northern bottlenose whale movement ecology, in order to aid assessments of human impacts, including underwater noise. The HYPMO-23 cruise constitutes the first dedicated fieldwork by the project in the offshore waters of the Iceland Sea and Norwegian Sea—areas considered prime habitat of this poorly understood species. Due to the difficulty of encountering northern bottlenose whales, we aim to collect a wide range of empirical information on their biology and ecology during each encounter.

CRUISE TASKS

Primary tasks have a higher priority than the secondary tasks. We will try to accomplish as many of the secondary tasks as possible, but they will be given a lower priority if they interfere with our ability to accomplish the primary tasks.

Primary tasks:

1. Deploy LIMPET satellite tags to record horizontal movements and dive behaviour
2. Collect identification photographs of tagged and non-tagged individuals
3. Collect visual observations on group size/composition and behaviour

Secondary tasks:

4. Make acoustic recordings of whales at the surface using a vertical array
5. Biopsy sampling of skin and blubber of whales for genetic and stable isotope analysis
6. Collect drone footage for photogrammetry and indicators of anthropogenic interactions
7. Deploy CATS tags to collect high-resolution sound and movement information

MAIN LOGISTICAL COMPONENTS

Research Vessel: “Hildur”

Length x beam: 18 m x 5 m. The team will work, sleep, and live on the oak two-masted schooner Hildur owned by North Sailing for the entire period. The vessel contains a separate area for the ship’s crew (3 persons), a navigation/engine room, a saloon with galley, and an area with three cabins from the scientific crew (5 persons) (Fig. 1). We will sail on engine for most of the time but may also set the sails if we want to transit to a new area with more speed. The vessel will have enough diesel and freshwater onboard for the entire period. The ship will be fitted with a low-height crow’s nest for spotting whales during the search phase. https://www.northsailing.is/the-boats/schooner-hildur/

Hildur has a small RHIB with outboard engine that will be used for tagging in sea states 0-2.

Contacts North Sailing:
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Stefán Jón Sigurgeirsson, stefan@northsailing.is, (+354) 869 2089
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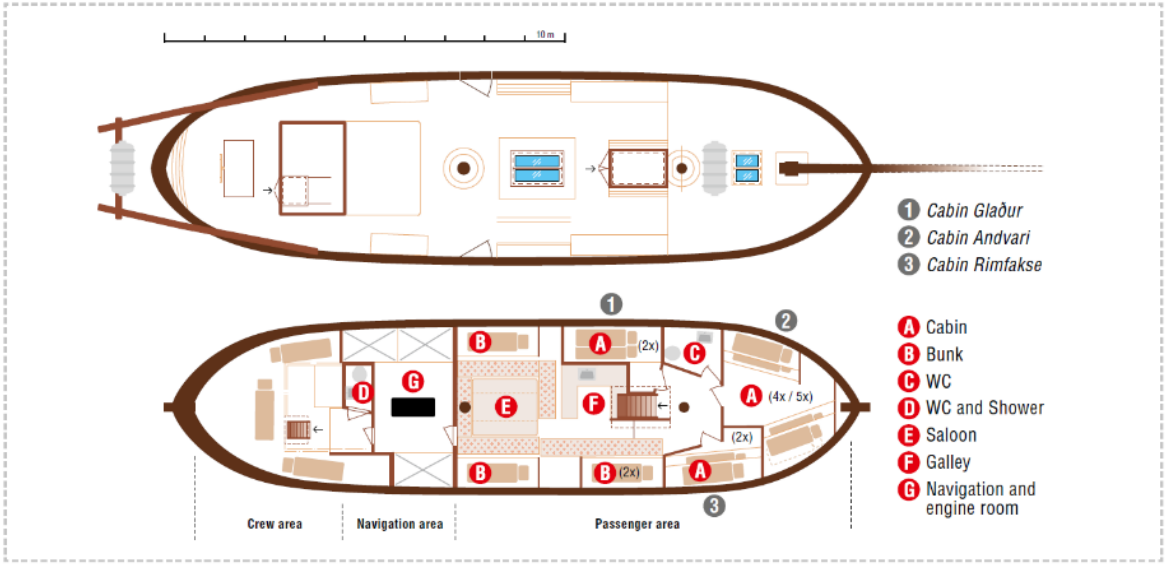


