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English summary

The 3S-projects is an international collaborative effort with the aim to investigate behavioral reactions of cetaceans to naval sonar signals, in order to establish safety limits for sonar operations. This report summarizes the achievements, activities and data collection of the 3S-2013 research trial conducted in Norwegian waters. The overall objectives of the trial were to do sonar dose escalation experiments on northern bottlenose whales and minke whales to investigate the threshold and severity of behavioral responses. The trial took place partly in Lofoten, but mainly in the waters around Jan Mayen from mid June to mid July 2013 using the FFI research vessel HU Sverdrup II. During the trial a total of 383 sightings of 990 individual marine mammals were recorded, including 220 bottlenose whale and 91 minke whale sightings. During previous trials we have struggled to tag minke whales with acoustic and motion sensor DTAGs, used very successfully with other species, and therefore a lot of effort was invested in improving tagging techniques prior to this trial. We were very close many times, but we did not manage to tag any minke whales. Given our effort and lack of success, we conclude that with this species smaller tags which can be launched at longer distances should be used to improve the tagging success rate, even if this means using simpler sensor equipment on the tag which reduces the quality of the data.

Bottlenose whales are extreme deep divers which are difficult to tag and track over time. We successfully combined visual tracking of the animals at the surface with acoustic tracking under water using the sophisticated Delphinus towed hydrophone array system developed by TNO. The ship sailed in a 1nmi by 1nmi box pattern, trying to keep the focal group inside the box. We conducted 48 focal follows of bottlenose whales using this technique, with a combined duration of 91 hours. We tagged 1 animal in a group of 4 using the ARTS remote tagging system. We successfully conducted a sonar exposure experiment on this group, and the results indicate that bottlenose whales are sensitive to sonar and respond in a way which is consistent with the responses reported for other species of beaked whales.

We knew that the task of this trial was very difficult. Despite our hard work and continuous effort to collect data, we did not manage to do more than 1 experiment. However, the single successful experiment conducted is the first one on this species and the first one on any beaked whales far from a naval training range. We therefore believe that what we did achieve will be a very important result.

This trial was the last of the planned 3S trials which includes naval sonar exposures. During the three 3S-2 trials conducted (3S-2011, 3S-2012 and 3S-2013) we tagged and experimented with 1 minke whale, 1 bottlenose whales and 27 humpback whales. The combined dataset collected therefore implies that overall the project has been successful, but collecting more data for minke and bottlenose whales should be a priority for future studies.

Sammendrag

3S-prosjektet er et internasjonalt prosjekt med den målsetting å undersøke hvordan hval reagerer på marinens sonarer. Hensikten er å bruke denne kunnskapen til å etablere retningslinjer for bruk av sonar som reduserer risikoen for negative miljøeffekter. Denne raporten oppsummerer resultatene fra 3S-2013 toktet i Norske farvann. Toktetes overordnede målsetning var å gjennomføre dose-eskaleringsforsøk på nebbhval og vågeval for å undesøke hvordan de reagerer og ved hvilke terskel slike responser eventuelt oppstår.Toktet ble gjennomført delvis i Lofoten, men først og fremst i havområdene rundt Jan Mayen fra midten av juni til midten av juli 2013 ved bruk av FFIs forskningsfartøy HU Sverdrup II. Under toktet gjorde vi 383 registreringer av tilsammen 990 sjøpattedyr, inkludert 220 nebbhval og 91 vågehval. Under tidligere tokt har vi hatt problemer med å få festet DTAG-sensorpakken som inneholder både akustisk og bevegelsessensorer på vågehval, og vi har derfor i forkant av årets tokt jobbet systematisk for å forbedre merketeknikken. Vi greide likevel ikke å merke noen vågevhal på dette toktet selv om vi var svært nære ved flere anledninger. Vår konklusjon er at for å opnå en akseptabel merkesuksessrate med denne arten trenger man mindre og lettere merker som kan skytes presist på lengre avstander. Dette vil sansynligvis innebære at man må bruke en enklere sensorutrustning.

Nebbhval (bottlenose) er spesialiserte dypdykkere som også er vanskelige å merke og spore over tid. Vi brukte en kombinasjon av visuelle sporing av dyret på overflaten og akustisk sporing under vann ved hjelp av en tauet antenne (Delphinus) som er utviklet av TNO. Sverdrup seilte i et 1*1nmi boksemønster, hvor man hele tiden forsøkte å holde dyrene inni boksen. Dette krevde god koordinering men fungerte veldig bra. Vi sporet 48 grupper med denne teknikken i tilsammen 91 timer. Vi merket 1 nebbhval i en gruppe på 4 ved hjelp av ARTS-systemet og gjenomførte en sonareksponering. Resultatet fra dette eksperimentete viser at den norske nebbhvalen er like følsom for sonar som andre arter av nebbhval andre steder i verden.

Vi viste at målsetningene ved dette toktet ville bli vanskelige å oppnå fordi de to målartene er vanskelige å jobbe med. Til tross for iherdig innsats klarte vi bare å gjennomføre ett eksperiment. Dette er skuffende, men dette eksperimentet er det første som er gjennomført på denne arten og det første som er gjennomført utenfor et sonar-treningsfelt på noen nebbhval. Vi tror derfor at det vi faktisk greide å få til vil gi oss et viktig resultat.

Dette toktet er det siste planlagte toktet i prosjektet. I løpet av de tre toktene med sonareksponering som er gjennomført som en del av 3S-2-prosjektet (3S-2011, 3S-2012 og 3S-2013) har vi merket og eksponert 1 vågehval, 1 nebbhval og 27 knøhval. Selv om det kombinerte datasettet er litt ubalansert regnes derfor prosjektet totalsett som en suksess. Mer data på nebbhval og vågehval er derimot viktig da disse artene ut fra de enkelt-eksperimentene vi har gjort ser ut til å være spesielt sensitive.

Contents

Preface

The 3S-2013 trial was conducted as part of the $3S^2$-project by the 3S-group. We are an international research consortium with the aim to investigate behavioral responses of cetaceans to naval sonar signals, in order to establish safety limits for sonar operations. The 3S-2013 trial was the third and last of the planned sonar trials within the $3S^2$-project. During these trials, field experiments are conducted where target whales are tagged and their behavior observed before during and after exposure to naval sonar signals and control sounds. The execution of field experiments, such as 3S-2013, in high Arctic waters requires special skills and equipment, not to mention incredible endurance. Our team consisted of 17 scientists from 7 different countries (Norway, The Netherlands, USA, New Zealand, Denmark, France and UK) in addition to the crew of 7 on the research vessel HU Sverdrup II. The research group included people with background in biology, underwater acoustics, oceanography, electronics, mechanical engineering, environmental science and operational sonar use; *Charlotte Curé, René Dekeling, Paul Ensor, Eirik Grøningsæter, Rune Roland Hansen, Eva Hartvig, Leigh Hickmott, Sander van IJsselmuide, Lars Kleivane, Petter Kvadsheim, Frans-Peter Lam, Patrick Miller, Machiel Oudejans, Lise Sivle, Mark van Spellen, Fleur Visser and Paul Wensveen.*

The main partners of the $3S^2$-project conducting the 3S-2013 trial were:

- The Norwegian Defense Research Establishment (FFI)
- The Netherlands Organization for Applied Scientific Research (TNO)
- Sea Mammal Research Unit (SMRU), Scotland
- Woods Hole Oceanographic Institution (WHOI), USA

In addition the following organizations are contributing to the project through their association with one or several of the main 3S-partners:

- Institute of Marine Research (IMR), Norway
- University of Saint-Etienne, France.
- Defense Material Organization, The Netherlands
- Kelp Marine Research (KelpMR), The Netherlands
- LK-ARTS, Norway
- Balena Research Ltd, New Zealand
- Open Ocean Consulting, UK
- WildNature.no, Norway

The $3S^2$ research project is funded by;

- The Norwegian Ministry of Defence
- The Netherlands Ministry of Defence
- Office of Naval Research, USA
- DGA, French Ministry of Defense

1 Introduction

Marine mammals are sensitive to sound in their environment. There is a continuing need to quantify the sensitivity of these animals to behavioural disturbance, and determine how potential behavioural changes may affect biologically significant activities, in order to regulate the use of powerful anthropogenic sound sources and design procedures to mitigate impact.

