Body condition and 3S-ORBS projects:

Jan Mayen 2016 trial cruise report

May 29 –June 29, 2016

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CRUISE REPORT

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Deployment of the Mixed-Dtag on a northern bottlenose whale using the ARTS system. Photo: Eilidh Siegal

The Hyperoodon 2016 Jan Mayen Trial was conducted as part of the $3S^3$ project funded by US Office of Naval Research and the body condition project funded by SERDP. Additional support was provided by the French and The Netherlands Ministries of Defence.

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Cruise report with 18 figures and 9 tables. This research trial was co-funded by the US Office of Naval Research (ONR) grant N00014-16-1-3059 and the Strategic Environmental Research and Development Program (SERDP) grant RC-2337, with additional support from by the French and The Netherlands Ministries of Defence, and in-kind support from the University of Oslo (participation of Rune Hansen). The authors wish to thank all other team members, and the dedicated ship's crew from North Sailing, Husavik, Iceland for making this field effort a success.

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EXECUTIVE SUMMARY

Overall, the Jan Mayen 2016 trial was successful with all primary tasks having been addressed as well as many of the secondary tasks. The primary platform Donna Wood was again successful to carry the team and all equipment, including the NUWC source developed for the SOCAL-BRS project which was successfully used. The zodiac tender was used more substantially for tagging efforts, with a majority of satellite tags and one mixed-Dtag deployed from the zodiac. Re-fuelling of Donna Wood from the Jan Mayen was successful. Weather conditions were somewhat worse than those experienced in 2013-2015, though a majority of days had workable conditions.

Whale were sighted in similar numbers and locations as previous years. Despite more difficult weather conditions and more time being successfully allocated to recovery, handling, and redeployment of acoustic buoys, more tags were deployed during the 2016 trial (13) than in any previous year (2013: 1; 2014: 10; 2015: 12). A shift in priority toward additional SPLASH satellite tag deployments led to seven deployments, a strong increase over three deployments in 2014 and 2015. However, six suction-cup deployments was somewhat less than the nine deployments made in 2015. Fewer whales were in a good position for pole tagging from the bow-sprit than in 2015, generally staying only a few metres too far forward for tagging. The ARTS biopsy collection system functioned successfully for the two deployments with long data records, but the biopsy collection system on the pole failed to function.

On 18 June, we conducted a DISTANT sonar exposure experiment using the NUWC source created for the SOCAL-BRS study. Visual confirmation of the whale's position was made prior to positioning the vessel 15 km east to conduct transmissions. This position was specified based upon Bellhop acoustic modelling predictions indicating a convergence zone at that range at relatively shallow depths and based upon considerations about bathymetry and the tilt angle of the source. In addition to the whale carrying a mixed-Dtag, six animals with SPLASH satellite tags were near the Dtagged whale. After exposure, no whales were seen where they had been sighted prior to the start of exposure. ARGOS data indicated the SPLASH-tagged whales had started to move SW, so we searched in that area, eventually recovering the Dtag roughly 40km SW from where the Dtagged whale was sighted prior the start of exposure. All of the SPLASH-tagged whales had travelled in a similar direction. The Dtag data indicated an unusual dive profile during the exposure period, with an apparent change from a shallow dive to a deeper dive, similar to responses of beaked whales in other BRS experiments. Dive depth was shallower after the exposure than before. The maximum received sound pressure level was 128 dB re 1 µPa (SEL: 134 dB re 1 μPa^2 s), but the avoidance response began prior to the maximum level received. Time of flight analysis of pulse arrival times was consistent with an avoidance response starting during exposure, with an increase in distance from the source of roughly 2.1 km after the response corresponding to 2.5-3.0 m/s swimming speed. Overall, the characteristics of the response observed seem to be highly consistent with the response to sonar documented in the 2013 3S2 experiment on northern bottlenose whales, and a short-range playback of lower source level 1-2 kHz signals in the 2015 trial. Further analysis of the Dtag and SPLASH behavioural data, plus acoustic detections from the bottom mounted acoustic buoys will enable a fuller description of the onset, spatial extent and duration of the apparent behavioural response.

The trial was therefore a successful pilot study for a possible full project to describe the interaction of received level and range in determining behavioural response to sonar in this off-range beaked whale. We have demonstrated our capability to conduct distant controlled exposure experiments from the sailboat platform, and the utility of using SPLASH tags to record responses of multiple individuals from the same experiment in multi-scale CEE design.

PERSONNEL

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* Charlotte and Remco departed the trial on the refuel supply boat on 11 June.

RESEARCH PARTNERS AND SPONSORS

The main research partners of the project conducting the Jan Mayen 2016 trial are:

- Sea Mammal Research Unit (SMRU), Scotland
- The Netherlands Organization for Applied Scientific Research (TNO), The Netherlands
- The Norwegian Defense Research Establishment (FFI), Norway

The following organizations also contributed to the 3S^3 or Body Condition projects:

- CEREMA Dter Est, Acoustics Group, Laboratoire de Strasbourg, France
- LK Arts, Kjerringøy, Norway
- Naval Undersea Warfare Center, Newport, RI, USA
- Kelp Marine Research, Hoorn, The Netherlands
- Calvin College, Grand Rapids, MI, USA

RESEARCH OBJECTIVES AND CRUISE TASKS

The goal of the body condition project is to collect baseline data of northern bottlenose whales (*Hyperoodon ampullatus*) off the island of Jan Mayen in order to develop and ground-truth non-invasive methods to track the body condition of free-ranging cetaceans. This includes attempting to understand their capacity to adjust foraging and anti-predator behaviors in response to their condition, and to understand the consequences of fluctuations in body condition in terms of the reproductive status and success of individual animals.

The 3S^3-ORBS (Off Range Beaked whale Studies) project aims to test whether and how the onset thresholds and severity of behavioural responses of northern bottlenose whales scale with received level and proximity to the sonar source. The 2016 Jan Mayen trial is part of a one-year pilot study in which we assess the feasibility of experimentally exposing whales to 3-4 kHz sonar signals within a range of target RLs that have been associated with behavioural responses in this beaked whale species, but at radically different distances in contrasting CLOSE and DISTANT treatments.

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. Field-test and use a new ‘mixed DTAG’ which will include location sensors and a DTAG3 sensor unit. These tags will be deployed on northern bottlenose whales using a pneumatically launched tagging system (ARTS) or using the hand pole. Regular DTAG3 and DTAG2 loggers will serve as backup.

2. Collect baseline data of northern bottlenose whales off Jan Mayen island with DTAGs

3. Collect skin/blubber samples and photographs for each tagged whale. Biopsy samples will be collected simultaneous with tagging using a specially-built ‘biopsy picker’ attached to the tag-attachment apparatus.

4. Conduct CLOSE (0.5-2.0 km) and DISTANT (10-40 km) sonar exposure sessions with tagged animals, using two source level schemes designed to target similar received levels at the animals. The exact location of the DISTANT exposures will depend upon acoustic propagation modeling based on the sound speed profile in the water column measured in the field.

5. Collect CTD profiles to measure sound speed and water density in the study area. Attempts should be made to lower the system to 600 m on a line close to areas where tags are deployed, near the acoustic buoys, and in the transmission path between the source and the tagged animals during sonar exposures. XBTs, which can be taken when the ship is moving, will be available as backup to the CTDs.

6. Deploy up to 8 SPLASH10 satellite tags on northern bottlenose whales in the study area

7. Deploy 3 Loggerhead Instruments bottom-mounted acoustic recorders and redeploy 2 for the following year

Secondary tasks:

1. Tag and conduct observations of non-target species, including blue, humpback, killer and minke whales. Photographs and biopsy samples will be taken in association with tag deployment on these species.

2. Conduct playbacks of natural sounds and control sounds to bottlenose whales, minke whales or killer whales. We will playback killer whale sounds to bottlenose and minke whales, and pilot whale sounds to killer whales.

3. Develop and test a visual protocol for social behavioral sampling of northern bottlenose whales

4. Take overhead photogrammetry images of tagged bottlenose whales and associated calves

5. Collect baseline information on movement patterns of mammal-eating killer whales in the Jan Mayen area using satellite tags.

OPERATION AREA

The operation area was from Iceland to Jan Mayen, including waters East of Iceland (Fig. 1, top). Though we had sightings of whales between Iceland and Jan Mayen, most of our effort was conducted in the waters near Jan Mayen (Fig. 1, bottom).

Two bottom-mounted acoustic recording buoys were recovered and redeployed at their current locations: 71°02.003’N, 07°01.981’W and 70°51.029’N, 06°08.266’W. A third acoustic buoy was deployed midway between these two locations near 70°53'43.20"N, 7° 1'13.50"W. All three buoys were recovered near the end of the trial, and two were redeployed to record the acoustic activity of the whales over the following year.

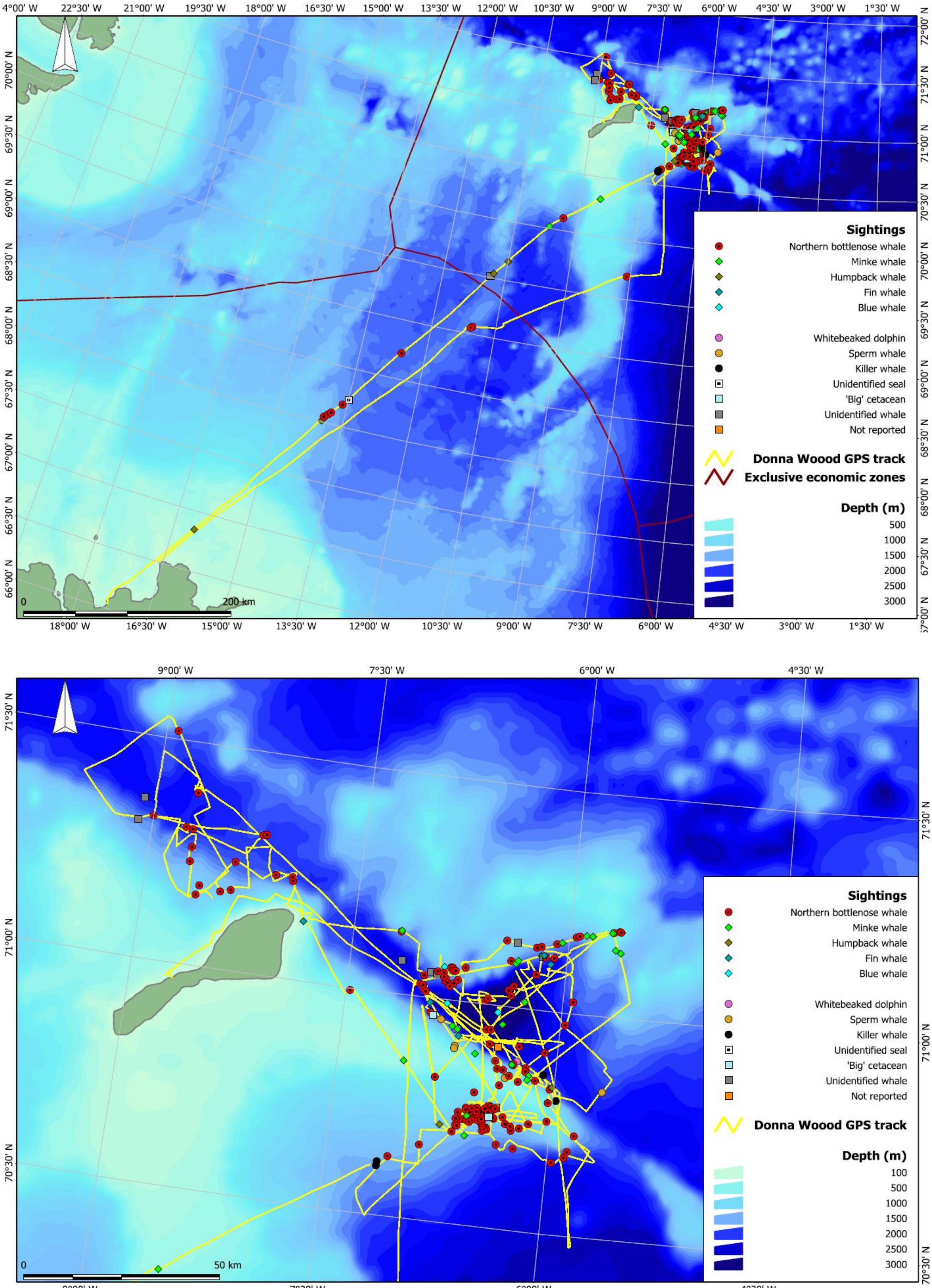


Figure 1. Top panel: Operating area, with vessel track (yellow line) and all species sighted. Bottom panel: zoom display showing vessel track and sightings in the Jan Mayen area.

EQUIPMENT AND PROCEDURES

Sailing Vessel Donna Wood

The 32m sailing boat Donna Wood (Fig. 2) was the base of operations and home to the crew for the entire period. Tagging was conducted from the deck of the sailboat using the ARTS system, and from the bowsprit using a hand-pole. Observations were conducted from the deck of the vessel and from a crow's nest located half-way above the main mast. VHF tracking antennas were mounted at the top of the fore-mast, overhead cameras were placed close to the crow's nest.

Figure 2. Left: Sailing vessel Donna Wood at sea. Arrows indicate the white observer crow's nest, and VHF antennae placed on the main mast. Four downward looking video cameras were placed near the crow's nest. The bow-sprit was used to attach tags using a hand-pole (right).

Biologging research devices

This study made use of version-3 Dtags provided by the University of Michigan, a new Mixed-Dtag with a Dtag3 core unit provided by U Michigan and housing and other components provided by U of St Andrews, and SPLASH10 satellite tags provided by Wildlife Computers (Table I).

Table I. Details of the three types of animal-attached tags used in the cruise.

Tag type	VHF range	Tagging method	Recording parameters
Mixed-Dtag, U Michigan, U St Andrews	148 MHz	ARTS or Pole – suction cup	Depth, temperature, 3-axis magnetism, 3-axis accelerations, audio (240 kHz), GPS logger, SPOT transmitter included
Dtag 3, U Michigan	219 MHz	Pole – suction cup	Depth, temperature, 3-axis magnetism, 3-axis accelerations, audio (240 kHz)
SPLASH10 (Wildlife computers) Limpet	N/A	Dan Inject or ARTS – barb	Satellite (ARGOS) up-linked positions and diving data

Version-2 Dtags have been successfully deployed using the ARTS tagging system since 2008, so in this trial, we used the Mixed-Dtag which has the external design of a version-2 Dtag, but with a Dtag-3 core sensor unit, a Fastloc-GPS logger, SPOT transmitter and other housing components. These new tags were used successfully for the first time in this trial using both the ARTS system (cover photo, Figure 3) and the hand-pole from the bowsprit of Donna Wood. We also had version-3 Dtags that could be deployed using the hand-pole from the bowsprit, but not using the ARTS system.

Figure 3. Left: Mixed-Dtag immediately after deployment on a Northern bottlenose whale using the ARTS launching system. Right: Pole tagging attempts from the bowsprit. Photo: Miguel Neves.

Tagging systems
The ARTS (Aerial Rocket Tag System) is a pneumatic launcher system used for suction-cup tagging, as well as collecting biopsy samples using the LKDart. Additionally, a custom tag carrier ('LKRBC') was used in order to collect biopsy samples simultaneous with tag deployments. The pole tagging system is a carbon fibre rod, using multiple sections, enabling tagging on close and semi close range animals. We used poles with 4 sections (~7m length) to tag from the bow-sprit of the research vessel.

VHF tracking systems
In addition to visual tracking, we used the processing radio direction finder, the DFHorten unit. The DFHorten is automatic direction finder device, which is connected to an array of 4 Yagi antennas in 4 different directions and further connected to a radio receiver. In addition to supporting visual tracking, the advantage of using the DFHorten becomes evident when the tagged whale is out of visual contact, in poor weather conditions, or even when it is dark. Additionally it is helpful to recovery floating tags.

Biopsy sampling systems
During ARTS tagging, biopsy samples were collected using the LKRBC custom biopsy collection system integrated into the ARTS launching system (Figure 4, left). The hand-pole included a custom biopsy collection system (Fig. 4). Biopsy samples were also collected using LKDarts deployed from the ARTS launching system. For all systems, 60mm standard Finn-Larsen biopsy tips were used. We also trialed a 40mm tip with a dental broach.