Figure 1. (above) Research vessel Hildur. (below) Deck plan

LIMPET satellite tags

We will aim to tag animals with ARGOS-linked satellite tags (Wildlife Computers SPOT and SPLASH10 models). The tags have the minimally invasive LIMPET configuration with two 6.5-cm darts that anchor into the dorsal fin or tissue below, and are deployed with the air pressure launcher Dan-Inject model JM.SP.25. Only adult males and adult female-sized whales will be targeted. Tags and darts will undergo high-level disinfection in an autoclave in Vestmannaeyjar before use, to reduce risk of infection. Darts will be kept in sterilisation pouches prior to use.

A maximum of n=11 animals will be tagged (n=9 SPOT and n=2 SPLASH10 tags are available). Only adults and subadults will be targeted; dependent calves or animals in visibly poor body condition will not be tagged. We will use the CLS Goniometer with directional antenna to receive bearings to the tagged animals nearby and collect ARGOS data messages from those tags.

Biopsy sampling

Biopsy samples of skin and blubber will be collected from animals in good body condition using the Dan-Inject system with the standard syringe arrow and tips that were custom-made by DanInject Austrasia. This system was successfully tested in summer 2022. The biopsy tips and arrows will be sterilised in 70% ethanol before each use. In case of a successful biopsy, the sample will be processed within 1 hour. We will divide the skin preferably into 4 samples (two stored in 99% ethanol, two frozen) and blubber into two samples (stored frozen).

Acoustic recordings

A custom-built horizontal array with two hydrophones will be towed behind the vessel for passive acoustic monitoring (PAM) of echolocating animals during the search phase. The two hydrophones in the array are connected to a laptop via an external soundcard and 100 m of cable. The laptop will run PamGuard for recording the audio and automatic click detection.

A vertical array of two hydrophones will be deployed from the main vessel during an encounter with the animals. The vertical array can only be used when the ship is stopped/drifting; the horizontal towed array can only be used when moving forward and should be recovered when animals are encounters.

UAV (‘drone’)

In low wind conditions, we will use a video-recording aerial drone (DJI Phantom Pro) to collect photogrammetry information on individual whales. The drone is equipped with a custom Lidar sensor/logger to record accurate altitude data. We may also use it to opportunistically record body markings of anthropogenic interactions as well as group-level behaviour.

OPERATION AREA

The operational area will the offshore waters in the North/Northeast of Iceland. We are permitted to work anywhere within the Icelandic EEZ, but we can expect the highest densities of bottlenose whales in the deep waters of the Iceland Sea and Norwegian Sea. In particular the core work areas will be around the Jan Mayen Ridge, in the Northeast, around the Kolbeinsey Ridge, in the North, and in intermediate areas with relatively steep bathymetry such as around sea mounts and the Icelandic continental slope. Decisions on which area to work in will also depend on weather forecasts.