This report summarizes the achievements, activities and data collection of the 3S-2013 research trial conducted in Norwegian waters. The overall objectives of the trial were to do sonar dose escalation experiments on northern bottlenose whales and minke whales to investigate the threshold and severity of behavioral responses. The trial took place partly in Lofoten, but mainly in the waters around Jan Mayen from mid-June to mid July 2013 using the FFI research vessel HU Sverdrup II. The data collected are currently being analyzed and final results and recommendations will be published in suitable formats later. The 3S-2013 trial is the third and last planned trial under the current 3S-project and at the end of this report a brief overview of the 3S2 project is provided.

The 3S-projects is an international collaborative effort with the aim to investigate behavioral reactions of cetaceans to naval sonar signals, in order to establish safety limits for sonar operations. The first phase of the 3S-project (3S-I) was focused on effects of sonar on Odontocetes (pilot whales, sperm whales and killer whales) (Kvadsheim et al 2006; 2009), and we collected a very rich dataset on these species (Miller et al 2011). The second phase of the project (3S-2), under which the 3S-2013 trial was conducted, focused more on Mycticetes (humpback whales and minke whales) (Kvadsheim et al 2011; 2012) but also on a high-latitude beaked whale (northern bottlenose whale). After the 2011 and 2012 trials, the dataset on humpback whales was relatively rich and expected to be conclusive on the efficacy of ramp up on humpback whales (Kvadsheim et al 2012). We had however only conducted a single experiment on a minke whale, and no experiments on bottlenose whales. Since the minke whale experiment indicated that minke whales are very sensitive to sonar and respond at low levels, it was a very high priority to replicate this experiment this year. Bottlenose whales are a member of the family Ziphiidae or beaked whales, and recent studies have shown that more tropical species of this group are also very sensitive to naval sonar disturbance (Tyack et al 2011, DeRuiter et al 2013). It was therefore a high priority during this year’s 3S-trial to also study if bottlenose whales are as sensitive to sonar as some of the other beaked whales. Because the priority of the project changed, we also changed field site. During previous trials we operated between Bear Island and Spitsbergen, but this year we operated around Jan Mayen where we expected to find larger aggregations of bottlenose whales, and we knew from catch data there were large numbers of minke whales.

1.1 Cruise tasks and priorities

The objective of the project was planned to be met through the execution of the following specific primary and secondary tasks:

1.1.1 Primary tasks

Tag minke whales and northern bottlenose whales with DTAG and record vocal-, movement- and surface behavior, and thereafter carry out sonar dose escalation experiments (SDE) where the tagged animals are exposed to LFAS sonar signals and control experiment without any active transmissions.

1.1.2 Secondary tasks

1) Tag humpback whales with DTAGs and record vocal -, movement- and surface behavior, and thereafter carry out sonar Ramp UP experiments where the tagged animals are exposed to LFAS sonar signals and control experiment.
2) Carry out control experiments where tagged animals are exposed to a playback of killer whale sounds and a reference sound.
3) Tag animals and record natural undisturbed behavior of target species.
4) Collect group behavioral data to investigate the effect of tagging.
5) Collect information about the environment in the study area. Ambient noise, CTD and XBT measurements, acoustic propagation modeling and prey field mapping using echosounders.
6) Biopsy sampling of target species.
7) Collection of bio-acoustic data using towed arrays.
8) Evaluation of feasibility of doing baseline research on bottlenose whales on Jan Mayen.

Experiments on minke whales and bottlenose whales were given a higher priority than additional experiments on humpback whales on this trial. Secondary tasks were generally given a lower priority if they interfered with our ability to accomplish the primary tasks.

1.2 Structure of cruise report

The main part of this report summarizes the outcome of the 3S-2013 full scale sonar exposure trial conducted in Lofoten and Jan Mayen in June-July 2013. However, the 3S project also conducted three additional field trials in support of the main trial in 2013, and the cruise reports of these trials are published as appendices to this report:

<u>3S-13 Baseline I - Tag test trial in Andfjord in January (Appendix D)</u>
The objective of this trial was to test and make operational the ARTS pneumatic tag launching system using DTAGv2 and the Ctag2012 tags, both with barb attachment. Humpback whale was our main target species.

3S-13 Baseline II – Minke whale effort in Vestfjord in May-June (Appendix E)

The objective of this trial was to collect baseline data on minke whales and conduct playbacks of killer whale, humpback whale and naval sonar sounds to them.

3S-13 Baseline III - Pilot whale effort in Vestfjord in May-June (Appendix F)

The objective of this trial was to tag long-finned pilot whales and record baseline vocal-, movement- and surface behavior, followed by playback experiments where tagged animals are exposed to mammal-feeding killer whale sounds and control sounds.

2 Method

2.1 Equipment and staffing

Conducting controlled sonar exposure experiments on free ranging cetaceans at sea requires a variety of sophisticated equipment and expertise. The main platform of the trial was the FFI RV HU Sverdrup II with a regular crew of 7. The research team consisted of 17 scientists with a multidisciplinary background, including experts in biology, underwater acoustics, oceanography, electronics, mechanical engineering, environmental science and operational sonar use. Detailed description of ship, tag boats, tagging equipment, tags, sonar source, towed acoustic arrays and other necessary equipment can be found in the 3S-2013 cruise plan (Appendix C).

2.2 Overview of operation

The operation cycles through different phases:

1) The search phase where we look for target species using visual effort (marine mammal observers) and a passive acoustic array to detect vocalizing animals. 2) A tagging phase where light boats are deployed to attach acoustic and motion sensor tags on the whales. 3) A pre-exposure phase where the attached tag records the animal's normal behavior, including dive behavior, movement patterns (position) and vocal behavior. Social behavior and the position of the tagged whale are also recorded by the marine mammal observers from initial sighting until the tag comes off. This enables us to not only study the effect of the sonar, but also potential effects of the tagging. 4) An exposure phase where the animal(s) are exposed to an escalating level of sonar sounds, while behavior is recorded using the same method as during the pre-exposure phase. After the sonar exposure the animals are also exposed to playbacks of predator sounds (killer whale calls) as a positive control, and non-predator sounds (broadband noise or humpback whale calls) as a negative control. 5) A post exposure phase where the tag and the marine mammal observers record behavior after the exposures are completed. After 15-17 hrs the tag detaches from the whale and is recovered to download the data. Attempts are made to collect a biopsy tissue sample of the tagged animal around the time of tag detachment. After a resting period, the operation then returns back to search phase to look for more study subjects.

The planned experimental design and data collection procedures are described in detail in the 3S-2013 cruise plan (Appendix C).

2.3 Tracking bottlenose whales acoustically and visually

Bottlenose whale are social animals and deep divers. In periods they dive relatively “shallow (100-300m) and can be seen at the surface relatively frequently, but roughly every 80min they make very long (> 1hr) and deep (>1000m) dives (Hooker and Baird 1999). During these deep diving periods, they can’t be tracked visually, but they vocalize quite regularly and could therefore be tracked acoustically under water. During this trial we used a very efficient procedure combing visual and acoustic tracking of the animals. When bottlenose whales were either sighted by the marine mammal observers or detected on the Delphinus acoustic array, the Sverdrup started sailing in a pattern of 1*1nmi boxes, trying to keep the focal group of whales inside of the box (Fig. 2.1.). The size of the box and this navigation pattern turned out to be a good compromise between the need to stay within visual and acoustic detection range, the need to stay close enough to do sampling of social behavioral upon every surfacing using naked eye or binoculars, and at the same time keep the ship moving at constant speed to optimize the performance of the acoustic array. The boxing pattern also kept the animals on one side of the ship, limiting the search sector for the visual observers, and solving the left-right ambiguity of the acoustic tracking. The advantage of being able to track the animal almost continuously, also during deep diving periods, was that you could more reliably track the same group over time, and you could guide the tag boats to a good position for the next tagging attempt. The main motivation however, was to use this procedure to determine when to start the sonar exposure, as our protocol implied that we should start sonar exposure at the start of a deep dive cycle.