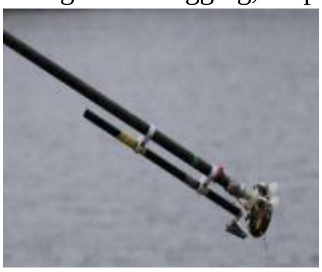


Figure 4. Mixed-Dtag mounted on the hand-pole for attachment, with a custom biopsy collection device. Photo Eilidh Siegal.

Photo-ID systems
Digital cameras were used to take photographs of study animals. Photographs of dorsal fins were taken for identification, and photographs were taken during tagging and biopsy operations.

Searching and line-transect survey
Visual sighting of Northern bottlenose whales and other cetaceans were collected from the deck of the operation vessel *Donna Wood* whenever weather conditions permitted. All sighting information was recorded using geo-referenced Logger software, provided by the International Fund for Animal Welfare.

CTD and XBT measurements
CTD profiles were measured near the acoustic buoy locations and tag retrieval locations using a new 2.3 kg Valeport Mini-CTD probe with a titanium housing. XBT measurements were made with a Sippican MK21/USB XBT using T7 probes.

Acoustic buoys

Loggerhead Instruments DSG-ST Ocean Acoustic Datalogger with an aluminium housing were deployed using an IXSEA Oceano 2500S universal acoustic release, provided by TNO, The Netherlands. We sampled audio at 144kHz using X3 lossless compression. A 256GB SD card enabled us to sample continuously during the trial. For the 11-12 month deployments, we recorded 2.5 minute of data every 45 minutes. The approximate water depth was assessed before each deployment by means of a lightbulb test.

Overhead video clips

Overhead video recordings were made by four Sony IR 37CSHR-IR 25m cameras attached to the crow's nest on the main mast, recording onto a Samsung SRD-470DP 4 Channel CCTV DVR DVD Player Recorder with 3TB HDD.

Sonar source

The sonar source used during controlled sonar experiments was a vertical line array consisting of 15 acoustic projectors. The source array was connected to the dry-end of the system by a 100ft (~30 m) Kevlar-reinforced electro-mechanical cable, resulting in a source depth of 27 m. The dry-end consisted of a rack mount (with amplifiers, transformers, digital processing, etc) inside a large pelicase box and was located in the saloon of Donna Wood. The system was initially developed by NUWC, Newport, RI for the SOCAL-BRS project. Monitoring of the sonar transmissions was done using a calibrated HTI hydrophone. To provide clean and stable power at 120 volts to the equipment, the entire system was powered by a Kipor IG2600 4-stroke petrol inverter generator, which was located on the deck during source operation.

Sound playback system

Sounds for natural sound playbacks would be played from a Lubell LL9642T underwater loudspeaker driven by a Cadence Z8000 car-stereo amplifier. Monitoring of the playback was done using an HTI hydrophone, which was later calibrated at TNO.

CHRONOLOGICAL SUMMARY

29 May, 2016

First teams arrive in Husavik, Iceland. Started testing and installation of all equipment.

30 May – 04 June

Set up and testing equipment on the research vessel

05 June – 08 June

Departure from Husavik, Iceland – transiting to Jan Mayen with some sightings and collection of 4 biopsy samples. Testing of CTD equipment/protocol and pressure resistance of Mixed-Dtags.

09 June – 10 June

Recovered and redeployed two acoustic buoys, transit to meet supply vessel

11 June – 12 June

Windy conditions. In harbour to refuel vessel from the SEAWORKS supply vessel. Transferred Curé and van Asch for return transit to Norway

13 June – 14 June

Many bottlenose whale sightings in canyon NW of Jan Mayen, some smaller animals, no seekers. Several sightings of other species.

15 June
Many encounters with seeking bottlenose whale. 2 SPLASH tags deployed. Some missed attempts with the Mixed-Dtag

16 June
Many animals with seeking behaviour. Another SPLASH tag deployed. One Mixed-Dtag was deployed but detached early due to broken suction cup stem. Poor weather late in the day

17 June
Improving conditions. Sighted large aggregation of killer whales, appeared to be herring feeding killer whales. Mixed-Dtag attached using pole from the bow-sprit. Good VHF beeps enabled VHF tracking for several hours before we moved away to position for a DISTANT experiment. Tag detached before sonar signals were transmitted.

18 June
Recovered first mixed-Dtag. 3 SPLASH and mixed-Dtag deployed. Tracking was possible for the period before positioning for a DISTANT experiment, which was conducted successfully. No bottlenose whales sighted in the tag location where many animals were sighted before the sonar signal transmissions. Satellite tracks relayed via ARGOS indicated movement to the SW, so we moved in that direction after the experiment. Mixed-Dtag recovered just before midnight UTC

19 June
Conducted CTD and transitted to NW canyon area. Several encounters, but no seeking whales and no tag attempts

20 June
Continued survey of NW canyon area in worsening conditions. More sightings, but no seeking whales so no tag attempts

21 June
Final satellite tag deployed. Two Dtag deployments, one short in duration. Other could not be tracked as no VHF beeps were heard after roughly one hour. Searched toward NE for Dtagged whale as final SPLASH tagged whale was noted to move in that direction. Several sightings and one tag attempt which did not stick due to unusual high-speed swim response of the tagged whale. Mixed-Dtag recovered just before midnight UTC

22 June
Transit south to previous location with many sightings, but few sighting and no seekers were found. Conducted an at-sea acoustic calibration of 3 mixed-Dtags. Late in the day, some seekers but no tagging attempts. Recovered SE acoustic buoy, and redeployed.

23 June
Fog and wind in north area. Few sightings with no seekers. Tested SPOT functionality during onboard float tests. Recovered 2 acoustic buoys.

24 June
Deployed final acoustic logger. Departed for Iceland in worsening conditions.

25 June
Transit to Iceland in worsening conditions. Some encounters with seekers South of Jan Mayen in fog. No tagging attempts possible.

26 June -27 June
Transit to Iceland in worsening conditions, arrived Husavik. Organizing gear.

28 June - 29 June
Packed all gear and departed Husavik.

DATA COLLECTED

Animal-attached tag data for Northern bottlenose whales

A total of six mixed-Dtag deployments were made with bottlenose whales, 5 using the ARTS system, and 1 using the hand-pole (Fig 5, Table II). The standard version-3 Dtag was not deployed. Three of the six deployments yielded sufficiently long records to be useful to the study (Fig. 6), two of which had an associated biopsy sample and one of which was subject of the DISTANT sonar experiment conducted. Two ARTS deployments detached early due to partial contact with water upon deployment, and one deployment failed due to broken stems. All sensors were effectively demonstrated: Dtag3 core units collected high resolution underwater movement and acoustic data; Sirtrack GPS loggers obtained high quality fixes when tags were sufficiently high on the body of the whales, and ARGOS location of the tag after detachment were recorded, aiding in tag recovery, as designed. No tags were lost.

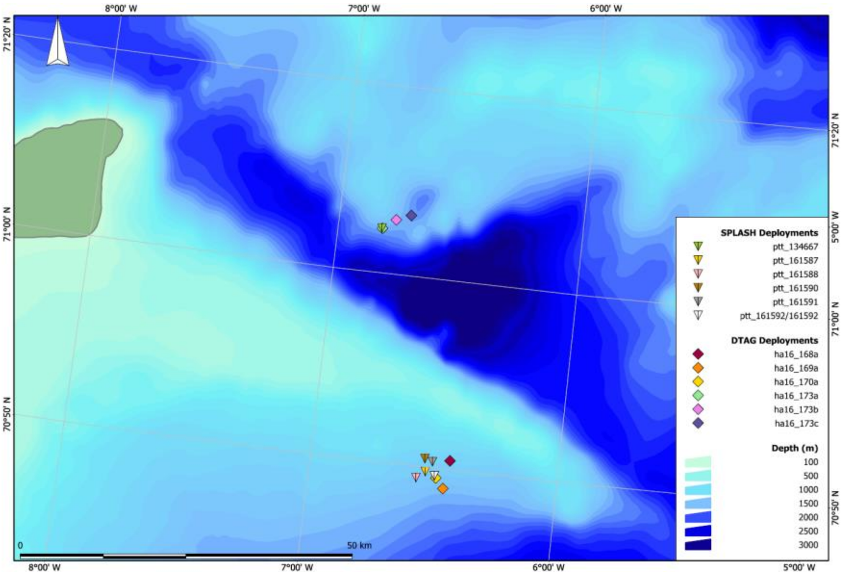


Figure 5. Location of Mixed-Dtag and SPLASH 10 deployments.

Table II. Details of Mixed-Dtag deployments on northern bottlenose whales.

Date	Deployment ID	Tag-on time and location	On-animal time	Tagging method	Releases burned? (y/n)	Experiment/ biopsy? (y/n)	Comments
16.06.2016	Ha16_168a	11:24 70 45.755N 06 26.276W	short	ARTS	No	No / yes	Lost cups because of broken stems, no data record
17.06.2016	Ha16_169a	22:44 70 43.495N	5 hrs 47 min	Pole	No	No / no	

		06 27.235W					
18.06.2016	Ha16_170a	07:06 70 44.268N 06 29.190W	13 hrs 8 min	ARTS	Yes	Yes / yes	
21.06.2016	Ha16_173a	09:01 71 03.560N 06 49.140W	11 hrs 43 min	ARTS	Yes	No / yes	Large crack in upper housing and a small one in lower housing.
21.06.2016	Ha16_173b	11:54 71 04.360N 06 46.007W	12 min	ARTS	No	No/ yes	
21.06.2016	Ha16_173c	17:52 N/A	short	ARTS	No	No / no	Very short deployment.

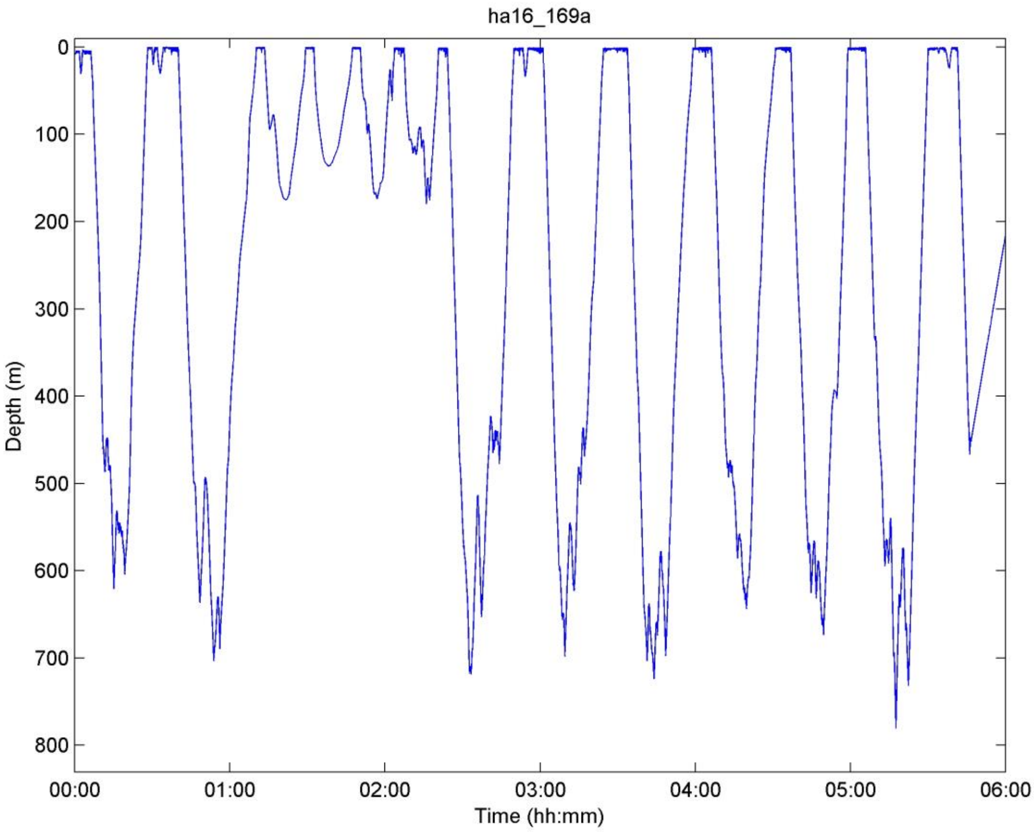


Figure 6. Example time-depth profile of a bottlenose whale.

Position and depth-recording satellite tags

SPLASH10 tags from Wildlife computers were deployed on 7 bottlenose whales using the Dan Inject and ARTS launching systems (Table III). Tag settings were specified to accomplish the prioritised data: 1) continuous records of horizontal movement and diving behaviour in relation to sonar transmissions, 2) continuous baseline behavioural records within the key area around Jan Mayen, and 3) records of large scale and long term movements. Transmission schedule was therefore set “on" during all hours of the day for all days of June to mid-July, with 550 daily transmissions in June and 300 in July. Subsequent periods were set to duty-cycling of transmissions every other day or less, aiming to extend battery life. Continuous dive summary data was collected with the “Behaviour Log” setting, and “Time Series” depth data with a 2.5 min sample rate was collected every 7th day for the purpose of validating the dive summary data.

The number of transmission days per tag deployment ranged from 2 to 38 days, with the four longest deployments lasting 33-38 days. Location fixes of good quality (i.e. Argos quality 1-3) and dive records with few gaps were accomplished, particularly for the four longest deployments (Table IV). Large scale movements showed similar patterns as in 2015; the whales moving out of the canyon hotspot, swimming southwards along the eastern side of the Jan Mayen ridge, with intermittent stops presumably searching for prey (Figure 7; Top). Two of the tracks show striking resemblances to 2015; one animal (Ptt161593) undertaking a migration southwards to the waters close to the Azores and another (Ptt161590) reaching the vicinity of the Faroe Islands before transmissions ended. In contrast to the southerly directed patterns, one an animal (Ptt161588) turned around at the southern end of the ridge, going 300 km north of Jan Mayen before finally heading back into the Jan Mayen canyon were transmissions ended. These longer term behavioural data sheds more light on the area usage of the bottlenose whales around Jan Mayen, and for the second time record a migration to southern waters, suggesting a temporal trend in at least some part of the population.