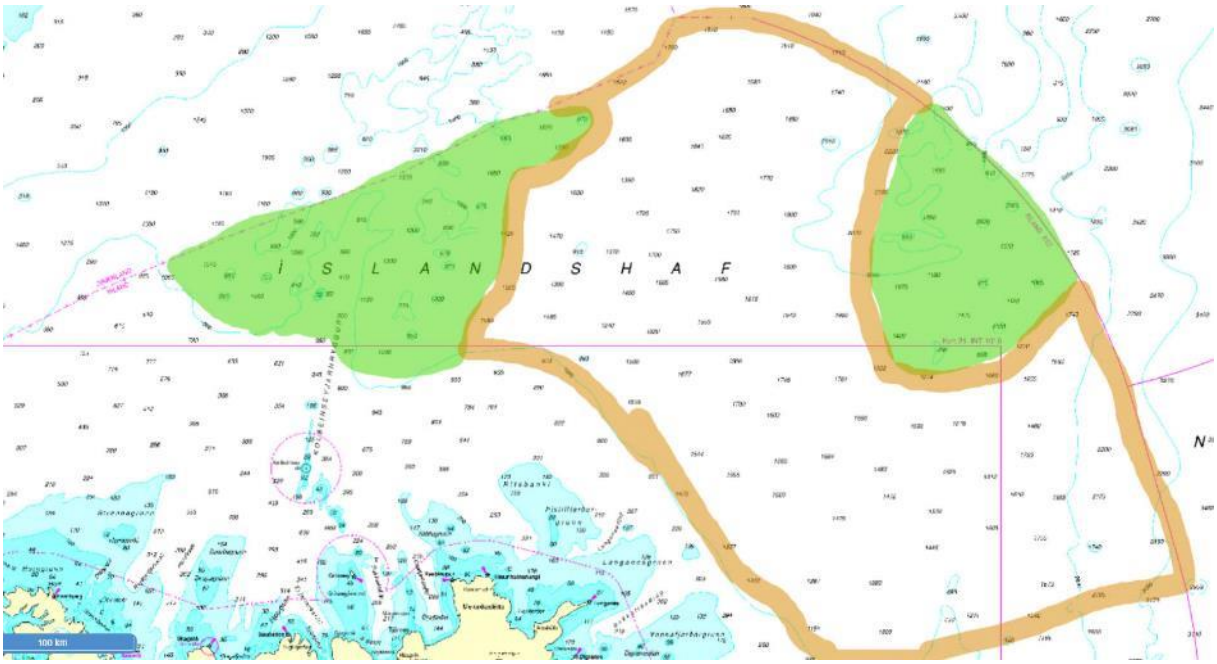


Figure 2: Operational area indicating areas considered having the highest chance of bottlenose whale encounters in green and a lower chance of encounters encircled in orange. See also Appendix A1 for a more detailed bathymetric chart.

SAILING SCHEDULE

23 May: Caroline picks up rental car in Reykjavik
26 May: Team travels to North Iceland and stays in Akureyri.
27 May: Embark vessel in the morning (~9-10am). Caroline returns the rental car.
27-28 May: Equipment installation, testing and training for all components
28-29 May: First day of research operations
19 June: Last day of research operations
20 June: Packing and travel
21 June: Return of rental car in Westman Islands

STUDY ANIMALS

The primary target species is northern bottlenose whales. Individuals of the target species will be chosen opportunistically from animals found in the study site. We may also satellite tag long-finned pilot whales and white-beaked dolphins, although these species are generally found further South during the fieldwork period.

SCIENCE CREW LIST / ROLES

Watch	Name	Primary Role	Secondary Role	Tertiary Role
A	Paul Wensveen	Cruise leader	Tagger/Biopsy	Visual/PAM
A	Babsi Neubarth	Sat tags/Boat driver	Photo ID/Biopsy	Visual/PAM
A	Patrick Kagerer	Drone	Vertical array/Photo ID	Visual/PAM
B	Caroline Haas	Vertical array	PAM/Photo ID	Visual
B	Tatiana Marchon	Photo ID	Visual/CATS tags	PAM

DAILY WORK PLAN

We will work at sea for the entire period in two separate watches that overlap around mid-day. The watch times will be determined in consultation with the ship's crew. The vessel will only return to port in case of a long window of unworkable weather. The science team will participate in the cooking and cleaning onboard, so we will establish a rota for this in the beginning of the cruise. A daily meeting will be held around lunchtime to discuss progress and determine the plan for the next 24 hours.

Search phase

We will search for animals by naked eye and with binoculars, and using the two-hydrophone towed array. We will use the crow's nest on the sailing boat as much as possible during this phase, rotating the observer every 1-2 hours. We will use the program Logger to record our search effort, weather conditions, and sightings of all mammals. One observer will be responsible for monitoring the towed array acoustically as well as physically. The vessel should not stop when the towed array is out, so when animals are located, we will recover the towed array to increase flexibility to manoeuvre.

Before and in the search phase, photo ID cameras, satellite tags and biopsies should be prepared and ready for use upon encountering animals.

Data collection phase

Once a group of bottlenose whales is encountered, we will observe the group and record sighting information (e.g. location, group size and composition, calf presence) and start taking identification photographs. The photographers will aim to take photos of all individuals. Bottlenose whales are known for being curious towards vessels so first we will give them the chance to approach the vessel. When we approach the animals it will be at a low speed.