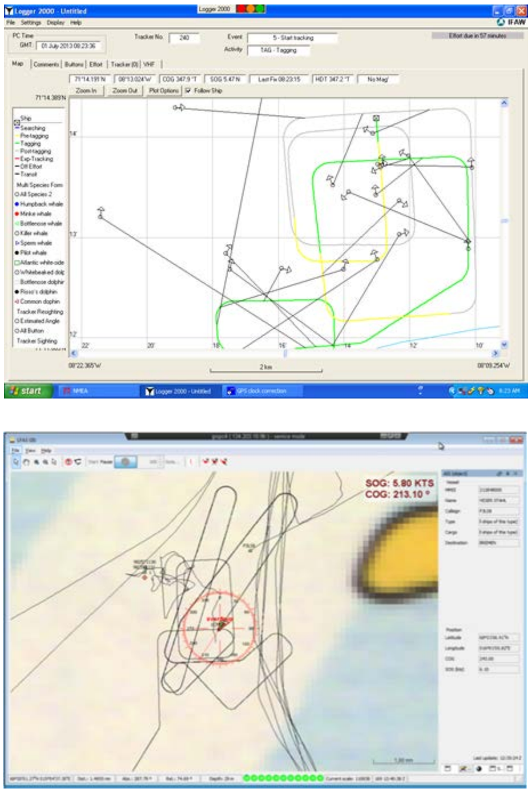


*Figure 2.1 Top panel: Screenshot from the Logger screen of the Marine mammal observer platform on Sverdrup. Triangles represent sightings of a group of bottlenose whales. The ship is sailing in 1*1nmi boxes at constant speed around the last known position of the bottlenose whales.*

Bottom panel: GIS display from the Delphinus system showing the estimated position of acoustic detections of bottlenose whales (pink dot). Black lines are the sailed track of the Sverdrup. The AIS position of the tag boats are also shown in this display (green dots).

In order to optimize the advantage of this combined visual and acoustic tracking procedure, very close coordination between the visual MMO-platform and the acoustic station was needed. A person on the MMO-platform was dedicated to be the coordinator and handled the navigation as well as communication between the ships navigators, the MMOs, the Delphinus operator and the tag boats over VHF-radio. The tracking coordinator had access to the Logger screen on the MMO platform where all the visual sightings were visible in a GIS display (Fig. 2.1), and on separate screen he could also see the position of the tag boats and acoustic detections (Fig. 2.1). This system was very helpful and reduced the need for radio communication.

The procedure described above was used to track bottlenose whales from initial detection to tag off. It was very carefully planned (Appendix C), and executed as planned. It is a very demanding procedure, but with the equipment available and experience of the people involved, it turned out to be very efficient. It was therefore used a lot during this trial (Fig. 3.2.)

2.4 Experimental procedure Ha13_176

This section summarizes the actual procedure used during the sonar exposure of a group of bottlenose whales on June 25th, tag id Ha13_176.

Figure 2.2 DTAGv2 deployed to Bottlenose whale Ha13_176 on June 25th using the ARTS system. The tag stayed attached for 18 hrs but slid to a lower position so that we had difficulty tracking it. Photo Eirik Grønningsæter/ WildNature.no/3S Project/FFI.

A large aggregation of bottlenose whales was found on the east side of Jan Mayen on June 23rd. After 35 hrs of tracking different groups of whales acoustically and visually (see section 2.3), and numerous close tagging attempts using hand-poles, a DTAGv2 was finally attached to an adult animal in a group of 4 using the ARTS-system. The tagging position was roughly 20nmi east-southeast of North cape Jan Mayen. Wind was southwest 3, clouded weather, sea state 3. The tag stayed on for 18hrs until it was released.

The tagged whale was tracked from the MMO platform on the Sverdrup from tag on, but tracking became increasingly difficult through the pre-exposure phase, probably because the tag moved to a lower position on the whale. 7 hrs after tag on, the focal whale was no longer sighted visually. MOBHUS was deployed to relocate the animal, and was partially successful as we did receive occasional clear signals from the VHF transmitter on the tag. We could therefore roughly position the tagged animal, and therefore decided to move on with the sonar exposure.

The planned design of the sonar exposure is describe in detail in the cruise plan (Appendix C). The idea of the design was to try to replicate the design of the AUTEC BRS experiments (Tyack *et al.* 2011) and the SOCAL BRS experiments (DeRuiter *et al.* 2013) on other species of beaked whales, with the limitation that we were using a moving source and had to track the whale form the source boat.

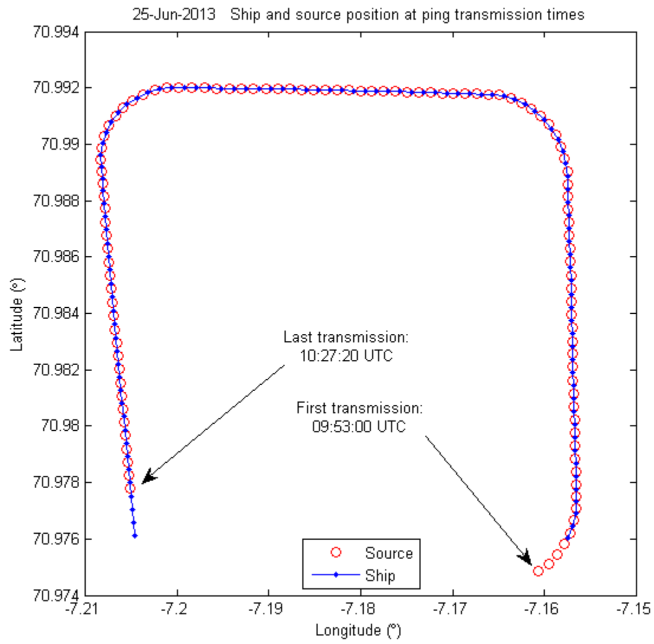


Figure 2.3 The sonar dose escalation experiment was conducted by sailing three legs of a 1 by 1nmi box while transmitting a 1 second 1-2kHz hyperbolic upsweep every 20 second. The transmissions started with a 20min linear ramp up from 152 to 214dB (re 1μPa @ 1m) followed by another 14 min of full power transmissions at 214dB. The blue line is the ship's track and the red circles are positions of sonar transmissions.

The sonar exposure was conducted as planned with a 20 min linear ramp and then full power transmissions until we had completed the pre-determined exposure sail track (Fig. 2.3.).

3 Results

3.1 Overview of operation

The 3S-2013 research trial took place partly in the Norwegian sea, in Lofoten along the coast of mainland Norway, but mainly in the Greenland sea, around the small Norwegian island Jan Mayen (Fig. 3.1). We operated between 67°-72° northern latitude and 20° eastern to 10° western longitude, between June 15th and july 15th 2013 using FFI RV HU Sverdrup II (Table 3.1.).