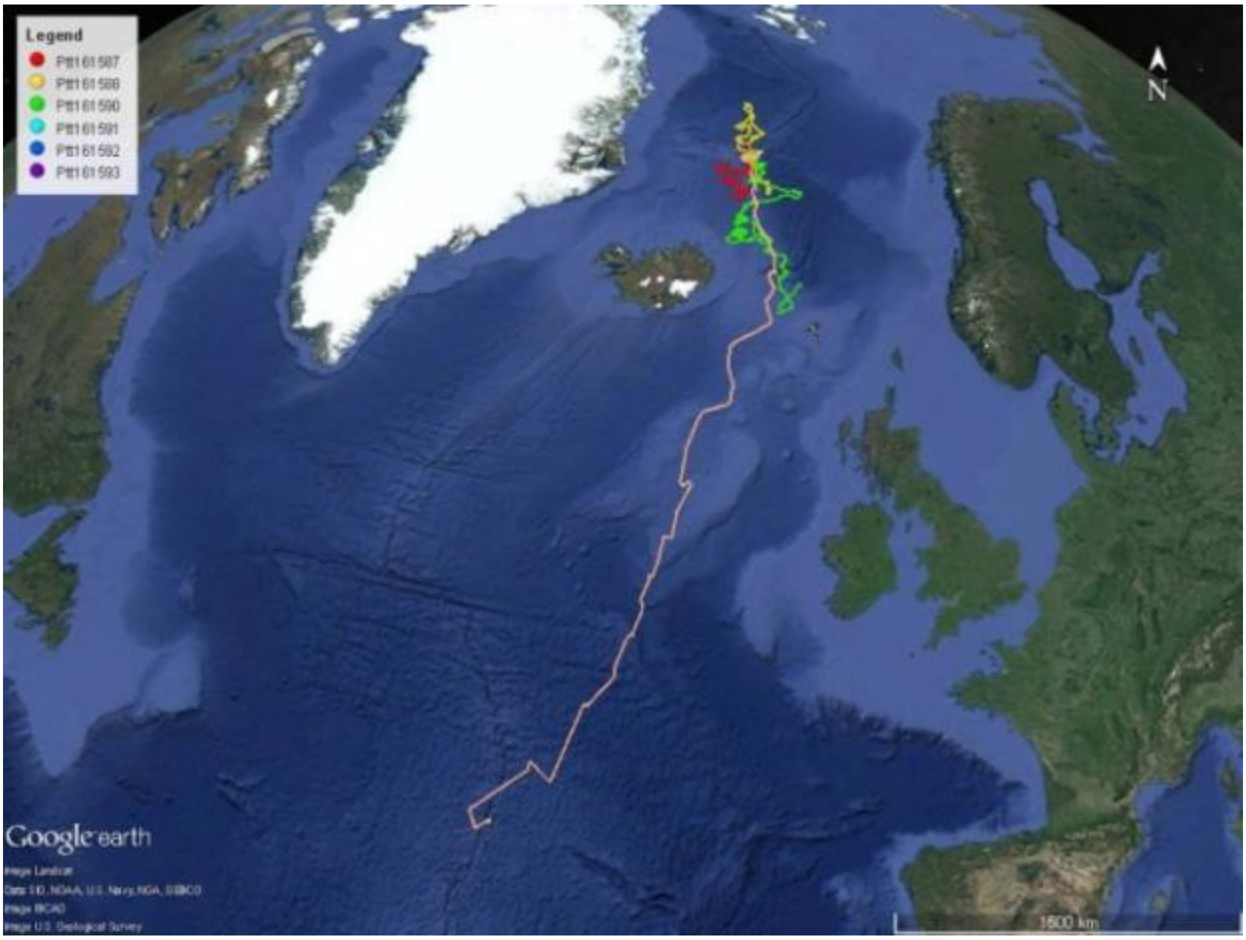
Table III. Deployments of SPLASH10 tags on northern bottlenose whales in 2016.

Serial No.	Ptt	Deploy. system	Tag on date and time (UTC)	Tag on location	Reaction (0-3)	No. fixes	Last fix date	Placement on animal	Duration
15A0391	161587	Dan Inject	15/06/16 22:04	70°44.691'N, 06°31.8988'W	1	634	20/07/16	Dorsal fin (left side)	35d 7h
15A0543	161588	ARTS	15/06/16 22:38	70°44.125'N, 06°33.975'W	1	773	20/07/16	Dorsal fin (left side)	35d 3h
15A1014	161590	Dan Inject	16/06/16 04:30	70°45.709'N, 06°32.354'E	*1*	612	19/07/16	Dorsal fin (left side)	33d 1hr
15A1015	161591	ARTS	18/06/16 10:30	70°45.530'N, 06°30.450'W	1	130	23/06/16	Saddle (right side)	5d 23h
15A1016	161592	Dan Inject	18/06/16 08:13	70°44.441'N, 06°29.639'W	1	85	22/06/16	Saddle (right side)	4d 20h
15A1017	161593	Dan Inject	18/06/16 08:15	70°44.442'N, 06°29.604'N	1	833	26/07/16	Dorsal fin (right side)	38d 1h
13A0774	134667	Dan Inject	21/06/16 09:05	71°03.571'N, 06°49.250'W	1	35	22/06/16	Dorsal fin (right side)	1d20h

Table IV Table of data successful data messages and location fixes by Argos quality.

		Data messages			Location fixes							
Ptt	Serial No	Status	Behavior	TimeSeries	Z	B	A	0	1	2	3	Total fixes
161587	15A0391	91	384	47	1	129	51	247	132	58	16	634
161588	15A0543	129	387	49	0	143	52	330	167	65	16	773
161590	15A1014	77	376	53	6	134	50	262	124	30	6	612
161591	15A1015	20	44	6	1	43	22	34	25	5	0	130

161592	15A1016	12	33	8	1	33	7	26	15	3	0	85
161593	15A1017	57	309	44	191	191	71	253	92	26	9	833
134667	13A0774	6	8	8	0	8	2	14	6	3	2	35



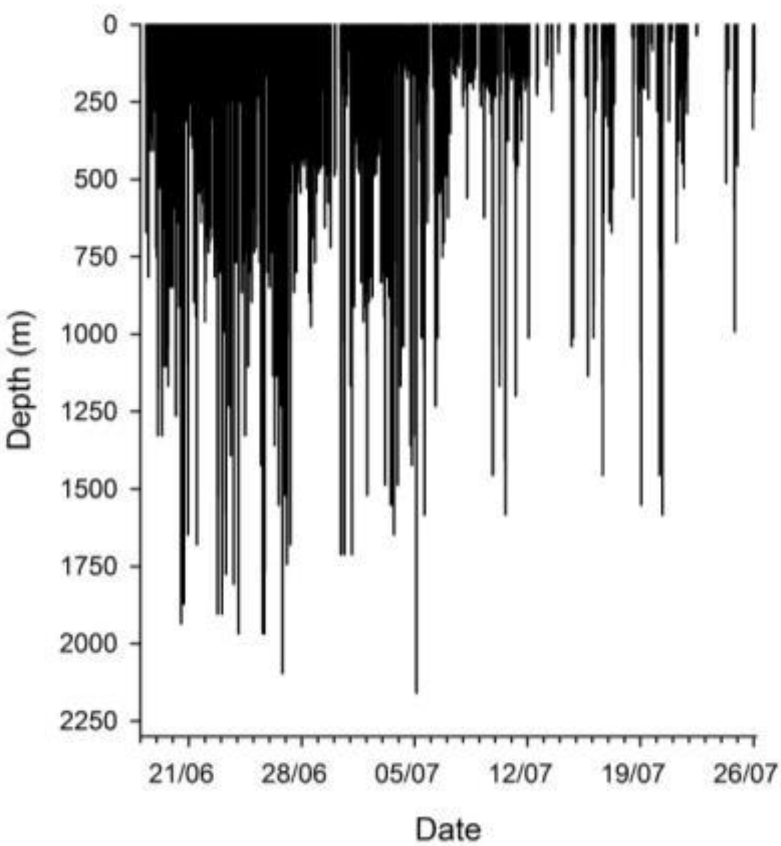


Figure 7. Movement tracks for bottlenose whales tagged with SPLASH-10 tags. The longest record of horizontal movement (top) and dive behaviour (bottom) was 38 days for ptt161593 (pink track). The animal moved over 3220 km southwest before transmissions ceased approximately 660 km north of the Azores archipelago.

Sonar exposure experiment

One DISTANT experiment with a bottlenose whale tagged with a mixed-Dtag (ha16_170a) was successfully conducted on 18 June. Six animals with SPLASH satellite tags were in the area nearby the Dtagged whale before exposure, and two (Ptt161592 and 161593) of these six were in the same group as the Dtagged animal when the tags were deployed. The focal group of 4-5 animals was visually tracked from Donna Wood during pre-exposure and, following protocol, visual confirmation of the tagged whale's position was made prior to positioning the vessel 15 km to the East to conduct sonar transmissions (Fig. 8). This position was specified based upon Bellhop acoustic modelling indicating a convergence zone at that range at relatively shallow depths.

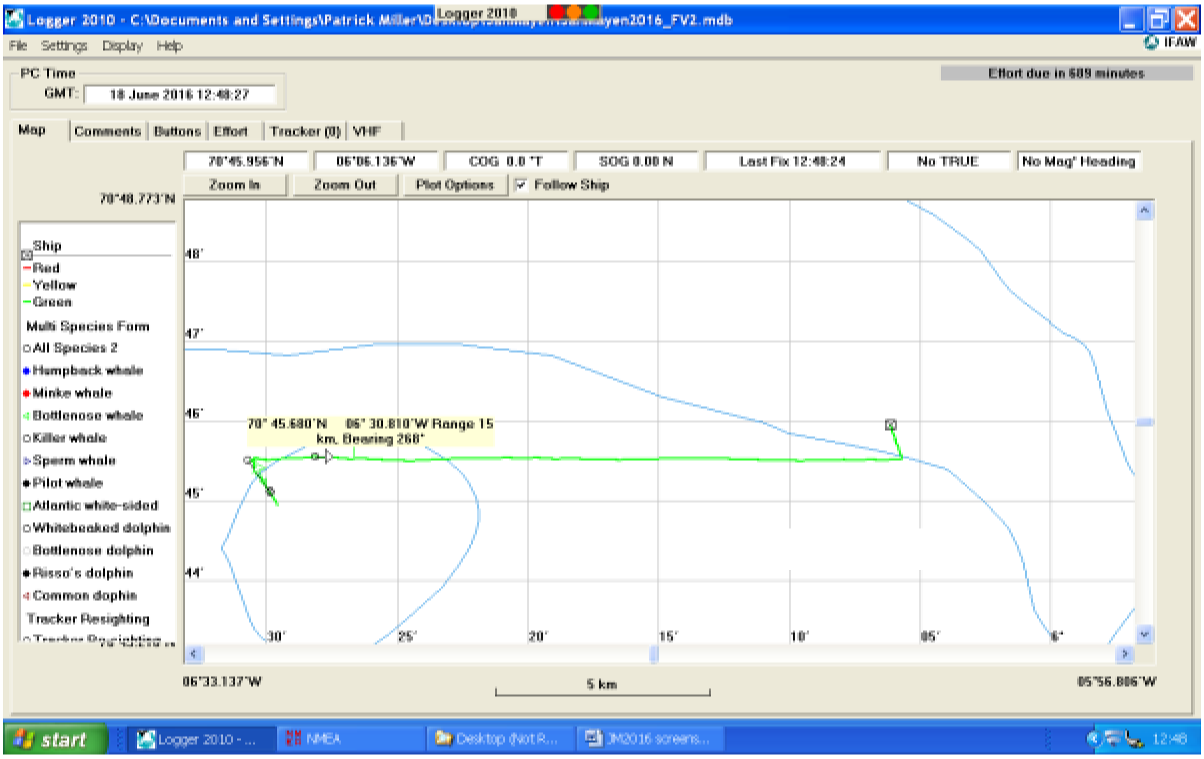


Figure 8. Screenshot of the Logger data recording system showing the location of the last sighting of the tagged whale, prior to positioning the source 15km to the East of the whale location. Analysis of the dead-reckoning track of the tagged whale later revealed that the source-whale distance was 17 km at the start of exposure.

Sonar transmissions started 5hrs after tag on and lasted for a period of 35 mins. The source level was increased with 1 dB per pulse during ramp-up for 20 mins followed by a full-power period of 15 mins with a source level of 214 dB re 1µPa m. The escalating dose was clearly visible in the acoustic record of the Dtag, with received levels reaching a maximum sound pressure level of 128 dB re 1µPa and a cumulative sound exposure level of 134 dB 1µPa^2 s (Fig 9), but behavioural responses began prior to the maximum level received.

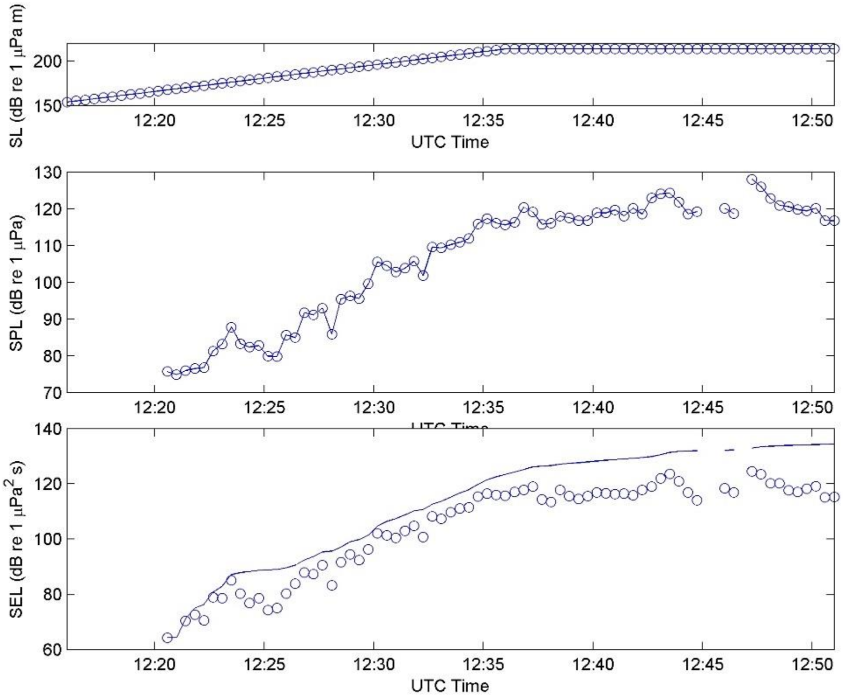


Figure 9. Source levels (top) and received sound pressure (middle) and sound exposure (bottom) levels.

Analysis of the mixed-Dtag data indicated that the focal animal made foraging dives to ~600 m depth during pre-exposure with search clicks and feeding buzzes identified in the acoustic recordings. An unusual dive profile can be seen during the exposure period, with an apparent change from a shallow dive to a deeper dive (Fig. 10) that is similar to responses of beaked whales in other BRS experiments. Heading data suggested a switch from non-directional to directional movement during exposure and changes in the acceleration and flow noise data suggested a change to high-speed energetic motion. Time of flight analysis of pulse arrival times was consistent with this avoidance response starting during exposure, with an increase in distance from the source of roughly 2.1 km after the response corresponding to 2.5-3.0 m/s horizontal speed.

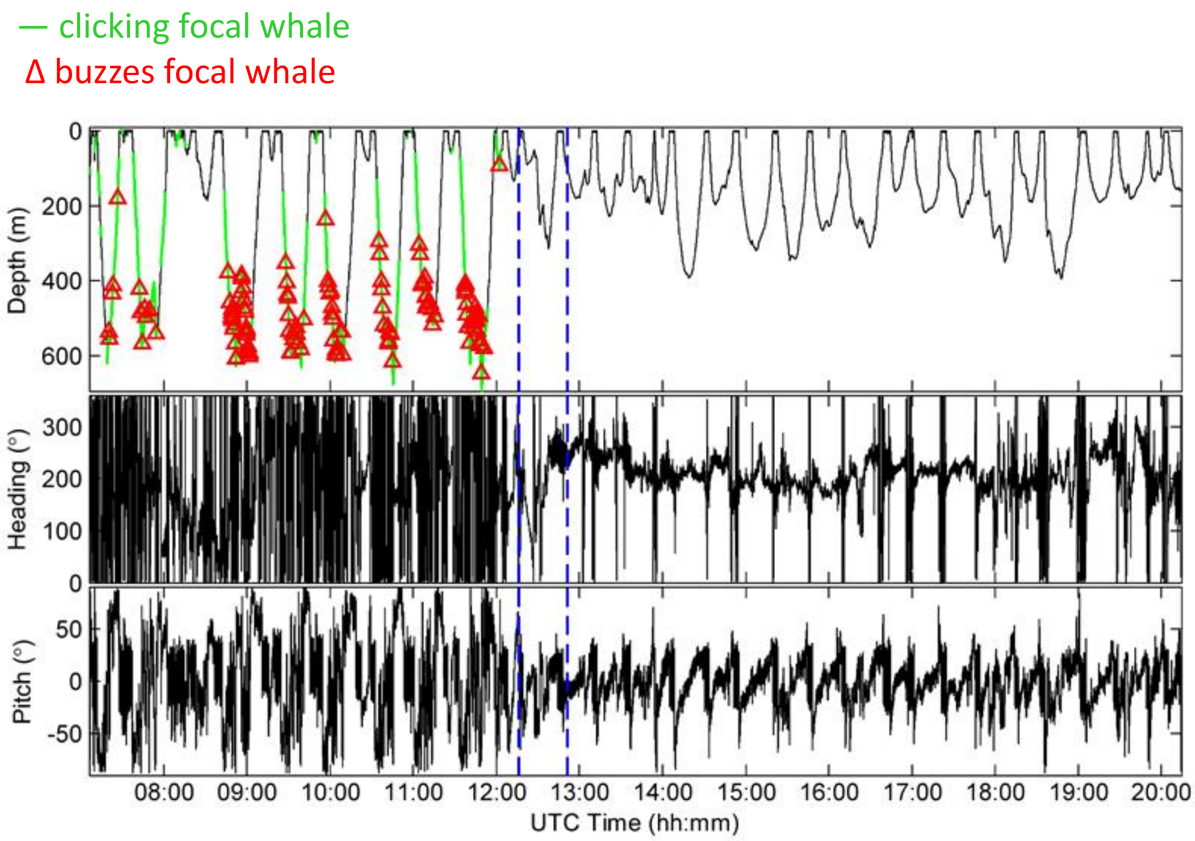


Figure 10. Tag record ha16_170a with the timing of the DISTANT sonar exposure marked in blue. Note the apparent change from foraging behaviour with large variation in heading to silent non-foraging behaviour with more shallow dives and very directed movement that continued until the tag came off ~8 hrs after the start of exposure.