If weather conditions allow, we will commence tagging or biopsy operations. There will be a dedicated photographer with the tagger/biopsy sampler to photograph the event. A head-mounted GoPro will also be used to record the tagging/biopsy sampling. We will likely start tagging on the main vessel and switch to the zodiac later, and only in good weather conditions (<SS3). Tagging is generally a higher priority, but biopsy may be priorised as it can be done from further away and increases in scientific value if animals are tagged.

In addition to assessing the success or failure of each tagging/biopsy attempt, it is critical to document the response of the animal to the operation, following the 1-4 point scale below:

0 No reaction: whale continued to show the same behaviour as before the attempt;
1 Low-level reaction: whale modified its behavior slightly, e.g. dived rapidly or flinched;
2 Moderate reaction: whale modified its behavior in a more forceful manner but gave no prolonged evidence of behavioral disturbance, e.g. tail slap, acceleration, and rapid dive;
3 Strong reaction: whale modified its behavior in a succession of forceful activities, e.g. successive percussive behaviours (breaches, tail slaps).

The tagger will attempt to place the tag on the dorsal fin, but near-misses may attach into the blubber near the dorsal fin. After a successful tag attachment we will use the CLS Goniometer with directional antenna to locate the tagged group for a maximum of 4 hours and attempt to collect more information, satellite tags and other, on these animals.

Data sheets for each tag or biopsy deployment/attempt should be completed promptly to assure that no information is lost.

A long pole with a net will be set up for recovering floating equipment.

The collection of drone video and vertical hydrophone recordings in this phase are secondary tasks and thus should only be conducted if they do not interfere with the primary tasks. Dipping hydrophone recordings will be made for a minimum of 10-15 mins when animals are close and the vessel is drifting. A data collection form will be filled out for each drone or hydrophone recording session.

If weather conditions allow, we will commence to fly the drone above the whales to make video recordings with the camera angled directly downwards. Each drone flights will last as long as possible given the battery duration, and the battery and SD card will be swapped after each flight. All UAV drone flights will be carried out following Icelandic Law. The drone will not be flown greater than 120 meters altitude or lower than 20 meters, and not over or near other vessels. If animals show signs of behavioural disturbance the drone operation will be stopped.

Data download and backup
Recorded data will regularly be checked and backed-up to at least two external hard drives. Written data sheets will regularly be copied into excel and digitised at the end of the fieldwork.

MANAGEMENT AND CHAIN OF COMMAND

Operational issues

Operational decisions such as the sailing plan or the organisation of the watches are made by the cruise leader in consultation with the skipper. Scientific decisions like which types of satellite tags to deploy and priorities of tagging versus biopsy are ultimately made by the cruise leader, after seeking advice from the appropriate members of the team.

Safety issues

The skipper will make the final decisions on safety issues. Always remember: ‘Safety First’!

TRIAL RISK ASSESSMENT

The vessel Hildur is fully equipped with all required safety equipment to conduct the operations within the study area. The University of St Andrews Health and Safety Office has created a safety risk assessment for the activities to be undertaken on board which must be understood and signed by all members of the science team and the skipper.

PERMITS

We are working under the institutional scientific permit of the Marine and Freshwater Research Institute (MFRI), which is a collaborating institution within the project. Biopsy samples will be transferred to MFRI which will store and facilitate analyses of the samples in collaboration with University of Iceland.

ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

Risk Inventory: The trial will be conducted during May-June 2023. This is a time when many marine mammals are expected to be present in the study area, and other human users of the area may be present. Other environmental impacts of the trial will primarily stem from usage of the

research vessels within the study area, and the impact of our research activities on the study animals.

The impact of the research vessels on the environment will be mitigated by driving at optimal speeds to reduce fuel consumption, and use of standard procedures to strictly regulate the disposal of waste materials. The impact of our activities on marine mammals is expected to be minor, and consist only of short-term behavioural disturbance. The activities to be conducted in the study area have authorization from the MFRI. Details of mitigation procedures to limit our impact on the study animals are detailed in the next section.

ANIMAL RESEARCH MITIGATION PROCEDURES

We have specified the following mitigation procedures to limit the potential impact of our research on the study animals.

Close approach by for tagging and biopsy sampling:

Approaches by the vessel will be made at minimal possible speed. We should not manoeuvre to stay within 10m of any individual whale for more than 10 minutes. Bottlenose whales are known to be curious towards large vessels, so we will generally let the whales come to us.