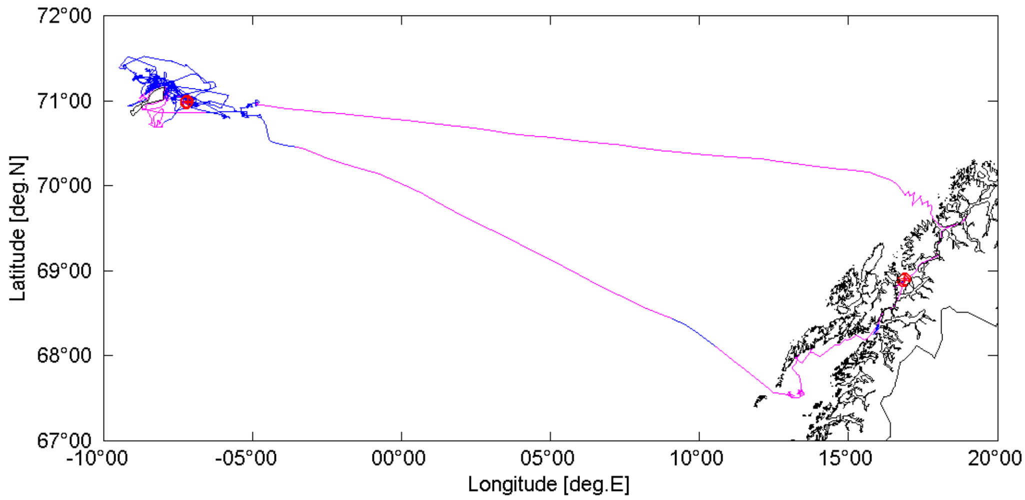
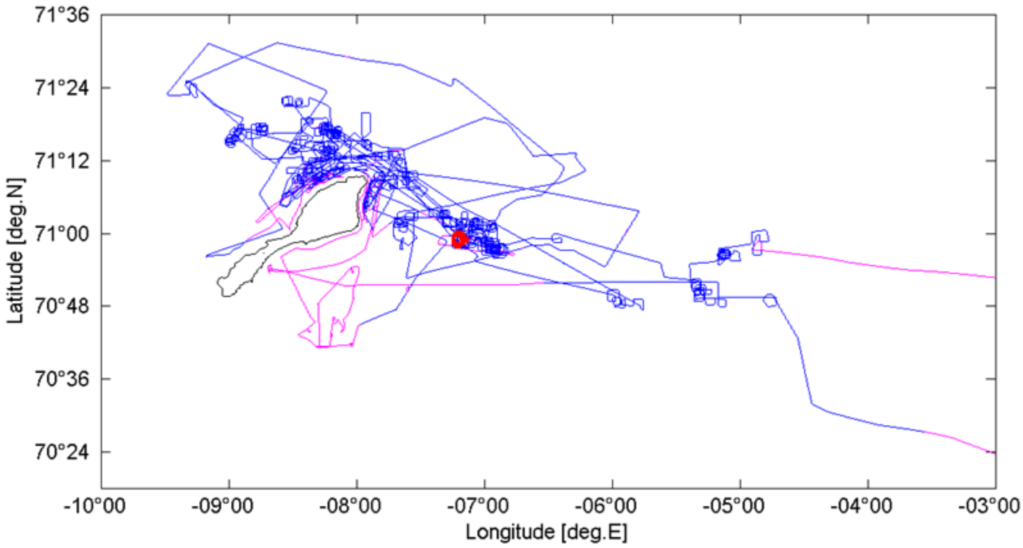


Figure 3.1 Sail tracks for the entire trial (June 15th -July 15th). Socrates sonar transmissions are shown in red. Towing of Delphinus array is shown in blue. We spent the first days (June 15-17th) in port in Tromsø to install equipment, then sailed to Vestfjorden to test procedures and work with pilot whales and minke whales (June 18-20th) before transiting to Jan Mayen (June 21-22nd). We spent almost three full weeks working around Jan Mayen (June 22nd – July 10th) (Fig. 3.2.) before transiting back to the coast (July 11-12th). The last 2 days (July 13-15) were spent in Tromsø to de-brief and demobilize. See Appendix B for daily sail tracks.

We spent the first couple of days of the trial in Vestfjorden tagging pilot whales and conducted playback experiments on them. This was partly to get the team started with something simpler than minke wales and bottlenose whales, but we also collected data which added great value to the 3S-13 baseline trial data set. The outcome of this is reported in the cruise report of the baseline trial (Appendix F). After this we transited across the Atlantic and spent the next three weeks working around Jan Mayen with the primary target species minke whales and bottlenose whales (Fig. 3.1 and 3.2). During the trial a total of 383 sightings of 990 individual marine mammals were recorded, including 220 bottlenose whale and 91 minke whale sightings. We tagged 1 whale during this trial, a bottlenose whale, and conducted 1 sonar exposure experiment. However, we sighted and tracked a great number of animals both visually and acoustically, and we discovered the potential of the Jan Mayen area as a field site for future whale research.



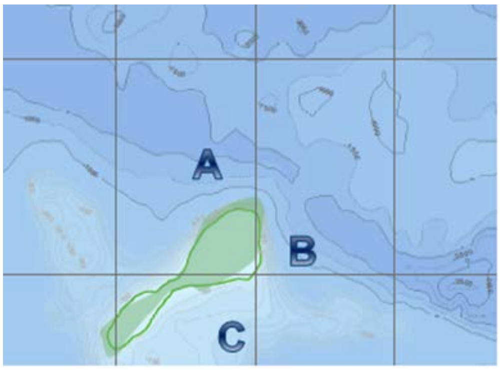


Figure 3.2 Top panel: Zoomed in view of the sailtrack around Jan Mayen between June 22nd and July10th. Socrates sonar transmissions are shown in red.Towing of Delphinus array is shown in blue.

Lower panel: We operated mainly along the deep water trench northwest (A) or northeast (B) of the island, or on the shallow shelf on the southeastern side (C).

3.2 Working conditions in Jan Mayen waters

The weather is always an important factor when working with marine mammals at sea. In order to work efficiently to find and tag whales at sea, you need both calm sea and good visibility. The waters off Jan Mayen are known to have a high density of whales but quite unfavorable weather conditions for this type of work with fog or wind. Based on analysis on meteorological observation from the Jan Mayen meteorological station, we expected to be able to operate 60% of the days (Fig. 3.3.). Weather statistics showed that we probably had less fog but more wind than average this year (Fig. 3.3.). In the end, our work log (Table 3.1.) showed that we were more or less operational more than 70% of the time spent at Jan Mayen. However, whereas we usually consider sea state 4 and above to be non-working conditions (Kvadsheim *et al. 2011, 2012),* we routinely worked under such conditions this year (Table 3.1.). During previous 3S trials around Spitsbergen we typically had 60-70% of days with *"perfect working conditions"* (sea state 0-1 and good visibility) (Kvadsheim *et al*. 2011, 2012), but this year we only experienced this very briefly (Table 3.1). Thus, compared to previous trials we had significantly worse weather conditions, but not much worse than was expected for this area. We therefore had to push the limits of what we consider acceptable weather for this type of work. Without compromising safety, this could only be done because we had very good equipment for deploying and picking up small boats at sea, and because our crews both on deck and in the small boats were very experienced.

Table 3.1 Overview of weather and overall activity during the trial. Wind force is given on the Beaufort scale. The color code for operational status is; fully operational (green), partly operational/reduced effort (yellow) and not operational (red).

Date	Area	Weather	Wind	Sea state	Activity	Op. status
June 15.	Tromsø	In port			Mobilization	No regular watches
June 16.	Tromsø	In port			Mobilization	No regular watches
June 17.	Harstad	In port			Mobilization	No regular watches
June 18.	Vestfjord	Changing cloud cover	SW3	2	MM-work	
June 19.	Vestfjorden	Clouded	SE4	3	MM-work	
June 20.	Vestfjorden	Clouded	SW4	3	MM-work	
June 21.	Norwegian Sea	Rain	S7	5	Transit	
June 22.	Greenland Sea	Fog	NW6	4	Transit	
June 23.	Jan Mayen	Changing cloud cover	N2	3	MM-work	
June 24.	Jan Mayen	Clouded	SW5	3	MM-work	
June 25.	Jan Mayen	Clouded	SW4	3	MM-work	
June 26.	Jan Mayen	Clouded	SW6	4	MM-work	
June 27.	Jan Mayen	Changing cloud cover	NE4	4	MM-work	
June 28.	Jan Mayen	Clouded	S6	4	MM-work	
June 29.	Jan Mayen	Rain	S6	3	Anchored	
June 30.	Jan Mayen	Rain	SE6	3	Anchored	
July 01.	Jan Mayen	Clouded	E5	3	MM-work	
July 02.	Jan Mayen	Changing cloud cover	SW4	4	MM-work	
July 03.	Jan Mayen	Clouded	SE5	4	MM-work	
July 04.	Jan Mayen	Clouded	W5	4	MM-work	
July 05.	Jan Mayen	Rain	N5	4	MM-work	
July 06.	Jan Mayen	Clouded	W2	2	MM-work	
July 07.	Jan Mayen	Fog	NW4	3	MM-work	
July 08.	Jan Mayen	Clouded	NE5	4	MM-work	
July 09.	Jan Mayen	Changing cloud cover	S5	4	MM-work	
July 10.	Jan Mayen	Clouded	NW4	4	MM-work	
July 11.	Greenland sea	Clouded	0	1	Transit	
July 12.	Norwegian sea	Clear sky	S2	2	Transit	
July 13.	Tomsø	In port			MM-work	
July 14.	Tromsø	In port			De-mobilization	No regular watches
July 15.	Tromsø	In port			De-mobilization	No regular watches

Another weather observation we made was that weather conditions can change amazingly quickly around Jan Mayen. If we operated close to shore, sudden changes in wind direction and force seemed to be explained by local effects caused by the island itself. However, also at high sea, wind and sea could pick up, but also calm down, unusually fast. We therefore had to constantly be alert when tag boats were on the water, and recover them quickly if conditions aggravated.