After exposure, no whales were sighted in the area where they had been seen prior to the start of exposure. ARGOS data indicated the SPLASH-tagged whales had started to move SW, so we searched in that direction, eventually recovering the Dtag roughly 40km SW from where the Dtagged whale was sighted prior the start of exposure (Fig. 11). All the SPLASH-tagged whales had travelled in a similar direction, except Ptt161587 which moved in a slightly more westerly direction. Very directional movement by the satellite tagged whales was visible for periods of ~8-10 hours after exposure, during which the animals travelled several tens of kilometres, which was consistent with dead-reckoning track derived from the high-resolution Dtag data (Fig. 11).

Preliminary analysis indicated a cessation of clicking in the acoustic recordings of the bottom-mounted mooring (Fig 11 for a period 13 hours, highlighting that animals in the area North of the tagged animals were also impacted by the sonar exposure.

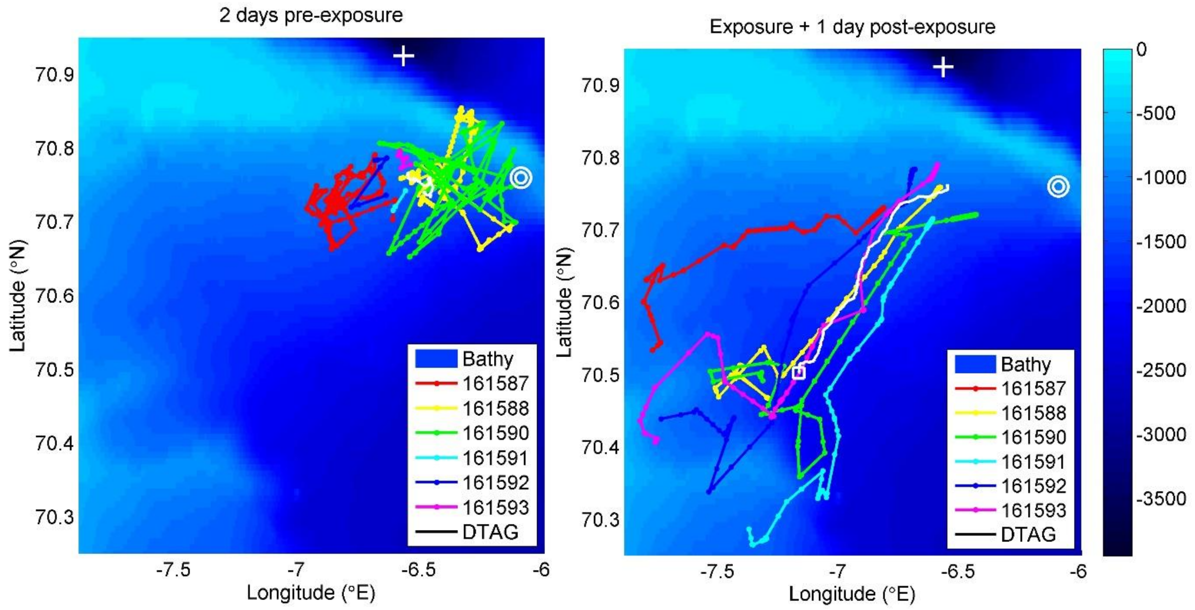


Figure 11. Geometry of the experiment showing the movement tracks of the six satellite tagged whales (labelled by Ptt) and dead-reckoned track of Dtagged animal (in white), the source location (white circle to the East), and the location of the acoustic buoy that was recording during exposure (white cross to the North). The left panel shows the movements up to 2 days prior to exposure and the right panel shows whale movements during exposure and up to 1 day after exposure. The dead-reckoning track of the focal animal was corrected for drift using sightings and tag recovery location (white square). The movement tracks of the satellite tagged animals were created by filtering the raw positional data using a continuous time correlated walk model (Johnson et al. 2008; R package crawl) that utilised the observation error ellipse information transmitted by ARGOS.

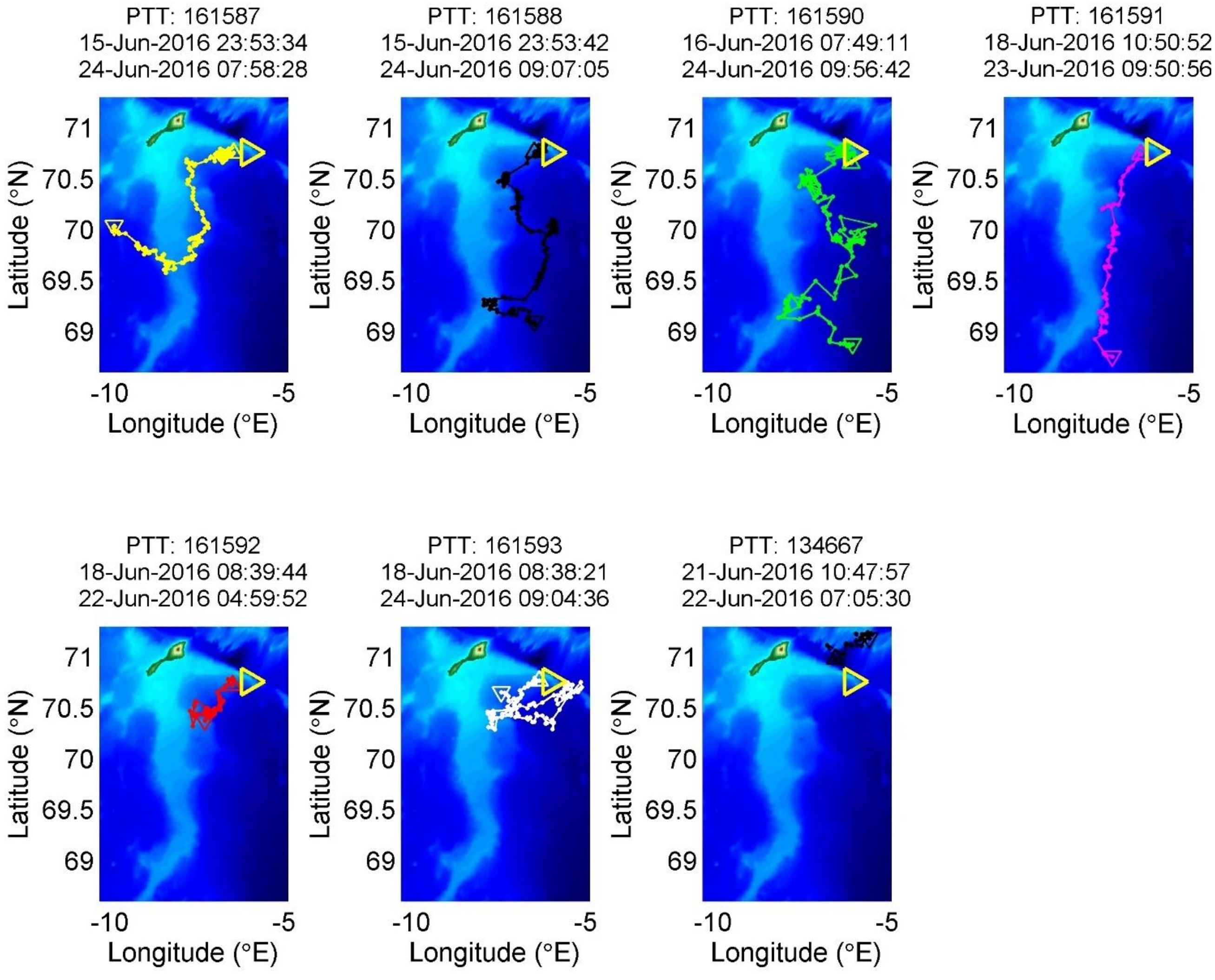


Figure 12. Raw, unfiltered satellite tag records showing larger scale movement tracks of satellite tagged whales up to 24 June, 6 days after the sonar exposure was conducted (3 tags had stopped transmitting within these 6 days). Note PTT 134667 was tagged after the DISTANT experiment was completed. Note that PTT161593 returned to the water near the experiment ~3 days after the exposure. The location of the source during exposure is indicated by a yellow triangle in each panel.

Behaviour Log dive records and Argos locations in relation to the sonar exposure were recorded by all six satellite tags deployed prior to the experiment (Figure 13). Periods of baseline data before transmission ranged from over 2 days to only 2 hours and data periods after exposure ranged from 4 to 26 days. Time Series dive profiles were additionally collected by three tags deployed on the very day of the experiment, thus offering greater resolution dive profiles for more detailed evaluation of behavioural responses (Figure 14).

The dive records for four of the tags (Ptt161587-8 and 161590-1) showed that these animals undertook distinctive avoidance dives resembling that of the 2013 experiment, swimming to maximum depths close to the water depth of the area. The start of these deep dives was either just after sonar onset (Ptt161587 and 161590) or near the end of sonar exposure (Ptt161588 and 161591). In contrast, the dive records of two other whales (Ptt161592 and 161593) rather indicated unusual changes in dive behaviour initiated during more shallow diving.

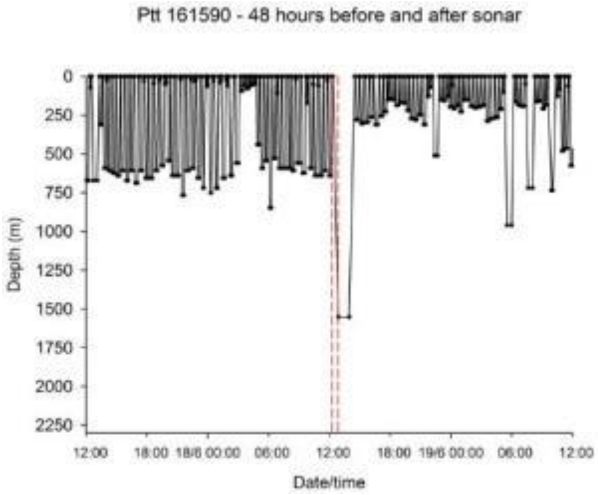


Figure 13. Example of dive data in relation to sonar (red dashed lines) for Ptt161590. Left panel shows all data transmitted from June 16 to July 18. Right panel shows dive data from 48 hours before to 48 hours after sonar exposure on June 18.

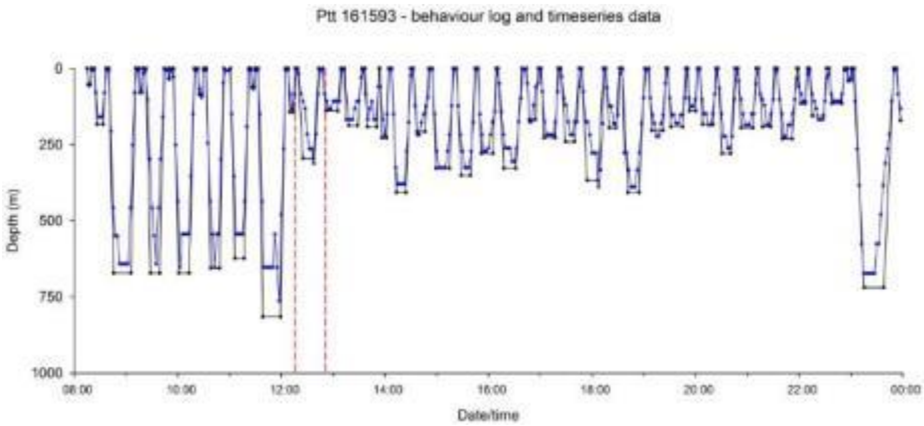


Figure 14. Example of dive data for ptt161593 in relation to the sonar exposure. Time Series (blue line), i.e. depth profile sampled every 2.5 minute, and Behaviour Log (black line), which was the prioritised scheme to collect dive data.

Biopsy samples

In total 11 biopsies were taken on five different days of the cruise (Table V). Sample sites were predominantly on the upper anterior of the body (Figure 15). Depending on the boat’s location (e.g. Norwegian or Icelandic waters), sub-samples for the following were taken for: 1) Iceland’s Marine Research Institute (skin); 2) body condition hormone analysis (blubber); 3) genetics (skin); 4) stable isotope analysis (skin) and 5) pollutants (skin).

Two of the samples consisted of skin samples from the suction cups of Mixed-DTags, obtained upon recovery of tag deployments Ha16_170a and Ha16_173a (Figure 1; Table 2). All biopsy tips were 60mm in length giving blubber thickness in the range of 4-22mm; excluding a barbed 40mm biopsy tip developed by Dr Sascha Hooker (U St Andrews) that gave a sample with a blubber thickness of 30mm.

*Table V. Summary of biopsies taken during cruise. Platform biopsy taken from (DW = Donna Wood, SC = tag suction cups, RIB = rigid-hulled inflatable boat). Response levels are: 0 = no reaction (i.e. no detectable change in behaviour); 1 = low-level reaction (i.e. short-term mild change, e.g. flinch or fast dive); 2 = moderate reaction (i.e. short-term forceful change, e.g. breach) and 3 = strong reaction (a succession of forceful activities). * Skin samples from suction cups of Mixed-Dtags processed post-tag recovery. ** Tag detached right away.*

Biopsy number	Date	Platform	Blubber thickness (mm)	Skin thickness (mm)	Response	Distance (m)	ARTS pressure (bar)	Tag deployed	Age class
LK-Ha-01	06/06/16	DW	4	2	1	18	7	No	-
LK-Ha-02	06/06/16	DW	18	3	1	25	8	No	-
LK-Ha-03	06/06/16	DW	22	2	1	19	8	No	-
LK-Ha-04	06/06/16	DW	8	3	1	11	8	No	Subadult
LK-Ha-05	16/06/16	DW	14	2	1	8	7.8	Yes**	Immature
LK-Ha-06	18/06/16	DW	16	1.5	1	11	7	Yes	Immature
Ha-07	18/06/16	SC*	-	-	-	-	-	-	-
LK-Ha-08	19/06/16	DW	30	2	0.5	25	7	No	Subadult
LK-Ha-09	21/06/16	RIB	4	1.5	1	11	7	Yes	Subadult
Ha-10	21/06/16	SC*	-	-	-	-	-	-	-
SI-Ha-11	21/06/16	DW	8	2	2	15	7.1	Yes**	Subadult

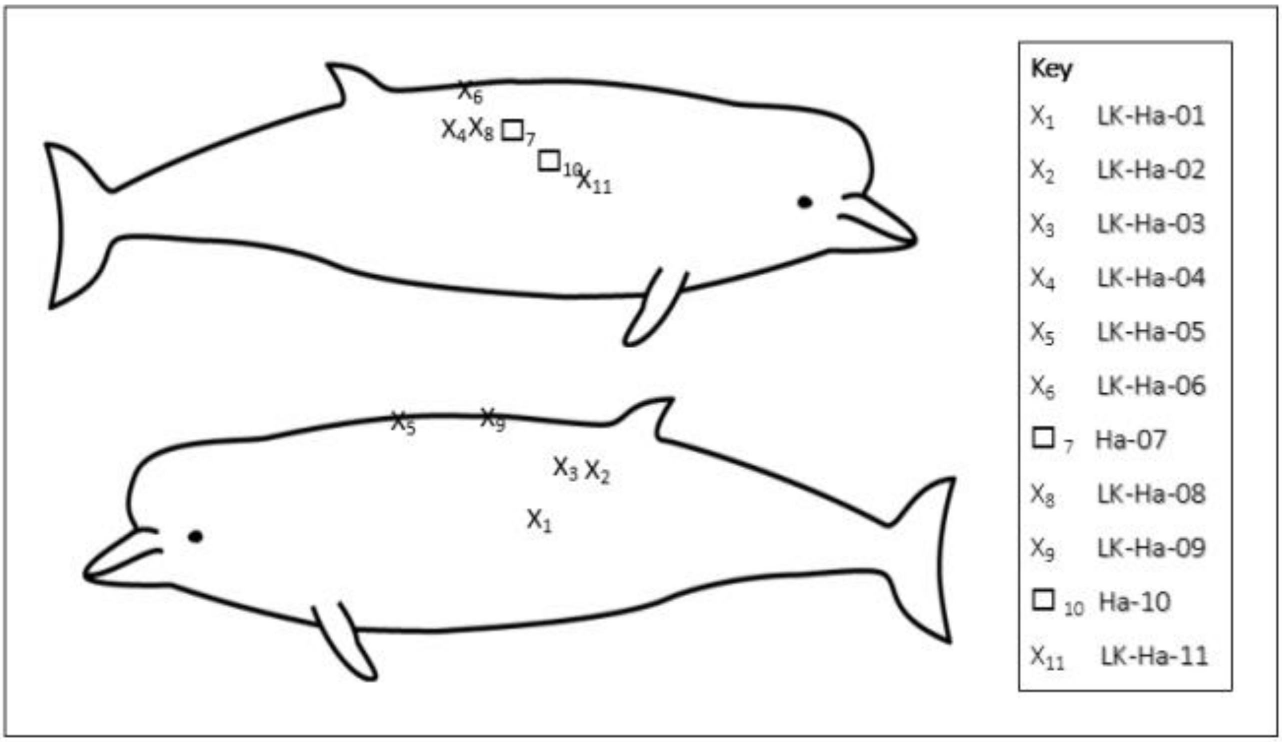


Figure 15. Biopsy sample sites for biopsies taken throughout the Jan Mayen 2016 cruise, including those taken via the ARTS via tag deployment or biopsy only effort (X) and skin samples taken from the suction cups collected post-tag recovery (□). The key related numbered symbols to the biopsy number.