Behavioural response monitoring:

During each tagging or biopsy attempt, and drone flight, the reaction to the procedure will be carefully observed and recorded using the 4-pt scale used by Hooker et al., 2001.

0 No reaction: whale continued to show the same behaviour as before the procedure;
1 Low-level reaction: whale modified its behavior slightly, e.g. dived rapidly or flinched;
2 Moderate reaction: whale modified its behavior in a more forceful manner but gave no prolonged evidence of behavioral disturbance, e.g. tail slap, acceleration, and rapid dive;
3 Strong reaction: whale modified its behavior in a succession of forceful activities, e.g. successive percussive behaviours (breaches, tail slaps).

If any animal in the group exhibits a level 4 response to a procedure, we will cease conducting that procedure, and cancel subsequent procedures in the study plan. For example, if a whale responds with a strong reaction during tagging, then no further tagging attempts, biopsy attempts, or drone flights will be conducted with that animal.

TRAVEL AND ACCOMMODATION

Haas, Kagerer & Wensveen will travel to North Iceland by rental car with the equipment; Marchon will travel by plane. Wensveen, Marchon and Kagerer stay in rented accommodation in Akureyri on 26 May; Neubarth and Haas stay at Neubarth's apartment. The entire team will stay on the vessel from 27 May to 20 June. On 20 June, Wensveen, Haas & Marchon will drive the rental car back to Reykjavik and then Westman Islands. Kagerer & Neubarth are planning to stay in the North.

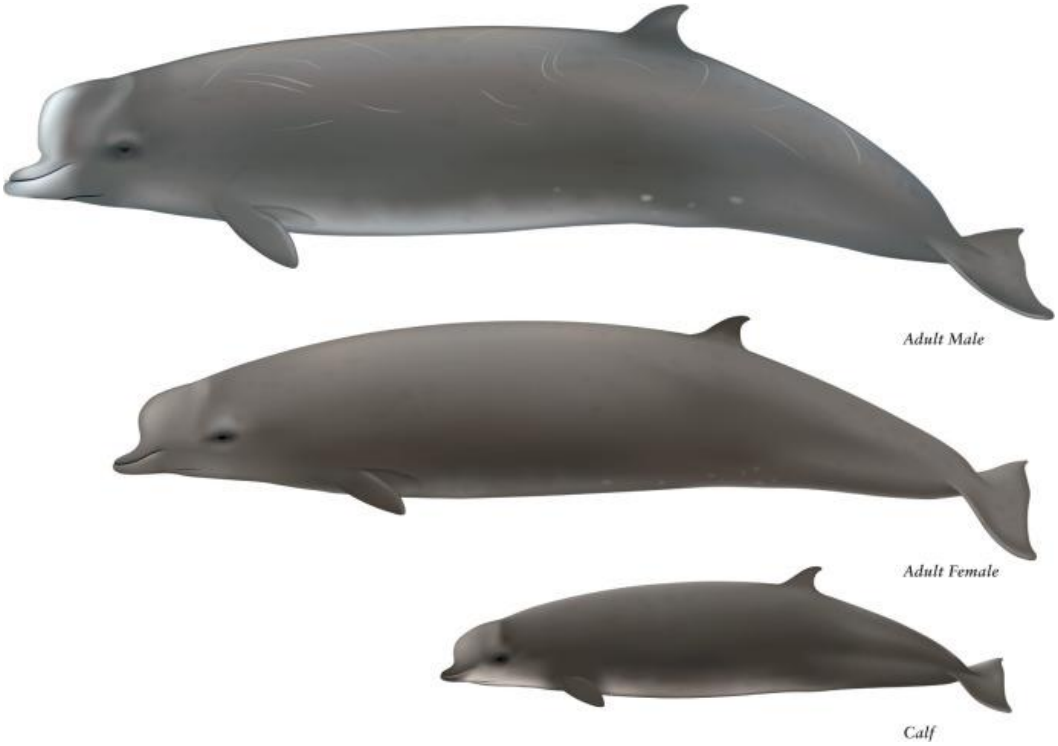
CONTACT INFORMATION

removed

EQUIPMENT & SHIPPING

Most of the equipment will be transported by rental car from the Westman Islands. Some equipment (i.e. 1 photo ID camera, vertical array including recorder, CO2 capsules, 1 suit) is already in Akureyri.