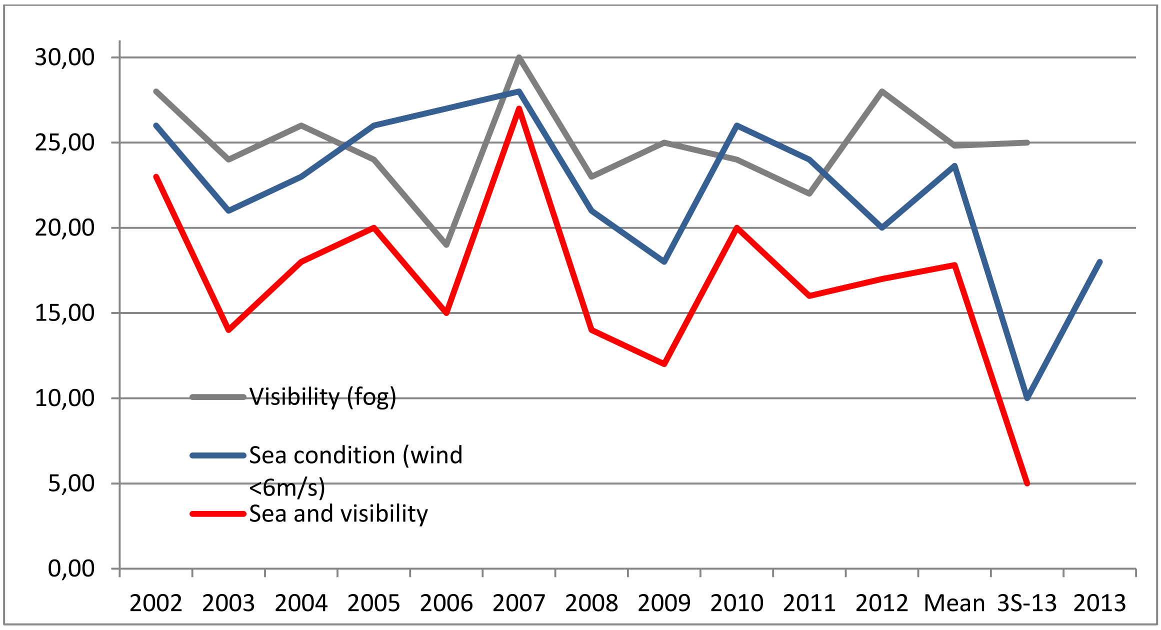


Figure 3.3 Our operation requires both good visibility and calm sea. Curves show number of days within a month (July) which has acceptable sea condition (wind <6m/s, blue line), acceptable visibility (no fog, grey line) and acceptable both visibility and sea condition at the same time (red line) at Jan Mayen the past 10 years (2002-2012). Data is from the Norwegian Meteorological Institute and is based on observations from the Jan Mayen meteorological station. Mean is the mean value from the past 10 years. 3S-13 is based on the conditions actually observed by us during the trial (from the ships log), and 2013 are observations made by the meteorological station on Jan Mayen during our stay. Based on this we conclude that we had "normal" visibility (fog) but more wind than normal. Because we pushed the limits of what we consider acceptable working conditions beyond 6m/s (Beaufort 4) (Table 3.1.), the red curve does not reflect the actual number of working days during the trial. This number was 11.5 days out of 18 (64%) (red dot) not 5 out of 30 (17%).

3.3 Marine mammal sightings

During the 3S-2013 trial we recorded 383 sightings of 990 marine mammals (Table 3.2). During the past two years of working in the Barents Sea we recorded 400 sightings of 906 animals in 2012 (Kvadsheim *et al.* 2012) and 521 sightings of 1607 animals in 2011 (Kvadsheim *et al.* 2011). Considering the significantly lower number of working days in 2013, this indicates that the Jan Mayen area has a very high density of marine mammals, even compared to the Barents Sea.

The primary target species of this trial were minke whale and northern bottlenose whales. Both these species were sighted frequently. We recorded 91 sightings of 96 minkes whales and 220 sightings of 690 bottlenose whales (Table 3.2.). When operating off the coast of Spitsbergen in 2011 and 2012 (Kvadsheim *et al.* 2011, 2012), we had to transit significant distances from the shelf break, where we could work with the baleen whales (minke whales and humpback whales) to the deep water areas where we expected to find bottlenose whales.

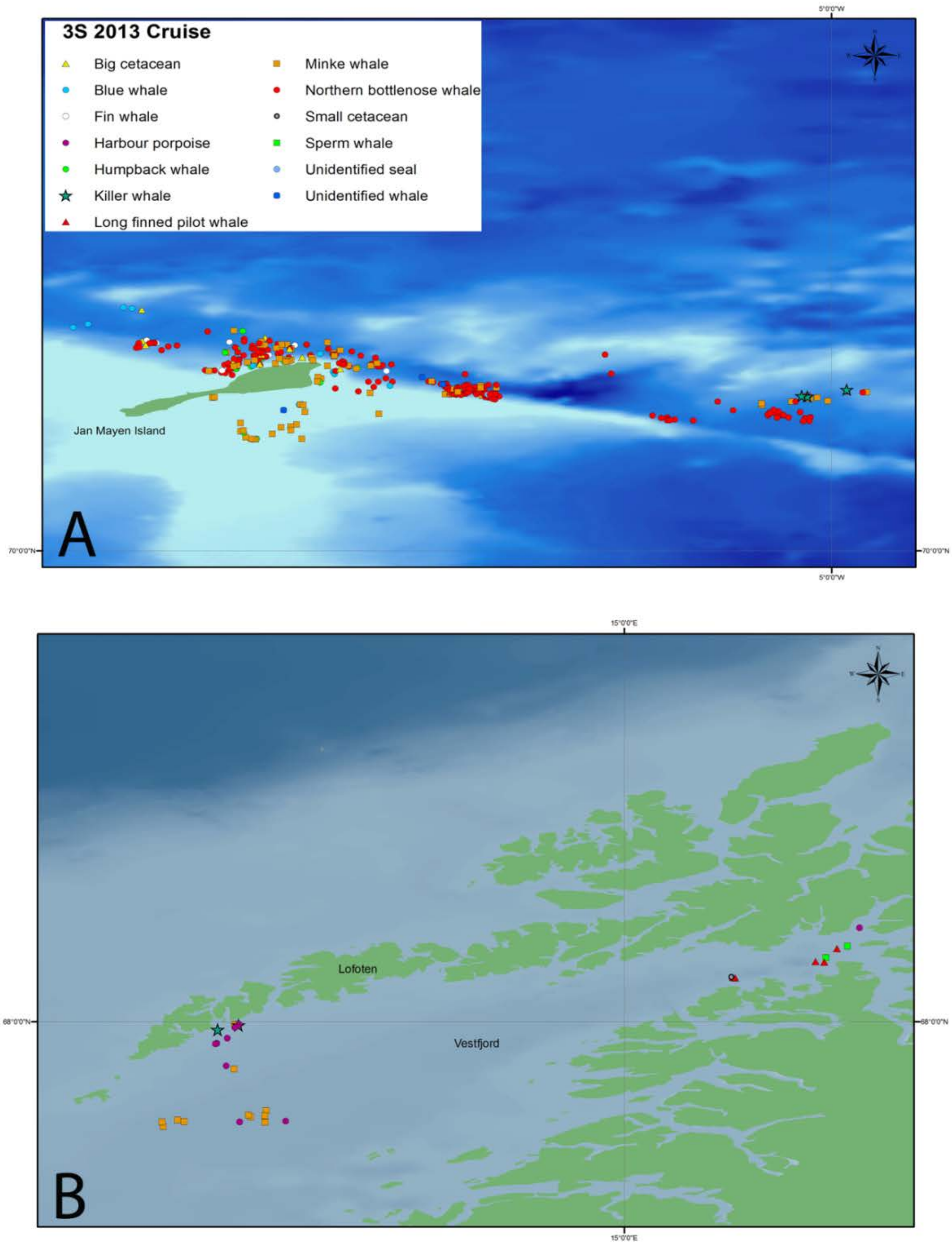


Figure 3.4 Sighting locations of the cetacean and pinniped species observed during the 3S 2013 cruise near Jan Mayen Island (A), and in Vestfjord, Norway (B), between 18-june - 10-july 2013.