CTD and XBT measurements

A total of 5 CTD casts and 5 XBT deployments were made in the Jan Mayen area, and one CTD cast was taken approximately midway to Jan Mayen during transit (Table VI, Fig 16). There was a notable degree of variation in water temperature at water depths <200m, which is likely to affect acoustic propagation in the area.

Table VI. CTD and XBT datasets collected during the trial

Cast	Date/Time	Type	Latitude		Longitude		Raw data file	Notes
			deg N	min	deg W	min		
1	06-Jun-16 13:51:11	CTD	68	21.488	13	17.272	20160606\ V000005.TXT	Test of equipment and procedure. Mixed-tags lowered down with probe
2	08-Jun-16 09:56:23	XBT	71	4.633	6	21.055	T7_00004.edf	Test of equipment and procedure
3	09-Jun-16 02:36:50	CTD	70	49.950	6	7.715	20160609\ V000004.TXT	SE acoustic buoy location
4	09-Jun-16 18:29:32	CTD	71	1.992	7	2.014	20160609_2\ V000011.TXT	NW acoustic buoy location
5	10-Jun-16 13:06:32	CTD	70	55.430	6	34.118	20160610\ V000005.TXT	Middle acoustic buoy location
6	15-Jun-16 09:17:11	XBT	71	1.250	6	31.346	T7_00005.edf	Northern part of deep canyon
7	17-Jun-16 14:23:16	XBT	70	41.374	5	43.530	T7_00006.edf	Eastern edge of study area
8	18-Jun-16 00:53:52	XBT	70	44.175	6	28.586	T7_00007.edf	Middle of future exposure area, during ha16_169a
9	19-Jun-16 02:26:54	CTD	70	42.956	6	40.676	20160619\ V000010.TXT	Middle of exposure area, after recovery of ha16_170a
10	20-Jun-16 07:52:20	XBT	71	30.385	9	8.536	T7_00008.edf	NW edge of study area, N of Jan Mayen island
11	21-Jun-16 20:48:33	CTD	71	7.883	6	28.302	20160621\ V000016.TXT	Before transit to recover tag ha16_173a

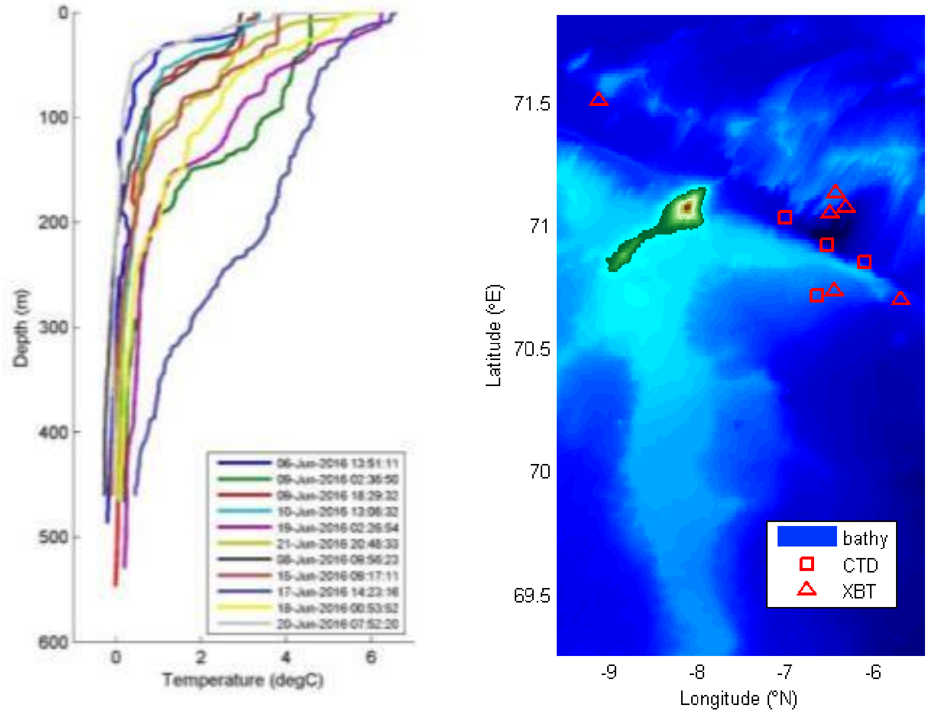


Figure 16. Left panel shows temperature profiles taken during the trial. Right panel shows the location of the CTD and XBT measurements taken near Jan Mayen.

Photo Identification

A total of 15,211 photographs were taken throughout the cruise. Six cetacean species were photographed over 19 days, with northern bottlenose whales photographed on 16 days (Table VII). All images were organised into folders according to: date, shift and camera. Further folders were created containing: 1) photo highlights; 2) video highlights; 3) personal photographs; 4) tag and biopsy photographs (categorised by tag deployment); and 4) species catalogues for cetacean species other than bottlenose (categorised by date).

Date	Number of Photos	Species Photographed
03/06/2016	87	-
04/06/2016	184	-
06/06/2016	1022	*H. ampullatus*
08/06/2016	9	*H. ampullatus*
09/06/2016	1247	*H. ampullatus; B. musculus*
10/06/2016	732	*H. ampullatus; B. musculus; B. physalus*
12/06/2016	193	-
13/06/2016	238	*H. ampullatus*
14/06/2016	1563	*H. ampullatus; P. macrocephallus*
15/06/2016	1729	*H. ampullatus; B. acutorostrata*
16/06/2016	1608	*H. ampullatus; O. orca*
17/06/2016	1653	*H. ampullatus; O. orca*
18/06/2016	1621	*H. ampullatus*
19/06/2016	317	*H. ampullatus*
20/06/2016	177	*H. ampullatus*
21/06/2016	2343	*H. ampullatus*
22/06/2016	238	*H. ampullatus*
23/06/2016	221	*H. ampullatus; B. physalus*
25/06/2016	29	*H. ampullatus*

Table VII. Number of photographs and the cetacean species photographed per day of the cruise, including northern bottlenose whales (*Hyperoodon ampullatus*), blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*), sperm whales (*Physeter macrocephalus*), minke whales (*Balaenoptera acutorostrata*) and killer whales (*Orcinus orca*).

Overhead video recordings

Successful overhead video recordings were made during tagging events, which can be useful to assess body size or shape of tagged whales and behaviour during tagging. From the four overhead cameras, 122hr of footage (139 GB in total) was recorded over 165 files across nine days. The mean frame rate was 24.8 frames s^{-1} (±SD 2.01) and the mean file duration was 45min 19s (±SD .037), although four files were blank. Northern bottlenose whales were captured by each of the four cameras (Figure 17), as were tag deployments from the Donna Wood (Figure 18).

Figure 17. Example still images of northern bottlenose whales from the 4 overhead cameras: 1) bow-starboard; 2) aft-starboard; 3) bow-port; and 4) aft-port.

Figure 18. Example of sequential still images (left to right, top to bottom) showing the deployment of Ha16_170a via the ARTS from the aft-starboard camera.

Acoustic buoy deployments

All acoustic buoys were successfully recovered and redeployed as planned (Tables VIII and IX), but the acoustic loggers themselves did not always function well. One of the long deployment datasets (far buoy) was unusable because its system noise increased almost immediately after the start of the recording There was no recording made by the far buoy deployed during the trial, likely due to an SD card fault. There was missing data from the near buoy deployed during the trial, which could have been due to an error in the recording system of the buoy or a copying / data-backup error.

Table VIII. Details of acoustic buoy deployments during the trial. AR=Acoustic release. Far= location furthest away from Jan Mayen, Near= location closest to Jan Mayen, Middle=new deployment location between Far and Near. Deployment time refers to when weights were deployed.

Deployment time [UTC]	Location	Latitude	Longitude	AR ID	Recording	Recovery	Notes
09/06/2016 06:21	Far	70°50.895N	06°08.226W	04DE-0455	Continuous	23/06/2016	The red led light did not work on the hydrophone, but test recording OK with a green indicator light in the recorder
09/06/2016 22:25	Near	71°01.945N	07°01.932W	08D1-0855	Continuous	23/06/2016	Discoloration of metal-to-metal connections in AR
10/06/2016 14:57	Middle	70°55.523N	06°33.640W	0803-0855	Continuous	22/06/2016	Light-bulb test indicated a depth of 2300m
23/06/2016 01:00	Far	70°51.128N	06°08.311W	04DE-0455	Periodic	TBA 2017	Test recordings OK, hydrophone led indicator OK. Logger ID 806121498
24/06/2016 08:39	Near	71°01.970N	07°02.152W	08D1-0855	Periodic	TBA 2017	Test recordings OK when using a different memory card. Logger ID 2016501988

Table IX. Details of Acoustic buoy deployments during the trial.

Recovery time [UTC]	Location	AR ID	Logger ID	Recording	First file [UTC]	Last file [UTC]	Notes
09/06/2016 04:15	Far	0803-0855	806113307	Periodic	17/06/2015 02:07:22	25/02/2016 09:37:22	Memory card full, probably due to high noise floor (+25dB), and thus recordings only up until February 2016.
09/06/2016 20:40	Near	08D1-0855	806121498	Periodic	30/06/2015 21:42:02	09/06/2016 20:57:03	Logger time behind GPS time by 1min 40s
22/06/2016 12:30	Middle	0803-0855	806121498	Continuous	10/06/2016 14:20:43	22/06/2016 11:16:05	
23/06/2016 00:10	Far	04DE-0455	201650198	Continuous	NA	NA	Only single recording stored at 80MB, likely due to SD card failure.
23/06/2016 15:00	Near	08D1-0855	806113307	Continuous	09/06/16 21:20:25	17/06/2016 21:38:53	Data recorded btw 09/06/2016 09:20:25 - 23/06/2016 12:54:39 (90 uncompressed files), but the last five days of data are missing. Logger time 2s behind GPS time at recovery.

Social Behaviour protocol testing and development

During the 2016 trial, an elevated crow's nest was placed roughly half up the main mast, roughly 12m above sea level. This new observation platform enabled the potential for systematic collection of social behaviour, as has been carried out in the past in 3S projects. A simpler, streamlined protocol was developed (Appendix 1) and tested during the trial, based upon a desired tracking distance of 500m from the tagged whale to avoid research vessel effect, especially seeking behaviour by the tagged whale.

Observers attempted to employ the new protocol on two occasions, when strong VHF signals were heard early in the tag deployments of ha16_169a and ha16_170. Unfortunately, in both cases, the tag slipped lower on the bodies of the tagged whales so VHF signals were lost and the protocol had to be abandoned. However, the effort was sufficient to evaluate the proposed protocol to enable refinement for future trials, should use of the protocol be desired.

Below are comments on our evaluation of the draft protocol. A revised protocol is detailed in Appendix 2.

<u>First sighting to tagging phase:</u>

- Overall, the crow's nest was an effective platform with good visibility and space for 2 people. The nest could be improved by adding a wind deflector, bolted steps for different sized people, and improved locations for storing equipment. However, given the rocking motions in the crow's nest, it was very challenging to use hand-held binoculars.

- It was typically possible to carry out group size and composition estimates when animals were close to the boat. Photo-id effort was intensive with at least 2 camera operators making a good effort to get photographs of all individuals.

- It was not possible to distinguish the full number of size classes suggested, so we simplified it to a smaller number of classes.

- The way in which group size is estimated was inherently different during this phase than during the follow phase, which had a tagged whale as a reference and was much further away. Thus, the two numbers do not seem comparable.

<u>Start baseline to focal follow.</u>

- It was not generally possible to take photo id during this phase due to the distance to the animals. We were able to get some photographs when we approached more closely to group ha16_169a.

- VHF beeps were needed to determine when the tagged whale was surfacing. When more than one group was nearby, reference to the DFHorten direction display was needed to be confident the correct group was being observed.

- It was generally not possibly to see the tag on the whale at the distance, but the tagged whale could be identified by correlating timing of beeps with surfacings of whales. However, this required a concentrated effort over many surfacings, and may not always be possible. Suggestion was made to mark the whale with paint using the ARTS system when tags were deployed.

- Once the tagged whale was identified within the group, it was possible to collect all parameters of the protocol. However, it was even more challenging to determine group composition observing from the crow's nest at 500m distance. So, an even simpler set of categories would be needed during this phase. We suggest 3 size classes might be possible, but seeing details of coloration will not always be possible to determine sex.

Post-Exposure phase:
- We were not able to reacquire the tagged whale after the experiment was conducted. For DISTANT exposures, it seems that will be the typical outcome.

OUTCOMES OF SPECIFIED CRUISE TASKS
Below the outcome for each of the cruise tasks is summarized.

Primary tasks:

Field-test and use a new 'mixed DTAG' which will include location sensors and a DTAG3 sensor unit. These tags will be deployed on northern bottlenose whales using a pneumatically launched tagging system (ARTS) or using the hand pole. Regular DTAG3 and DTAG2 loggers will serve as backup.

OUTCOME: A total of six mixed-Dtag deployments were made with bottlenose whales, 5 using the ARTS system, and 1 using the hand-pole. Three of the six deployments yielded sufficient long records to be useful to the study, one of which was the subject of the DISTANT sonar experiment conducted. Two ARTS deployments detached early due to partial contact with water upon deployment, and one deployment failed due to broken stems. All sensors were effectively demonstrated: Dtag3 core units collected high resolution underwater movement and acoustic data; Sirtrack GPS loggers obtained high quality fixes when tags were sufficiently high on the body of the whales, and ARGOS location of the tag after detachment were recorded, aiding in tag recovery, as designed. No tags were lost. Detailed plans for an improved version of the mixed-Dtag system have been prepared.

Collect baseline data of northern bottlenose whales off Jan Mayen island with DTAGs

OUTCOME: Baseline data was collected for three Dtag deployments with on-animal durations of roughly 5 and 12 hours (Fig 7; Table I). Pre-exposure baseline data of roughly 5 hours was recorded for whale ha16_170a, prior to exposure from distant baseline.

Collect skin/blubber samples and photographs for each tagged whale. Biopsy samples will be collected simultaneous with tagging using a specially-built 'biopsy picker' attached to the tag-attachment apparatus.