SHIPPING ADDRESS:
North Sailing
Garðarsbraut
640 Húsavík



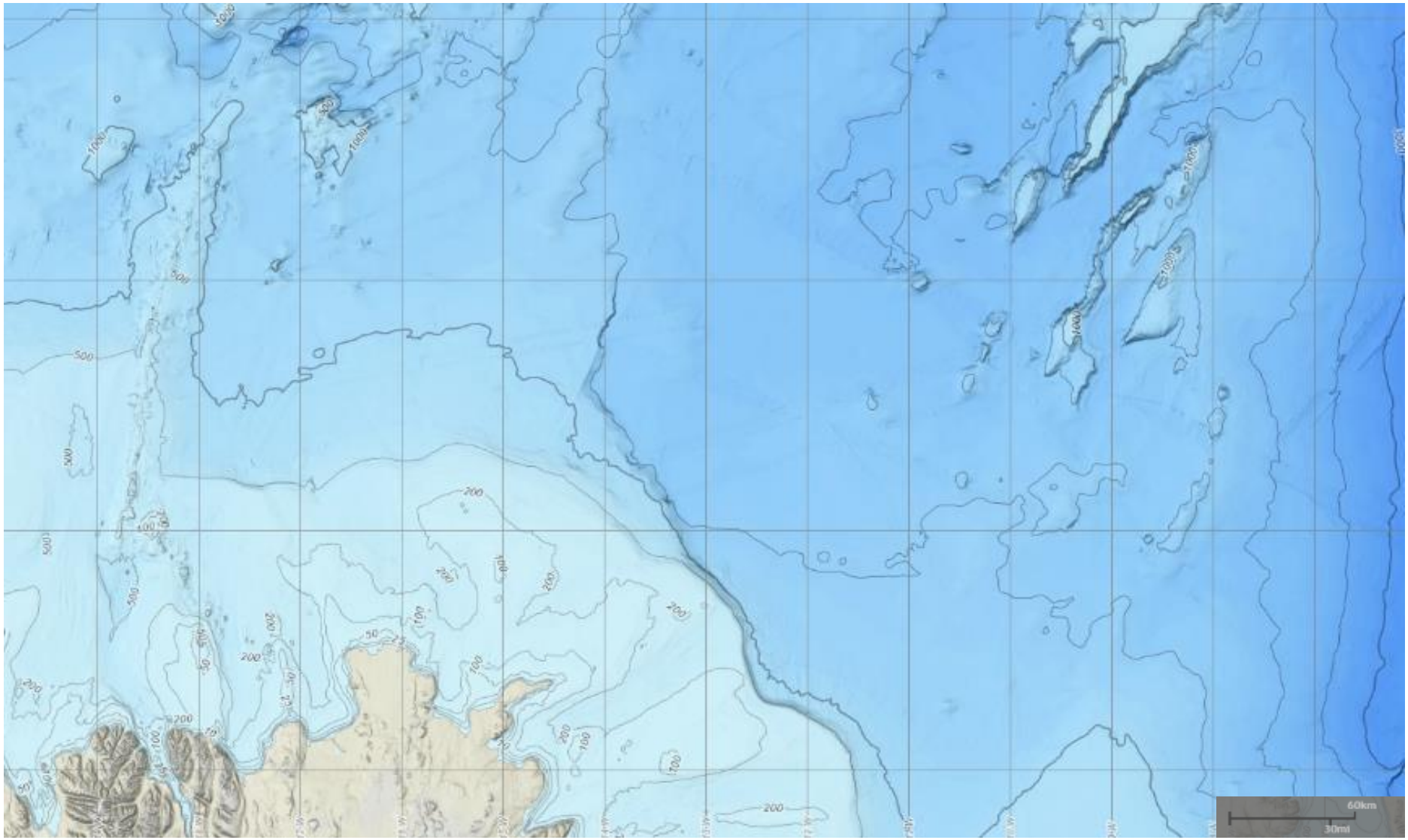


Figure A1. Bathymetry of the operational area

APPENDIX B: High-resolution bathymetry Dreki Area