The Jan Mayen area is characterized by steep deep water bathymetry very close to the island, particularly on the northern side. We therefore frequently sighted minkes whales, while working to tag bottlenose whales and vice versa (Fig. 3.4.). Based on historic records minke whales would be found in particular high numbers on the shallow shelf on the southeastern side of the island. We did search there briefly, and did encounter many minke whales (Fig. 3.4.). However, this area is a little too shallow for towing Delphinus and Socrates, and bottlenose whales are not expected to be found there. We therefore spent most of the time north of the island in the deep water trench, were both target species were sighted frequently (Fig. 3.4.). The larger baleen whales were also sighted in this area relatively frequently (Table 3.2 and Fig. 3.4). Jan Mayen seems to be a unique area for research on bottlenose whales, where such research can also be combined with research on baleen whales.

Table 3.2 Number of sightings, number of animals, low-best-high group size, and distance from ship (average - maximum and minimum) for all cetacean and pinniped species recorded between 18-June and 10-July.

	Number of		Group-size (average)			Sighting distance from ship (m)		
Species	**sightings**	**animals**	**low**	**best**	**high**	**average**	**maximum**	**mimimum**
Blue whale	15	18	1,0	1,2	1,1	1617	6639	100
Fin whale	8	9	1,0	1,1	1,0	1414	5084	300
Humpback whale	12	17	1,7	1,4	2,3	1397	3131	300
Sperm whale	2	2	1,0	1,0	1,0	3066	3131	3000
Killer whale	4	12	3,0	3,0	4,7	2239	4500	612
Minke whale	91	96	1,0	1,1	1,0	806	5000	10
Long-finned pilot whale	5	100	15,8	20,0	26,3	1840	3000	400
Northern Bottlenose whale	220	690	3,0	3,1	4,7	1634	5800	10
Harbour porpoise	10	13	1,2	1,3	1,7	1625	3131	500
Unidentified seal	1	1	1,0	1,0	1,0	550	550	550
Unidentified small cetacean	1	16	12,0	16,0	18,0	3500	3500	3500
Unidentified whale	14	16	1,2	1,2	1,4	2982	6600	200
Total sum	**383**	**990**						
Total average			**2,8**	**2,6**	**4,2**	**1837**	**4197**	**768**

3.4 Visual effort

In total, 372 h and 46 min of visual effort were conducted over a period of 22 days. On average, 3 persons were doing observations during the searching phase and during tagging (including pre-tagging, tagging and post tagging). During experiments, the main visual effort was conducted from MOBHUS 1, with a reduced visual effort of average 2 persons doing visual observations from HUS.

3.5 Social and surface behavior

Social and surface behavior observations were collected for northern bottlenose whales and minke whales. The protocol for data collection was identical to the group behavioural protocols previously used (Visser *et al*. 2014), but adapted for the 3S2 target species (Visser *et al.* 2011). In addition to the protocol in 2011-2012, the duration of the dive and surfacing period of the focal group were recorded, to gain insight in the dive cycles of the northern bottlenose whale. In case of solitary whales, only surface behavioral parameters were recorded (e.g. display events). Combined sampling of group behavior and tracking of northern bottlenose whale and minke whale focal groups was established from the HUS observation platform. Data collection included pre-, during- and post tagging and baseline group behavior data collection and tracking.

Table 3.3 Daily visual effort on Sverdrup (HUS). Given in the table is total time (duration) of visual observations, and the average number of MMOs doing observations (visual effort). This is given as total effort for the day, and for three categories of activities; Searching, Tagging and Experiment. The summary line gives the total number of time spent and the average number of visual observers (visual effort).

Date	Daily total		Searching		Tagging/tracking		Experiment	
	duration	**effort**	**duration**	**effort**	**duration**	**effort**	**duration**	**effort**
18.06.2013	14:21:49	2,06	04:39:38	3,5	09:42:11	2,13	08:04:39	1
19.06.2013	23:59:59	3,7	19:20:31	3,92	04:39:28	3,67		
20.06.2013	16:26:34	3,45	10:43:54	3,58	05:42:40	3,17		
21.06.2013	transit							
22.06.2013	06:13:06	2,5						
23.06.2013	15:23:07	2,8	09:24:08	2,83	05:58:59	2,83	23:59:59	4,14
24.06.2013	23:59:59	2,68	02:54:41	3,5	21:05:18	2,72	07:45:00	2
25.06.2013	23:59:59	4,14						
26.06.2013	07:45:00	2						
27.06.2013	17:08:34	2,7	14:12:59	2,5	02:55:35	3		
28.06.2013	12:39:00	3,09	12:39:00	3,09				
29.06.2013	code red							
30.06.2013	07:32:13	3,28	02:46:34	3,5	04:45:39	3		
01.07.2013	23:59:59	3,29	10:56:27	2,67	13:03:32	3		
02.07.2013	18:55:56	1,71	17:18:16	1,69	01:37:40	2		
03.07.2013	18:25:07	3,23	09:22:50	3,3	09:02:17	3,4		
04.07.2013	23:59:59	3,33	16:13:24	3	07:46:35	3,58		
05.07.2013	23:59:59	2,68	20:12:25	2,31	03:47:34	3,33		
06.07.2013	23:59:59	3	07:24:38	3	16:35:21	2,91		
07.07.2013	22:33:16	2,16	14:20:05	2,33	08:13:11	2,5		
08.07.2013	17:30:51	2,57	07:58:42	3	09:32:09	3,17		
09.07.2013	23:59:59	2,67	17:58:15	2,65	06:01:44	3		
10.07.2013	17:06:49	3,38	08:59:51	3,13	08:06:58	3,17		
11.07.2013	00:24:42	2			00:24:42	2		
12.07.2013	11:45:54	3	11:45:54	3				
Sum/average	396h 12min	2,84	218h 14min	2,97	139h 1min	2,92	39h 50min	2,38

3.5.1 Northern bottlenose whales

We conducted 51 focal follows of surface and social behavior for northern bottlenose whale groups, of which 1 with a successful DTAG deployment. In total, 76 hours of focal follow data was collected. Focal follows had durations of 2 minutes to 5.3 hours. A total of 14 follows were collected during baseline phases. All other 37 focal follows included one or more experimental phases: pre- during and post tagging (2 follows), pre-tagging + tagging (9 follows), tagging + post-tagging (5 follows) or tagging (21 follows). The focal follow of the focal group of the tagged whale included tagging and post-tagging phases (focal follow ended when focal group was lost from sight during the post-tagging phase).

Figure 3.5 A small group of bottlenose whales being observed from the MMO platform on Sverdrup during a tagging attempt. Photos: Eirik Grønningsæter/ WildNature.no/3S Project/FFI.

Northern bottlenose whales were commonly sighted in tightly spaced groups, with a moderate to high degree of synchrony and coordination at the surface (Fig. 3.6). Group size during focal follows ranged from 1 to 10 animals, with up to 20 individuals divided over several groups in the focal area (within 200 m of the focal individual). Average group size during focal follows (± SD) was 3.8 ± 1.7 individuals. Groups were mostly very tightly spaced, with less than a body length (BL) between individuals (58% of records), or tightly spaced (1 to 3 BL between individuals; 34% of records). Occurrences of milling, as well as the occurrence of surface display events, were relatively rare. Several breaches (7), loggings (3) and tailslaps (3) were recorded.