OUTCOME: Biopsy samples were collected from two of the three tagged whales. The biopsy picker functioned for both long-duration ARTS deployments, but did not succeed for the pole deployment.

Conduct CLOSE (0.5-2.0 km) and DISTANT (10-40 km) sonar exposure sessions with tagged animals, using two source level schemes designed to target similar received levels at the animals. The exact location of the DISTANT exposures will depend upon acoustic propagation modeling based on the sound speed profile in the water column measured in the field.

OUTCOME: One DISTANT sonar exposure was conducted, based upon acoustic propagation modeling based on the sound speed profile measured prior to exposure, bathymetry, and bottom sediment information. We were not able to conduct a CLOSE exposure. Experiment number was limited by difficulties tagging whales. One tagged whale could not be tracked after deployment as the tag apparently slipped too low on the whale's body.

Collect CTD profiles to measure sound speed and water density in the study area. Attempts should be made to lower the system to 600 m on a line close to areas where tags are deployed, near the acoustic buoys, and in the transmission path between the source and the tagged animals during sonar exposures. XBTs, which can be taken when the ship is moving, will be available as backup to the CTDs.

OUTCOME: A total of six CTD casts, and five XBT deployments were successfully made. Location of measurements and profiles are shown in Fig 8.

Deploy up to 8 SPLASH10 satellite tags on northern bottlenose whales in the study area

OUTCOME: A total of seven SPLASH10 satellite tags were deployed on northern bottlenose whales in the study area. One tag was lost at sea after a missed attempt. Six of the seven deployments were prior to the DISTANT sonar exposure, and one after the exposure. Plots of the satellite tagged whale movements are shown in Figs 2, 3.

Deploy 3 Loggerhead Instruments bottom-mounted acoustic recorders and redeploy 2 for the following year

OUTCOME: The two Loggerhead instruments acoustic recorders deployed over the winter were successfully deployed. The recorder in the SE position further from Jan Mayen had a noise fault. Three recorders were deployed as planned after a depth measurement of 2400m was made using a light-bulb test for the new middle location. Two of the three recorders successfully recorded data, while the logger in the SE position failed to record more than 100MB of data apparently due to a faulty SD data card. After further testing on-board, two acoustic recorders were redeployed for one year in the same SE and NW positions as the previous year.

Secondary tasks:

Tag and conduct observations of non-target species, including blue, humpback, killer and minke whales. Photographs and biopsy samples will be taken in association with tag deployment on these species.

OUTCOME: Photographs were taken of blue, fin, killer and minke whales encountered in the study area, but no tagging or biopsy attempts were made with non-target species.

Conduct playbacks of natural sounds and control sounds to bottlenose whales, minke whales or killer whales. We will playback killer whale sounds to bottlenose and minke whales, and pilot whale sounds to killer whales.

OUTCOME: No natural sound playbacks were conducted.

Develop and test a visual protocol for social behavioral sampling of northern bottlenose whales

OUTCOME: A visual protocol for social behavioral sampling was prepared, and implemented with observers positioned on a newly-installed crow's nest. Observations of whales associated with the tagged whale could be made from the crow's nest in good weather conditions, but some details of the protocol were not successful. Sufficient information was obtained to develop a refined protocol for future use.

Take overhead photogrammetry images of tagged bottlenose whales and associated calves

OUTCOME: Overhead images were successfully recorded from 4 cameras attached to the crow's nest. Calibration recordings of the tag boat were successfully recorded for measuring whale body size in the images.

Collect baseline information on movement patterns of mammal-eating killer whales in the Jan Mayen area using satellite tags.

OUTCOME: Killer whales were encountered in the Jan Mayen area, but appeared to be larger groups typically associated with herring-feeding killer whales. No observations of mammal-feeding killer whales were made. All satellite tags were deployed on northern bottlenose whales.

RECCOMENDATIONS FOR FUTURE RESEARCH TRIALS

The recommendations below were tabulated following a debrief meeting involving the entire science crew. They are not intended to be required for future research, but rather the benefit of each suggestion should be evaluated against the cost to accomplish it.

Safety Issues:
- tighter ratlines and bowsprit netting
- practice going up and down to crow's nest while vessel is still in harbour.

- improve small boat deployment system for swell conditions
- check engine is working before boat is lowered to the water as part of a boat deployment protocl
- make kitchen safer for use at sea

Facility: vessels and space:
- small boat was highly effective for tagging and should be used more with 2 good teams
- 2 boxes on the small boat to store gear
- mount baskets in the lounge for gloves and small gear
- develop a 'lowered' position for the boat to load gear before it goes into the water
- Consider placing DFHorten box in the wheel-house
- get real GPS heading for input into logger
- get new logger computer
- crow's nest was largely effective, but do more calibration of range sticks, consider to obtain wider field of view binoculars for use in the crow's nest
- establish a box to keep gear in the crows nest, and have check-list for items to bring up using a specific ruck-sack
- add wind screen, bolted steps with clips to stabilize a step at different levels, possible foldable step to be smaller

Tagging platforms:
- install a seat at the very tip of the crow's nest to greatly increase tagging productivity
- Consider lowerable tagging platforms to the side of the vessel held firm using the mast cables. Should have safety lines and a footrail to stop slippage
- replace 2nd boat in the stern with a tagging platform – or have a more solid boat that a tagger could stand on
- use small boat more, need to have 2 ARTS taggers per shift for maximum effort
- refine sights and do practice in realistic conditions

Tags:
- make tags with more robust components, eg stems and housing to enable use of higher pressure. Goal is to enable 8 bars pressure.
- have 2 properly weighted dummy tags for efficient target practice
- have 4 mixed-Dtags
- try to make the tag smaller, more streamlined
- design tag to float higher in the water to enable use of the salt-water-switch for the SPOT
- develop rechargeable VHF and SPOT units to reduce weight and improve reliability
- have 3 recovery nets, not just one
- be sure you have a good system to monitor location of SPLASH and SPOT tags
- consider GPS telemetry of the whale position to enable experiments

Biopsy:
- biopsy picker on the pole did not trigger. Needs more testing
- consider skin collector for SPLASH tag robot
- dental brooch biopsy tip yielded a very nice sample. Do more testing with capability to use more of those types of tips
- larger gloves, more Ziploc bags, 'do not disturb' sign on biopsy kit, coolbox to temporarily store samples
- consider to use double-barrell Knut gun for multiple biopsies, and more precise aiming

Acoustic buoys:
- tubs were helpful to keep lines tidy
- do longer test recordings of equipment
- bring spare SD cards formatted for use
- have a SD card reader so the recorded data can be copied from the S card. Does that require another Loggerhead recorder?
- reduce number of people on the deck during deployment
- bring more data hard drives with more capacity, and have a protocol for use. WIFI system?
- consider to deploy acoustic buoy after aggregation locations are identified
- use AUV or drifter recorder to sample more areas

Sonar source:
- use calibrated recording system to monitor source level
-record outgoing signal on monitoring output (was not working)
- longer cable to get the source deeper
- install a working tilt sensor in the array to improve accuracy of propagation modelling

CTD:
- pulley on the yard-arm was useful
- bring more gloves
- use a bicycle system to pull up the line?
- have automatic fisheries winch installed

Photo-id / overhead cameras:
- 70D camera with 100-400 lens was a big improvement over 30D, which should be retired as it does not always function well
- develop a catalog / computer system for use in the field to enable recognition and sorting of marks, and in-field processing of images
- consider use of drones to get overhead images of individuals – enables left-right marks to be seen and would aid in determination of group composition
- consider to do photo-id from the crow's nest
- difficult to photo-id whales right in the stern, try to improve that area for photo-id
- consider higher resolution video cameras placed higher on the mast
- develop a simple, dedicated mounting system

Staffing:
- Bring on more tagging effort to increase efficiency during larger aggregations
- 5 per watch is crucial to maintain capability
- tracking phase needs sufficient people: 1 person for Horten/logger, 2 in crow's nest

Donna Wood:
- great vessel for the research
- assure toilets have a bar to hold in rough seas
- cabins need to be water-tight
- install hooks for cabin doors to keep them partially open

APPENDIX I. DRAFT PROTOCOL FOR SURFACE BEHAVIORAL SAMPLING USED DURING THE TRIAL.

FOCAL FOLLOW PHASE	MAIN OBJECTIVE	PROTOCOL	SAMPLING RATE	NOTES
First sighting – end tagging effort	1. Identify individuals in group 2. Record group size & composition	1. Photo ID 2. Social behaviour protocol (partly – for group size and composition only	One sighting and one resighting record per phase per group (finalise at end of phase)	Optimal phase to collect individual and group ID/composition data due to proximity to animals; inds will likely alter behaviour in response to RV
Start baseline - End experiment Case I: in (reasonable) sighting range Case II: too far for observations	Identify key social behaviours (+ photo ID)	I - Full social behaviour protocol II - Not possible	I - One record per surfacing bout II – n/a	Collect social behaviour data when possible (depending on distance from RV), for animals in baseline and during experiment
Post experiment – End focal follow effort	1. Identify individuals in group 2. Identify key social behaviours	1. Photo ID 2. Full social behaviour protocol	One record per surfacing bout	Enable comparison of individual and group ID/ composition & social behaviour during baseline, pre- and post exposure

Parameter	Definition	Logger input	Quantification	Phase
Group size	Number of animals most closely associated with the tagged individual	Low, best and high estimate of group size	Number of individuals	ALL

	and with each other			
Group composition	Number of adults, adult males, immature adults/females, imm. males, subadults and calves in the group	Estimate of number of each age/sex class (definitions below)	Number of individuals per age-class	ALL
Number of individuals in focal area	Number of individuals within 200 m of the tagged individual	Best estimate of number of individuals in focal area	Number of individuals	Start BASE – end focal follow
Individual spacing	Distance between individuals in the focal group (in body lengths (BL))	Individual spacing category	*Very tight*: <1 BL *Tight*: 1–3 BL *Loose*: 3–15 BL *Very loose*: >15 BL and within focal area *Solitary*: no other individual in focal area and/or distant from nearest neighbour	Start BASE – end focal follow
Milling	% of surfacings in focal group with different orientation than surfacings of tagged individual	% of surfacings with different orientation	Number_ 0-100 (0 = all surfacings same orientation; 100 = full milling, all surfacings different orientation)	Start BASE – end focal follow
Surface behaviour events	Number of events per type of surface behaviour in the focal group	Number of events per event type (spyhop, log, breach)	Number of events	Start BASE – end focal follow
Comments	Additional comments on (rare) behaviours not covered by the protocol	Text	Consistently comment on occurrence of the state/event type commented on, each time it occurs	ALL

DEFINITIONS

GROUP:

All individuals in closer proximity to the focal animal (tagged whale) and each other than to other individuals in the area.

This definition is different from other standard definitions of 'group'. The difference is that group membership is defined based on the relative spacing of individuals to each other. It is not defined as, for example, all animals that have been travelling consistently together since start of observation. **There are several reasons to adopt this group definition for field observations, and it is the backbone of the protocol, so please ensure you understand the definition, and why it is used this way.** It is essential that this definition is used to ensure high quality data collection of social behaviour.

The reasons include 1) we do not know which animals consider themselves to form 'a group', from field observations. Thus, defining it based on a qualitative measure such as – 'have been together in the same area for some time' is prone to error (observer bias, sightability bias, interpretation bias, etc), and also strongly reduces our ability to qualitatively assess changes in distribution/association of individuals across exposure periods and different behavioural states. 2) Following from 1) we need quantitative measures to define a group, not based on assumption from observer as to who form a group together. We therefore developed a dynamic definition of the group for field observations, which is centred around the tagged individual.

In our 2014 paper, we describe the group definition and rationale in detail, and I paste the section on group behaviour below. Please also read the paper, for further clarification.

Copied from Visser et al. 2014 paper:

2.3. Definition of the focal group

The composition of groups is dynamic and could change during the focal follows. We therefore defined the focal group as the group of individuals in closer proximity to the tagged individual and each other than to other individuals in the area (Figure 1). For this purpose, we first defined different spacing categories based on the distance between individuals measured in BLs (Table 1). *Closely associated pairs (<1 BL), such as mother-calf pairs, were treated as a single unit in the assessment of distances between individuals.*

When the tagged whale surfaced, the first step in estimating group size was to determine the nearest neighbour of the tagged individual. The focal group included all individuals with similar proximity (according to the individual spacing categories; Table 1) to the tagged whale or other group members as the nearest neighbour. *If the nearest neighbour was in closer proximity to other individuals than to the tagged whale, then the tagged whale was assigned as solitary.*

Thus, focal group membership was based on the relative distribution of individuals around the tagged whale (Figure 1). Our definition is comparable to the chain-rule, which identifies group members based upon maximum distance between nearest neighbours (e.g., 50 m; Smolker et al., 1992). However, instead of a predetermined absolute distance, **we based group membership on the relative distances between individuals to capture the variation in individual spacing that we observed in our study animals.**

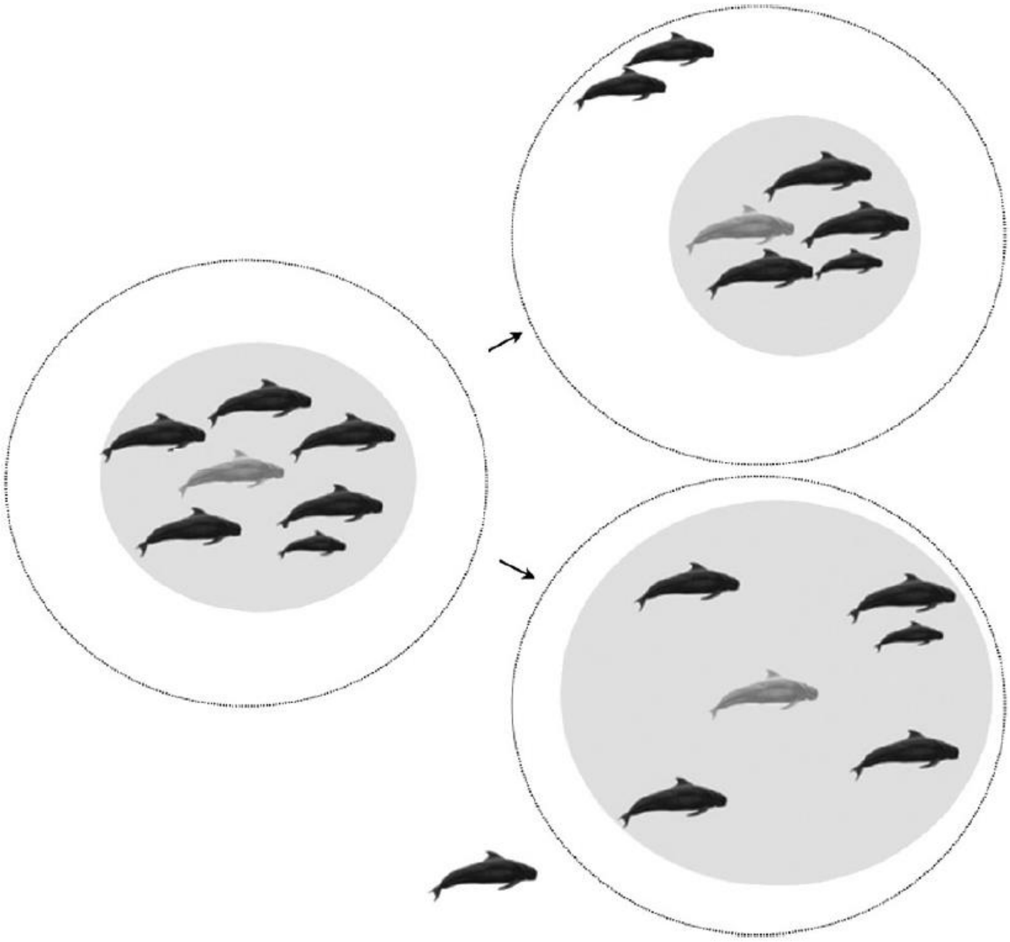


Figure 1. Determination of the focal group. The focal group (grey area) is the group of individuals in closest proximity to the tagged individual (grey animal) and each other. The focal area (dashed circle, not to scale) encompasses the 200 m radius around the tagged whale. For example, a focal group of 7 individuals (left) changes its organisation. Top right: Two individuals become more distantly spaced (3–15 BL) from the tagged whale and other individuals in the focal group than the spacing within the focal group (<1 BL). The group splits up in two smaller groups, and the group with the tagged animal remains the focal group. Bottom right: The focal group becomes more widely spaced, but the relative spacing between individuals remains the same (3–15 BL). One animal leaves the focal group and the focal area.

Additional notes: following from the protocol, the tagged whale can be solitary, even if other individuals are relatively close-by, but closer spaced to each other than to the focal whale. This may be counterintuitive, but what you actually record is a measure of relative spacing, not that the whale is alone in the area; Mother calf pairs should be treated as a single ‘individual’/unit in the assessment of relative spacing between individuals when defining the group (i.e. if the focal animal is tightly paired, the distance to its nearest neighbour is <1 BL (to the individual with which it is paired), but this NN distance should be ignored to avoid the group size always being ‘2’ in case of paired whales; see bottom right graphic in Figure 2). All individuals are included in the count of group size and composition, this procedure only applies to defining the individuals in the group of the tagged individual.

AGE/SEX CLASSES

ADULT: Adult-sized individual

ADULT MALE: Largest size, very flat forehead, often white melon, white ring

IMMATURE ADULT/FEMALE: Medium size, bulbous head, little white color

IMMATURE MALE: Large size, flat forehead, less clear white, white ring

SUB-ADULT (male or female): Smaller, less bulbous head

CALVES: Notably small (1/2 size of accompanying animal), can have foetal folds

Additional notes:

- Full explanation of social behaviour sampling protocol rationale and set-up, including expanded explanation on group definition, sampling of the parameters can be found in Visser et al. 2014.

- Sampling takes place once per surfacing bout, the period between first surfacing after a dive and last surfacing before a dive. Thus, data collected represents the social behaviour during the entire bout. There record is best taken towards the end of the surfacing bout (*i.e.* when animals have been up for several breaths), so that the observer has the time to observe the individuals for some time, and during several surfacings, before he/she calls the behaviour. This allows for higher quality data recording. It’s possible to standardise the sampling regime by always taking a Logger record at the first or second surfacing, but only filling in the social behaviour data when the individuals are diving again, giving the observer the full sequence to observe the behaviour.

- Protocol to be adapted when behaviours are observed that should be captured, but are not yet included in the sampling regime. Examples are: not all individuals are diving while tagged animal is not at the surface for some time (*i.e.* asynchrony in diving behaviour), lining up, strong changes in speed, mode of swimming (if not captured by tag, or by only part of the group)

- Use comments to mark states or events that need recording, but are not in the protocol yet, keep recording occurrence consistently in comments throughout follow; consider adding new parameter to protocol post-follow.

APPENDIX 2:
REVISED SOCIAL BEHAVIOUR PROTOCOL FOR FUTURE RESEARCH

FOCAL FOLLOW PHASE	MAIN OBJECTIVE	PROTOCOL	SAMPLING RATE	NOTES
First sighting – end tagging effort	1. Identify individuals in group 2. Record group size & composition	1. Photo ID 2. Social behaviour protocol (partly – for group size and composition only	One sighting and one resighting record per phase per group (finalise at end of phase)	Optimal phase to collect individual and group ID/composition data due to proximity to animals; inds will likely alter behaviour in response to RV
Start baseline - End experiment Case I: in (reasonable) sighting range Case II: too far for observations	Identify key social behaviours (+ photo ID)	I - Full social behaviour protocol II - Not possible	I - One record per surfacing bout II – n/a	Collect social behaviour data when possible (depending on distance from RV), for animals in baseline and during experiment
Post experiment – End focal follow effort	1. Identify individuals in group 2. Identify key social behaviours	1. Photo ID 2. Full social behaviour protocol	One record per surfacing bout	Enable comparison of individual and group ID/ composition & social behaviour during baseline, pre- and post exposure

Parameter	Definition	Logger input	Quantification	Phase
Quality score	Quality score for the social behaviour record, to identify whether data collection was feasible and accurate, or low quality due to large distance, multiple groups present, poor sightability or otherwise.	Tick box for low quality behaviour observations	Box ticked: low quality observation (default: box not ticked = good quality); optional: add comment on why low quality, and any parameter that could still be sampled at high quality	ALL
Group size	Number of animals most closely associated with the tagged individual and with each other	Low, best and high estimate of group size	Number of individuals	ALL
Group composition	Number of mature males, immature males/females and calves in the group (when possible, e.g. during tagging, extend classes with subadult males, juveniles)	Estimate of number of each age/sex class (definitions below)	Number of individuals per age-class	ALL
Number of individuals in focal area	Number of individuals within 500 m of the tagged individual	Best estimate of number of individuals in focal area	Number of individuals	Start BASE – end focal follow
Individual spacing	Distance between individuals in the focal group (in body lengths (BL))	Individual spacing category	*Very tight*: <1 BL *Tight*: 1–3 BL *Loose*: 3–15 BL *Very loose*: >15 BL and within focal area *Solitary*: no other individual in focal area and/or distant from nearest neighbour	Start BASE – end focal follow
Milling	% of surfacings in focal group with different orientation than surfacings of tagged individual	% of surfacings with different orientation	Number_ 0-100 (0 = all surfacings same orientation; 100 = full milling, all surfacings different orientation)	Start BASE – end focal follow

Surface behaviour events	Number of events per type of surface behaviour in the focal group	Number of events per event type (spyhop, log, breach)	Number of events	Start BASE – end focal follow
Comments	Additional comments on (rare) behaviours not covered by the protocol	Text	Consistently comment on occurrence of the state/event type commented on, each time it occurs	ALL

DEFINITIONS

GROUP: <u>All individuals in closer proximity to the focal animal (tagged whale) and each other than to other individuals in the area.</u>

This definition is different from other standard definitions of 'group'. The difference is that group membership is defined based on the relative spacing of individuals to each other. It is not defined as, for example, all animals that have been travelling consistently together since start of observation. **There are several reasons to adopt this group definition for field observations, and it is the backbone of the protocol, so please ensure you understand the definition, and why it is used this way.** It is essential that this definition is used to ensure high quality data collection of social behaviour.

The reasons include 1) we do not know which animals consider themselves to form 'a group', from field observations. Thus, defining it based on a qualitative measure such as – 'have been together in the same area for some time' is prone to error (observer bias, sightability bias, interpretation bias, etc), and also strongly reduces our ability to qualitatively assess changes in distribution/association of individuals across exposure periods and different behavioural states. 2) Following from 1) we need quantitative measures to define a group, not based on assumption from observer as to who form a group together. We therefore developed a dynamic definition of the group for field observations, which is centred around the tagged individual.

In our 2014 paper, we describe the group definition and rationale in detail, and I paste the section on group behaviour below. Please also read the paper, for further clarification.

Copied from Visser et al. 2014 paper:

<u>*2.3. Definition of the focal group*</u>

The composition of groups is dynamic and could change during the focal follows. We therefore defined the focal group as the group of individuals in closer proximity to the tagged individual and each other than to other individuals in the area (Figure 1). For this purpose, we first defined different spacing categories based on the distance between individuals measured in BLs (Table 1). *Closely associated pairs (<1 BL), such as mother-calf pairs, were treated* *as a single unit in the assessment of distances between individuals*.

When the tagged whale surfaced, the first step in estimating group size was to determine the nearest neighbour of the tagged individual. The focal group included all individuals with similar proximity (according to the individual spacing categories; Table 1) to the tagged whale or other group members as the nearest neighbour. *If the nearest neighbour was in closer proximity to other individuals than to the tagged whale, then the tagged whale was assigned as solitary.*

Thus, focal group membership was based on the relative distribution of individuals around the tagged whale (Figure 1). Our definition is comparable to the chain-rule, which identifies group members based upon maximum distance between nearest neighbours (e.g., 50 m; Smolker et al., 1992). However, instead of a predetermined absolute distance, we based group membership on the relative distances between individuals to capture the variation in individual spacing that we observed in our study animals.

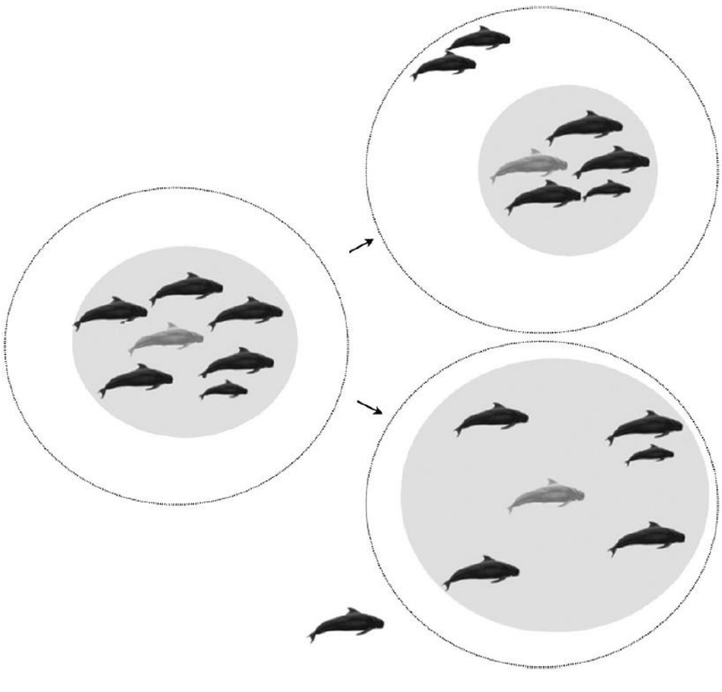


Figure 1. Determination of the focal group. The focal group (grey area) is the group of individuals in closest proximity to the tagged individual (grey animal) and each other. The focal area (dashed circle, not to scale) encompasses the 200 m radius around the tagged whale. For example, a focal group of 7 individuals (left) changes its organisation. Top right: Two individuals become more distantly spaced (3–15 BL) from the tagged whale and other individuals in the focal group than the spacing within the focal group (<1 BL). The group splits up in two smaller groups, and the group with the tagged animal remains the focal group. Bottom right: The focal group becomes more widely spaced, but the relative spacing between individuals remains the same (3–15 BL). One animal leaves the focal group and the focal area.

Additional notes: following from the protocol, the tagged whale can be solitary, even if other individuals are relatively close-by, but closer spaced to each other than to the focal whale. This may be counterintuitive, but what you actually record is a measure of relative spacing, not that the whale is alone in the area; Mother calf pairs should be treated as a single ‘individual’/unit in the assessment of relative spacing between individuals when defining the group (i.e. if the focal animal is tightly paired, the distance to its nearest neighbour is <1 BL (to the individual with which it is paired), but this NN distance should be ignored to avoid the group size always being ‘2’ in case of paired whales; see bottom right graphic in Figure 2). All individuals are included in the count of group size and composition, this procedure only applies to defining the individuals in the group of the tagged individual.

AGE/SEX CLASSES

Classes included in all records (following Gowans et al. 2001):

MATURE MALE: Largest size, very flat forehead, often white melon, white ring

IMMATURE MALE/FEMALE: Medium size, bulbous head, little white color

CALVES: Notably small (1/2 size of accompanying animal), can have foetal folds

Classes included ad libitum, when possible (close range):

SUBADULT MALE: Large size, flat forehead, less clear white ring than mature male

JUVENILE: Small animal, sized between calf and immature male/female

Additional notes:

- Full explanation of social behaviour sampling protocol rationale and set-up, including expanded explanation on group definition, sampling of the parameters can be found in Visser et al. 2014.

- Sampling takes place once per surfacing bout, the period between first surfacing after a dive and last surfacing before a dive. Thus, data collected represents the social behaviour during the entire bout. The record is best taken towards the end of the surfacing bout (*i.e.* when animals have been up for several breaths), so that the observer has the time to observe the individuals for some time, and during several surfacings, before he/she calls the behaviour. This allows for higher quality data recording. It’s possible to standardise the sampling regime by always taking a Logger record at the first or second surfacing, but only filling in the social behaviour data when the individuals are diving again, giving the observer the full sequence to observe the behaviour.

- Protocol to be adapted when behaviours are observed that should be captured, but are not yet included in the sampling regime. Examples are: not all individuals are diving while tagged animal is not at the surface for some time (*i.e.* asynchrony in diving behaviour), lining up, strong changes in speed, mode of swimming (if not captured by tag, or by only part of the group)

- Use comments to mark states or events that need recording, but are not in the protocol yet, keep recording occurrence consistently in comments throughout follow; consider adding new parameter to protocol post-follow.

Appendix 3: Sightings of marine mammals during the trial. Codes used are MN: humpack whale; HA: northern bottlenose whale, SL? unknown seal, W?: unknown whale, BA: minke whale, BM: blue whale, BP: fin whale, PM: sperm whale, B? unknown baleen whale, LAl: white-beaked dolphin, OO: killer whale. An empty cell for group size indicates it was not possible to estimate the number of animals, but at least one was present.

Date Time (UTC)	VesselLatitude	VesselLongitude	Species	Group size
05/06/2016 19:58:59	66.85184	-16.0647	MN	1
06/06/2016 08:29:52	68.01253	-14.0133	MN	1
06/06/2016 08:55:01	68.05066	-13.9466	HA	3
06/06/2016 09:33:11	68.04813	-13.9392	HA	8
06/06/2016 09:57:12	68.07547	-13.8773	HA	4
06/06/2016 10:07:53	68.08914	-13.8448	HA	3
06/06/2016 11:27:09	68.19006	-13.6032	HA	3
06/06/2016 12:21:23	68.23539	-13.4986	SL?	
06/06/2016 18:53:00	68.72438	-12.5716	HA	1
07/06/2016 04:56:12	69.51358	-10.8602	W?	
07/06/2016 05:20:39	69.54165	-10.7951	MN	1
07/06/2016 07:08:41	69.66355	-10.5074	MN	1
07/06/2016 11:54:50	70.01871	-9.64925	BA	1
07/06/2016 13:14:27	70.10439	-9.34982	HA	1
07/06/2016 16:59:23	70.31579	-8.49761	BA	1
08/06/2016 10:46:41	71.10349	-6.3864	HA	3
09/06/2016 03:10:59	70.8419	-6.13388	HA	5
09/06/2016 09:33:41	71.00734	-6.56077	HA	3
09/06/2016 10:51:34	71.01213	-6.52754	HA	2
09/06/2016 13:04:49	70.94239	-6.54604	HA	1
09/06/2016 14:13:00	70.94417	-6.48847	HA	2
09/06/2016 15:42:11	70.99134	-6.77294	BM	1
09/06/2016 16:51:09	71.02608	-6.98791	HA	3
09/06/2016 17:31:08	71.02805	-6.99396	HA	6
09/06/2016 22:50:24	71.01859	-6.95484	HA	4
09/06/2016 23:47:33	71.0177	-6.97233	HA	3
10/06/2016 03:00:40	70.97793	-6.42528	BM	1
10/06/2016 04:59:00	71.07954	-6.2061	HA	2
10/06/2016 05:36:27	71.07975	-6.12753	BP	2
10/06/2016 07:30:12	71.02698	-5.93012	HA	2
13/06/2016 03:56:25	71.15883	-8.6546	HA	3
13/06/2016 07:35:09	71.30824	-8.76107	HA	2
13/06/2016 08:15:20	71.30508	-8.72274	HA	3
13/06/2016 10:54:09	71.30419	-8.245	HA	