3.5.1.1 'Boxing' methodology

The focal follow data for the northern bottlenose whales was mostly obtained during boxing. This is a sailing strategy whereby the navigator sails a square track (box), with the aim to keep the focal group located 'within the box'. This is achieved by close coordination between the visual observers (when the group is at the surface) and the acoustics team (when the group is vocalising, and under water). This method proved to be highly effective for the tracking of northern bottlenose whale groups given restricted maneuverability of the research vessel (in this case by the deployed TNO Delphinus array). The combined efforts between the acoustics and visual teams and the coordination of the navigator enabled longer-term tracking in close enough proximity (<1 km) for high quality visual data collection of northern bottlenose whale group behaviour. See section 2.3. for a more detailed description of this methodology.

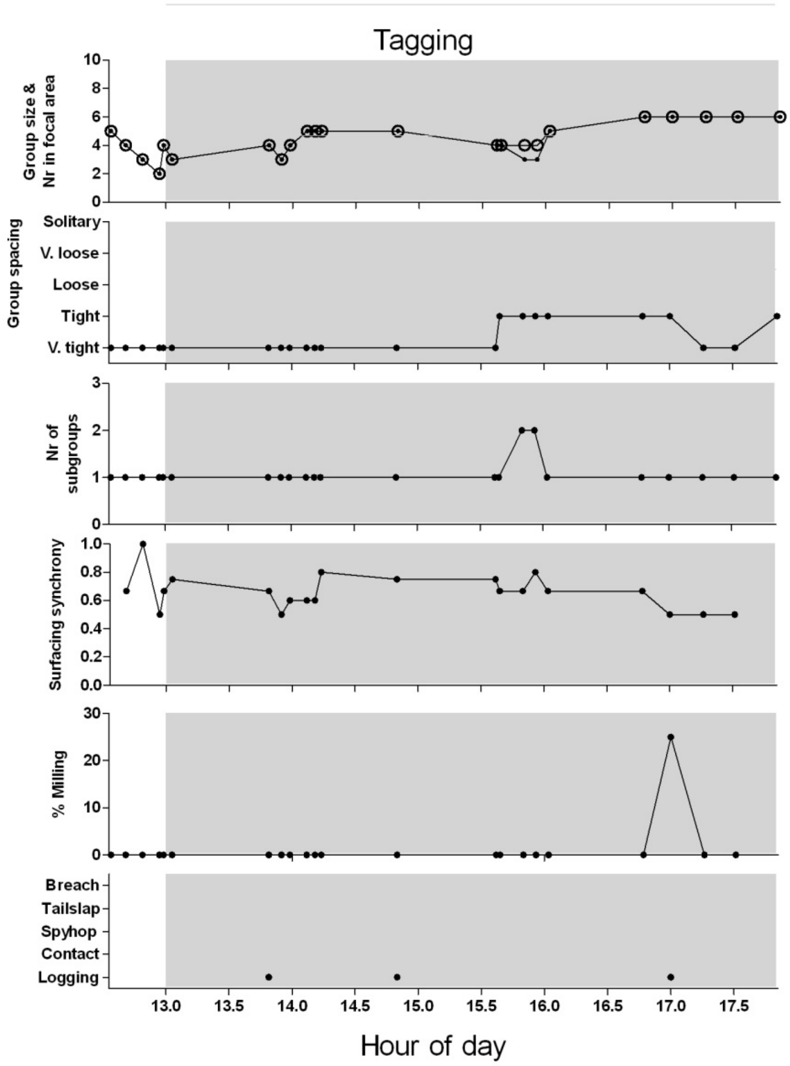


Figure 3.6 Example of collected social behavior data. The 5.3 hr focal follow of northern bottlenose whale group 277, conducted July 3rd, 2013. The stacked graphs show (top to bottom) the social behavior parameters 1) group size and number of individuals in the focal area, 2) group spacing, 3) the number of subgroups in the focal area, 4) surfacing synchrony and 5) the percentage milling of the focal group and 6) the presence of surface display events.

3.6 Tagging

Tag boat 1 (TB1) was set up to deploy tags using both a hand held pole (8m) and a cantilever 16m long pole (Appendix C), as well as the tag-launcher ARTS, while tag boat 2 (TB2) was setup to deploy tags using the tag-launcher ARTS. This year the intention was to use the ARTS from both tag boats, however because of extended periods of tagging attempts tag teams needed to take turns, and both teams mostly used TB2 with the elevated launching platform (Fig. 3.7). As for previous years the priority tag was the standard DTAGv2 holding a fastLoc GPS logger (Appendix C). Based on previous experience that suction cups do not stick effectively to minke whale skin in these waters (Kvadsheim *et al.* 2011), this tag was modified with 4 small barbs replacing the suctions cups (Fig. 3.9.) when targeting minke whales. However, the standard configuration with suction cups was used when targeting bottlenose whales. Tagging attempts were only made on minke whales and bottlenose whales during this trial.

Figure 3.7 Tag boat 2 (MOBHUS) trying to tag a small group of bottlenose whales as observed from the MMO platform on Sverdrup. Photo: Fleur Visser

The goal of having a 24 hour continuous tagging capability was successfully met by using a 6 hrs on/off watch rotation between the tag teams (as was also used with the rest of the crew). Only on some very few occasions both tag teams were operational on the water at the same time.

3.6.1 Bottlenose whales

On the 22nd of June we had our first contacts with bottlenose whales, both visually and acoustically, about 70 nm east of Jan Mayen as we were arriving there. However, due to technical problems the tags were not ready to be deployed and we therefore did not attempt to tag these animals.

On the 23rd of June we had multiple sightings of bottlenose whales, but still had tag technical problems, and therefore we were only operational with the DTAGv3. Decision was made to have a first short deployment with this tag, and also only use pole tagging techniques, since the ARTS-DTAG3-system had not been field tested properly yet. We operated in relative rough tagging conditions, with not too much wind but with difficult swell. Over the next 24 hrs of continuous tagging effort we had many (>10) close approaches at distances of less than 10 meters (Fig. 3.8), but still not close enough for pole tagging. As soon as the technical problems with DTAGv2 were fixed, we switched to using this tag and the ARTS tag launching system. Within 1 hrs of this switch a tag was deployed on a bottlenose whale at a distance of 10 meters using 8.5 bar of launching pressure (Fig. 3.8). Initially the tag was sending 1-3 VHF beeps at every surfacing, however after only a few hours we only had occasional signals from the tag, most likely because it had moved to a lower position on the whale (chapter 2.4).

After these initial tagging attempts, which did lead to a tag being deployed and a sonar exposure experiment conducted (chapter 2.4 and 3.8), we never again experienced similar tagging conditions with many whales aggregated in one area and being relatively easy to approach. Between July 1st and 11th we had many encounters of smaller groups of animals, and had several missed tagging attempts at distanced between 13-18m. The closest approaches were often at distances of 30-40 meters, and thus tagging was not possible.

Figure 3.8 Upper panel: A very close (but not close enough) tagging attempt on a bottlenose whale using a hand held pole with a v3 DTAG on June 23rd. Photo Eirik Grønningsæter/ WildNature.no/3S Project/FFI.

Lower panel: DTAGv2 deployed to a Bottlenose whale on July 1st using the ARTS system. Unfortunately this tag detached after a minute. Photo Paul Ensor.

3.6.2 Search for lost tags

During 3S-2012 at the west coast of Svalbard, we lost contact with a humpback whale during the tracking phase (Kvadsheim *et al* 2012). The same happened this year during 3S-2013 during the tracking phase of a bottlenose whale. In both cases the tags were relocated and recovered. The signal from the floating tag was picked up from the top radar position of Sverdrup at a distance of 12nm, and we could hear the signal from upper bridge from 9nm. The tracking equipment we used was the radio receiver R-1000 connected to a hand held 3-element yagi antenna, and the tracker used headphones to maximize the hearing sensibility. The only difference between the two cases was the weather conditions, with flat calm seas in 2012 and windy conditions with Beaufort 4 in 2013. In both cases the lost tag was a DTAGv2, with a custom made radio beacon.