13/06/2016 12:14:28	**71.31704**	**-8.20772**	**HA**	**2**
13/06/2016 15:17:51	**71.32076**	**-9.00121**	**HA**	**2**
13/06/2016 16:42:36	**71.35593**	**-8.99814**	**W?**	
13/06/2016 19:15:00	**71.41417**	**-8.71887**	**HA**	**3**
14/06/2016 04:05:39	**71.02075**	**-6.97313**	**BP**	**2**
14/06/2016 05:04:51	**70.97261**	**-6.90734**	**HA**	**2**
14/06/2016 05:09:14	**70.96603**	**-6.90233**	**B?**	**1**
14/06/2016 05:37:00	**70.95894**	**-6.89139**	**PM**	**1**
14/06/2016 06:46:10	**70.91323**	**-6.6966**	**PM**	**1**
14/06/2016 06:46:59	**70.91219**	**-6.69675**	**PM**	**1**
14/06/2016 07:07:47	**70.92032**	**-6.64045**	**BP**	
14/06/2016 09:35:34	**70.86332**	**-6.20065**	**HA**	**4**
14/06/2016 09:40:52	**70.85729**	**-6.21554**	**PM**	**1**
14/06/2016 12:29:29	**70.86455**	**-6.24218**	**HA**	**2**
14/06/2016 13:23:32	**70.87381**	**-6.25648**	**HA**	
14/06/2016 13:33:31	**70.87741**	**-6.25881**	**LAl**	**15**
14/06/2016 14:23:04	**70.88233**	**-6.27291**	**HA**	**1**
14/06/2016 14:54:09	**70.87241**	**-6.30276**	**BA**	**1**
14/06/2016 15:22:17	**70.86343**	**-6.24482**	**HA**	**4**
14/06/2016 15:39:47	**70.85251**	**-6.18003**	**BA**	**1**
14/06/2016 16:13:30	**70.8428**	**-6.18573**	**BA**	**1**
14/06/2016 17:58:11	**70.82628**	**-6.03118**	**HA**	
14/06/2016 18:09:50	**70.82352**	**-6.01653**	**MN**	**1**
14/06/2016 18:20:25	**70.82178**	**-6.01656**	**HA**	
14/06/2016 20:20:00	**70.82964**	**-5.68316**	**PM**	**1**
14/06/2016 23:03:18	**70.97182**	**-5.97375**	**HA**	**2**
15/06/2016 03:36:56	**71.12101**	**-6.17237**	**BA**	**1**
15/06/2016 06:29:55	**71.04228**	**-6.27982**	**HA**	
15/06/2016 06:50:52	**71.0476**	**-6.36707**	**HA**	**3**
15/06/2016 08:12:55	**71.02701**	**-6.35271**	**HA**	**3**
15/06/2016 10:34:55	**70.98111**	**-6.71157**	**BM**	**1**
15/06/2016 10:56:46	**70.95349**	**-6.7245**	**BA**	**1**
15/06/2016 11:07:48	**70.93907**	**-6.70811**	**BA**	**1**
15/06/2016 13:28:30	**70.913**	**-6.46914**	**HA**	**3**
15/06/2016 14:24:11	**70.90644**	**-6.43381**	**HA**	**3**
15/06/2016 14:44:31	**70.87885**	**-6.4211**	**HA**	**2**
15/06/2016 16:15:39	**70.8304**	**-6.37632**	**HA**	**4**
15/06/2016 18:42:12	**70.77162**	**-6.43782**	**HA**	
15/06/2016 18:56:08	**70.75326**	**-6.46121**	**HA**	**3**
15/06/2016 19:37:16	**70.75308**	**-6.4995**	**HA**	**3**
15/06/2016 21:59:07	**70.73978**	**-6.54517**	**HA**	**4**
15/06/2016 23:04:55	**70.73518**	**-6.58137**	**HA**	

15/06/2016 23:06:18	**70.73618**	**-6.58172**	**HA**	**4**
15/06/2016 23:58:18	**70.73818**	**-6.61213**	**HA**	**12**
16/06/2016 00:15:15	**70.73457**	**-6.6272**	**HA**	**4**
16/06/2016 01:25:42	**70.72495**	**-6.64664**	**HA**	**4**
16/06/2016 02:04:32	**70.72155**	**-6.63399**	**HA**	**1**
16/06/2016 02:10:00	**70.72226**	**-6.62969**	**BA**	**1**
16/06/2016 02:39:09	**70.73565**	**-6.55688**	**HA**	
16/06/2016 03:20:52	**70.76332**	**-6.53237**	**HA**	**3**
16/06/2016 03:21:26	**70.7631**	**-6.5307**	**HA**	**4**
16/06/2016 03:31:59	**70.76321**	**-6.52553**	**HA**	**8**
16/06/2016 04:06:36	**70.76135**	**-6.52869**	**HA**	**8**
16/06/2016 04:39:10	**70.76237**	**-6.54134**	**HA**	**5**
16/06/2016 05:19:18	**70.7587**	**-6.53668**	**HA**	**8**
16/06/2016 05:26:00	**70.76382**	**-6.53476**	**HA**	**8**
16/06/2016 05:31:18	**70.7611**	**-6.53642**	**HA**	**2**
16/06/2016 05:39:02	**70.75795**	**-6.53695**	**OO**	**4**
16/06/2016 05:52:16	**70.7556**	**-6.53871**	**OO**	**8**
16/06/2016 06:09:50	**70.74345**	**-6.49258**	**HA**	**5**
16/06/2016 06:32:36	**70.75436**	**-6.47495**	**HA**	
16/06/2016 06:51:39	**70.75552**	**-6.53307**	**HA**	**3**
16/06/2016 06:54:03	**70.75646**	**-6.54276**	**HA**	**4**
16/06/2016 07:47:02	**70.75748**	**-6.51616**	**HA**	**4**
16/06/2016 10:16:57	**70.74604**	**-6.56803**	**BA**	**1**
16/06/2016 10:52:47	**70.77907**	**-6.49395**	**HA**	**2**
16/06/2016 10:57:04	**70.77505**	**-6.47854**	**HA**	**3**
16/06/2016 11:01:18	**70.77168**	**-6.46261**	**HA**	**2**
16/06/2016 11:02:36	**70.77028**	**-6.45858**	**HA**	**2**
16/06/2016 12:01:34	**70.75903**	**-6.41969**	**HA**	**5**
16/06/2016 12:12:09	**70.76369**	**-6.42031**	**HA**	**6**
16/06/2016 12:20:27	**70.76706**	**-6.42874**	**HA**	**4**
16/06/2016 12:21:38	**70.76588**	**-6.42564**	**HA**	**3**
16/06/2016 12:23:24	**70.76457**	**-6.42236**	**HA**	**6**
16/06/2016 13:38:39	**70.76169**	**-6.41142**	**HA**	**5**
16/06/2016 15:01:05	**70.77139**	**-6.37271**	**HA**	**3**
16/06/2016 15:01:06	**70.77139**	**-6.37271**	**HA**	**2**
16/06/2016 16:07:13	**70.73973**	**-6.54089**	**HA**	
16/06/2016 16:46:46	**70.73266**	**-6.55115**	**HA**	**2**
16/06/2016 17:44:38	**70.70821**	**-6.65456**	**HA**	**3**
17/06/2016 04:49:23	**70.82418**	**-6.81571**	**HA**	**1**
17/06/2016 08:34:16	**70.86015**	**-6.36631**	**HA**	**4**
17/06/2016 08:49:04	**70.85661**	**-6.35403**	**HA**	**4**
17/06/2016 09:29:13	**70.84772**	**-6.32343**	**HA**	**1**

17/06/2016 10:35:28	**70.85404**	**-6.08392**	**OO**	**3**
17/06/2016 11:29:21	**70.81062**	**-5.99721**	**OO**	**60**
17/06/2016 13:12:21	**70.72759**	**-5.84601**	**HA**	**2**
17/06/2016 15:22:12	**70.68408**	**-5.8664**	**HA**	**3**
17/06/2016 15:58:19	**70.6848**	**-5.88124**	**HA**	**2**
17/06/2016 16:38:47	**70.6614**	**-5.95597**	**HA**	**1**
17/06/2016 17:50:20	**70.68624**	**-6.10173**	**HA**	
17/06/2016 18:19:56	**70.69827**	**-6.23405**	**HA**	**4**
17/06/2016 21:23:25	**70.71301**	**-6.40483**	**HA**	
17/06/2016 21:30:41	**70.72023**	**-6.42622**	**HA**	
17/06/2016 21:52:34	**70.72263**	**-6.43193**	**MN**	**1**
17/06/2016 22:05:55	**70.72153**	**-6.43464**	**HA**	**3**
17/06/2016 22:06:42	**70.72171**	**-6.43561**	**HA**	
17/06/2016 23:18:26	**70.72856**	**-6.46307**	**HA**	**8**
18/06/2016 01:33:19	**70.74619**	**-6.46501**	**HA**	**5**
18/06/2016 02:46:37	**70.74842**	**-6.32884**	**HA**	**6**
18/06/2016 04:05:02	**70.75311**	**-6.0273**	**HA**	**3**
18/06/2016 05:43:41	**70.73698**	**-6.22492**	**HA**	**4**
18/06/2016 06:17:21	**70.74483**	**-6.38469**	**HA**	**2**
18/06/2016 06:20:39	**70.7444**	**-6.39958**	**HA**	**4**
18/06/2016 06:24:55	**70.74335**	**-6.41967**	**HA**	**5**
18/06/2016 06:52:53	**70.73882**	**-6.47392**	**HA**	**5**
18/06/2016 07:34:55	**70.73641**	**-6.48555**	**HA**	**4**
18/06/2016 07:42:06	**70.73981**	**-6.49099**	**HA**	**2**
18/06/2016 07:56:54	**70.75077**	**-6.50598**	**HA**	**4**
18/06/2016 09:57:57	**70.75484**	**-6.50355**	**HA**	**2**
18/06/2016 10:36:32	**70.75835**	**-6.50853**	**HA**	**15**
18/06/2016 10:58:18	**70.7588**	**-6.44416**	**HA**	**7**
18/06/2016 18:18:45	**70.70768**	**-6.75791**	**MN**	**1**
18/06/2016 19:10:05	**70.67397**	**-6.87107**	**HA**	**1**
18/06/2016 21:05:57	**70.63132**	**-7.07458**	**HA**	
18/06/2016 21:19:09	**70.61745**	**-7.11861**	**OO**	
18/06/2016 21:26:57	**70.61085**	**-7.13145**	**OO**	**30**
19/06/2016 05:21:57	**70.85174**	**-7.03995**	**BA**	**1**
19/06/2016 07:30:23	**70.9987**	**-7.46165**	**HA**	**5**
19/06/2016 09:52:35	**71.13486**	**-7.84194**	**BP**	
19/06/2016 11:02:01	**71.22207**	**-7.96961**	**HA**	**2**
19/06/2016 11:38:39	**71.23061**	**-7.97821**	**HA**	**4**
19/06/2016 12:45:30	**71.23021**	**-8.09015**	**HA**	**2**
19/06/2016 14:25:32	**71.25044**	**-8.38682**	**HA**	**2**
19/06/2016 16:33:28	**71.16007**	**-8.62744**	**HA**	
19/06/2016 18:13:24	**71.23056**	**-8.68785**	**HA**	**4**

19/06/2016 19:39:31	**71.2562**	**-8.71119**	**HA**	**2**
20/06/2016 03:42:31	**71.31564**	**-9.0701**	**W?**	
20/06/2016 09:10:26	**71.51794**	**-8.92188**	**HA**	**3**
20/06/2016 16:04:30	**71.17939**	**-8.45887**	**HA**	**3**
20/06/2016 16:59:59	**71.17935**	**-8.39249**	**HA**	
21/06/2016 01:55:18	**71.14211**	**-7.16917**	**HA**	**1**
21/06/2016 02:08:20	**71.14327**	**-7.16561**	**BA**	**1**
21/06/2016 03:13:37	**71.08699**	**-7.03322**	**W?**	**1**
21/06/2016 03:55:46	**71.05468**	**-6.95116**	**HA**	**3**
21/06/2016 04:03:34	**71.05234**	**-6.97594**	**W?**	**6**
21/06/2016 04:20:24	**71.05745**	**-6.91542**	**W?**	**1**
21/06/2016 04:24:47	**71.05828**	**-6.91036**	**BM**	**1**
21/06/2016 04:37:30	**71.06042**	**-6.89595**	**HA**	
21/06/2016 04:41:56	**71.06118**	**-6.89306**	**HA**	**4**
21/06/2016 06:22:08	**71.05319**	**-6.81924**	**HA**	**8**
21/06/2016 06:25:22	**71.05028**	**-6.82284**	**HA**	**4**
21/06/2016 07:15:11	**71.04868**	**-6.82388**	**HA**	**20**
21/06/2016 08:01:38	**71.06221**	**-6.83182**	**HA**	**2**
21/06/2016 08:19:52	**71.05124**	**-6.83383**	**HA**	**8**
21/06/2016 11:26:54	**71.07169**	**-6.81141**	**HA**	**2**
21/06/2016 11:41:24	**71.07533**	**-6.79421**	**HA**	**5**
21/06/2016 11:54:34	**71.07239**	**-6.79589**	**HA**	**3**
21/06/2016 12:20:14	**71.07375**	**-6.79494**	**HA**	**3**
21/06/2016 12:40:40	**71.06779**	**-6.79433**	**HA**	**3**
21/06/2016 13:17:46	**71.04944**	**-6.81223**	**HA**	**6**
21/06/2016 13:40:15	**71.03427**	**-6.77668**	**HA**	**5**
21/06/2016 15:52:10	**71.04391**	**-6.70048**	**HA**	**3**
21/06/2016 17:20:58	**71.07185**	**-6.71077**	**HA**	**7**
21/06/2016 21:38:36	**71.14323**	**-6.44359**	**HA**	**1**
21/06/2016 21:58:21	**71.1444**	**-6.3533**	**W?**	
21/06/2016 22:19:20	**71.14112**	**-6.24165**	**HA**	**2**
21/06/2016 22:28:26	**71.14063**	**-6.19409**	**HA**	**1**
21/06/2016 22:49:17	**71.15105**	**-6.08589**	**HA**	**2**
21/06/2016 22:53:52	**71.15522**	**-6.06371**	**BA**	**1**
21/06/2016 23:09:42	**71.16614**	**-5.982**	**HA**	**2**
21/06/2016 23:20:42	**71.17269**	**-5.9252**	**HA**	**3**
21/06/2016 23:26:55	**71.17562**	**-5.89289**	**BA**	**1**
21/06/2016 23:37:08	**71.17934**	**-5.83854**	**BA**	**1**
22/06/2016 03:20:32	**71.00963**	**-6.27517**	**BA**	**2**
22/06/2016 04:13:22	**70.97071**	**-6.42593**	**BA**	**1**
22/06/2016 07:39:22	**70.90471**	**-6.09295**	**HA**	**1**
22/06/2016 09:31:40	**70.93135**	**-6.28528**	**HA**	**6**

22/06/2016 14:04:20	**70.88567**	**-6.50963**	**BA**	**1**
22/06/2016 15:36:43	**70.76338**	**-6.47734**	**B?**	**1**
22/06/2016 19:09:03	**70.74608**	**-6.17024**	**HA**	**4**
22/06/2016 20:40:26	**70.73058**	**-6.18337**	**HA**	**4**
22/06/2016 20:42:35	**70.73007**	**-6.18215**	**HA**	**4**
22/06/2016 21:46:36	**70.73471**	**-6.26268**	**HA**	**2**
23/06/2016 05:07:09	**71.14427**	**-5.64317**	**BA**	**1**
23/06/2016 05:12:19	**71.15183**	**-5.65209**	**BA**	**1**
23/06/2016 05:45:05	**71.19385**	**-5.69922**	**HA**	**1**
23/06/2016 05:48:06	**71.19247**	**-5.69949**	**BA**	**1**
23/06/2016 05:57:41	**71.19267**	**-5.69553**	**HA**	**5**
23/06/2016 06:33:47	**71.19428**	**-5.66757**	**BA**	**3**
23/06/2016 06:35:53	**71.19319**	**-5.66265**	**HA**	**3**
23/06/2016 09:40:24	**71.1205**	**-6.09038**	**HA**	**3**
23/06/2016 10:19:16	**71.12792**	**-6.10344**	**W?**	**1**
23/06/2016 10:35:28	**71.12004**	**-6.14535**	**HA**	**2**
23/06/2016 10:37:40	**71.12058**	**-6.15136**	**BP**	**2**
23/06/2016 11:35:50	**71.10532**	**-6.31055**	**BA**	**1**
23/06/2016 11:38:47	**71.10359**	**-6.32321**	**BA**	**2**
25/06/2016 03:00:22	**69.69371**	**-7.58194**	**HA**	**2**
25/06/2016 19:33:42	**69.06438**	**-11.0551**	**HA**	**6**
25/06/2016 21:17:04	**69.05128**	**-11.0918**	**HA**	**15**