We conclude that when searching for a lost tag we would cover at least 8 nmi to both sides of the transect line, at least up to weather conditions of Beaufort 4.

3.6.3 Minke whales

With the experience from 2011, we were optimistic in terms of having tagging opportunities from small boats on this species. As in 2012 the main tactics was to launch the tag boat quickly when minke whales were sighted in good weather conditions. The primary tag boat used was TB2 (Mobhus), and we primarily used the barb DTAGv2 with the ARTS-system, even though we also had prepared the CTAG (Appendix C) as a backup tag.

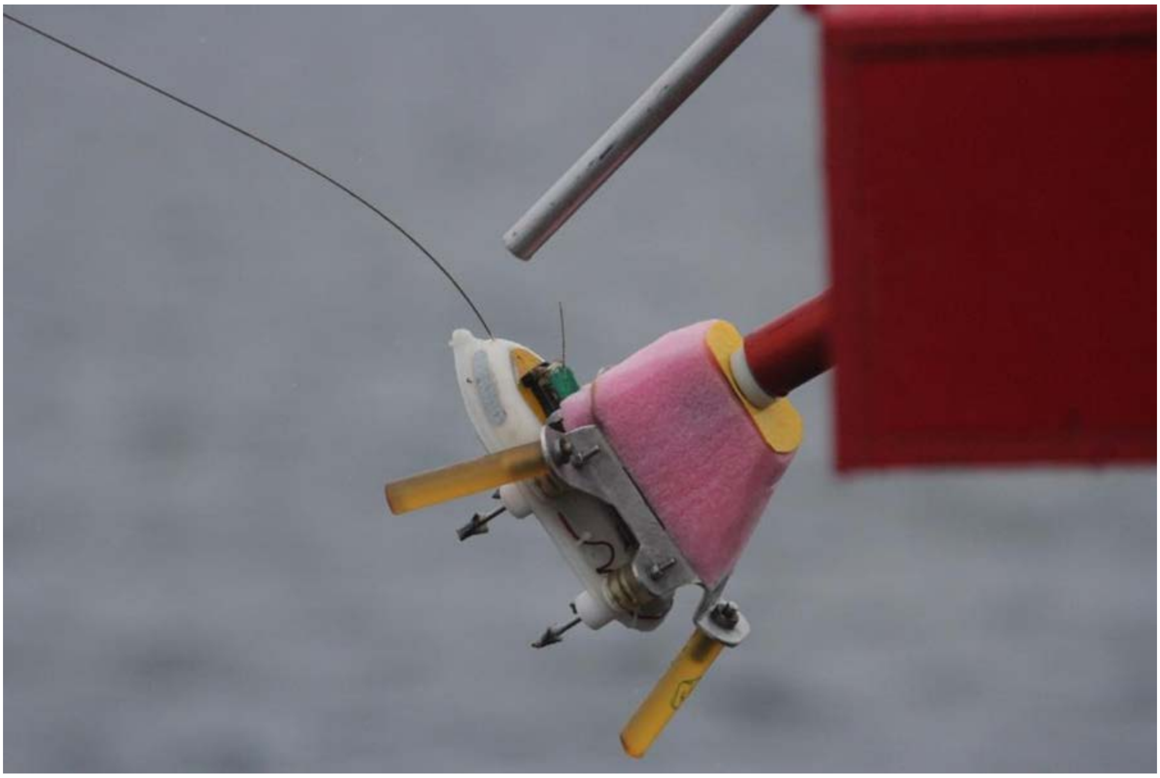


Figure 3.9 The barb DTAGv2 mounted on the ARTSCarrier-robot , ready to be deployed on a minke whale. Photo Paul Ensor.

On the 19th and 20th of June both tag boats were operating in the outlet of Vestfjorden, and a number of whales were sighted but only on one occasion did we have a whale within tagging range. TB2 was equipped with two ARTS systems, one loaded with the DTAGv2-barb tag in the back at the drivers position and the other loaded with the CTAG in the front. This setup was an attempt to maximize tagging effort if we encounter a “seeker” and to be able to quickly switch from DTAG to CTAG which can be launched at longer distances. On the 19th of June we soon found out that our target minke whale was not seeking the tag boat, and we therefore tried to approach with the CTAG. We had one miss on this whale at 17meters and 8,5 bar, and this was the only tagging attempt we had during the whole trial on this species.

As we arrived at the waters around Jan Mayen, we found to our surprise that minke whales were often sighted in the deep water areas where we also found bottlenose whales (Fig. 3.4). We therefore established the tactic that tag teams always brought a minke whale tag with them when they went out to tag bottlenose whales. On several occasions the tag teams also switched target species, and opportunistically attempted to approach minke whale. Even though we only had one day of dedicated minke whale effort on the shallow banks on the east coast of Jan Mayen, this multispecies tagging attempt still outbalanced the effort between the two primary target species. Nevertheless, tag teams were never close enough to tag any minke whales around Jan Mayen. This could be either because animal don’t show very strong seeking behavior in this area, or because of the difficult weather conditions. Minke whales were not sighted on the rear occasions when we had flat calm water. It’s also possible that the noise of the waves braking against the tag boats in windy conditions is partly the reason why minkes are careful in seeking the tag boats.

3.6.4 Tagging and tracking whales – experiences from the 3S trials

While pole-tagging was effective for many 3S target species, we found that efficiency was too low for several species, especially killer whales, minke whales, and bottlenose whales. The size of the target animal, as well as surface appearance, determines possible launching ranges when using the ARTS system. When we stared to experiment with launching techniques using the ARTS system, our ambition was to double the tagging range compared to the handheld standard pole technique. At the time this was especially with the focus on killer whales (Kvadsheim et al. 2007). Today we are operational for tagging at distances of 10-12 meters with the ARTS system, as was our goal, and this would be well suited for killer whale, pilot whales, seeking minke whales, seeking bottlenose whales, and probably multiple smaller cetacean species like some beaked whales and dolphins.

However, as we have experienced during this trial, we would like to increase the tagging range even further to 15-18 meters, though at these ranges we will be at the outer limit of tagging successes. We did have a number of launchings at these distances, and also for some of these we were very close to successful attachments. Further development, especially on sight and also on range determination techniques would increase the rate of success at longer ranges.

Tracking experiences during our 3S trials are positive on ranges up to 3nm, when tracking on DTAG radio beacons, while somewhat less when tracking on the CTAG radio beacon. From our preliminary tests ahead of the trial it seems that there are no big range difference between the tag boat (MOBHUS) and the mother boat (HU Sverdrup) setup, even with a significant difference in height of the antennas. The new digital radio direction finder (DFHorten) was mounted on both platforms, connected to 4-element yagi antennas by high quality antenna cables. Our experiences with tracking will be forwarded to the producer of the DFHorten unit (ASJ Electronic Design), and hopefully it will be possible to obtain stable tracking ranges of 5nmi in the future.

3.7 Passive acoustic detection and tracking

This year the Delphinus array was towed extensively while searching for and tagging northern bottlenose whales (see Table 3.4 for an overview of the recordings made). In total 341 hours of data has been recorded, collecting almost 10 TByte of acoustic data.

During the survey and tagging phases several software packages were used to Detect, Classify and Localize (DCL) the northern bottlenose whale vocalizations:

1. Carcharodon: Processing for the (16 beamformed) MF hydrophones (1-40 kHz), this was the main software package used for the detection, classification and localization of the NBW vocalizations (Fig. 3.10 and 3.11).
2. Thetis: Processing for the UHF hydrophones (1-150 kHz), this year the Left-Right ambiguity could be solved using the triplet sensor in the Delphinus array (Fig. 3.12). NBW detections could be passed on to Carcharodon for localization using the Target Motion Analysis (TMA) tools.
3. GIS: Used to combine and visualize the track of H.U. Sverdrup, the tracks of the tag boats and other boats using AIS, acoustic detections and bathymetry (Fig. 3.13). The GIS display was mirrored on an Android 10-inch tablet located on the observation deck so that the visual observers had clear overview of their current position and course, the acoustic detections and the tag boats (Fig. 2.1).

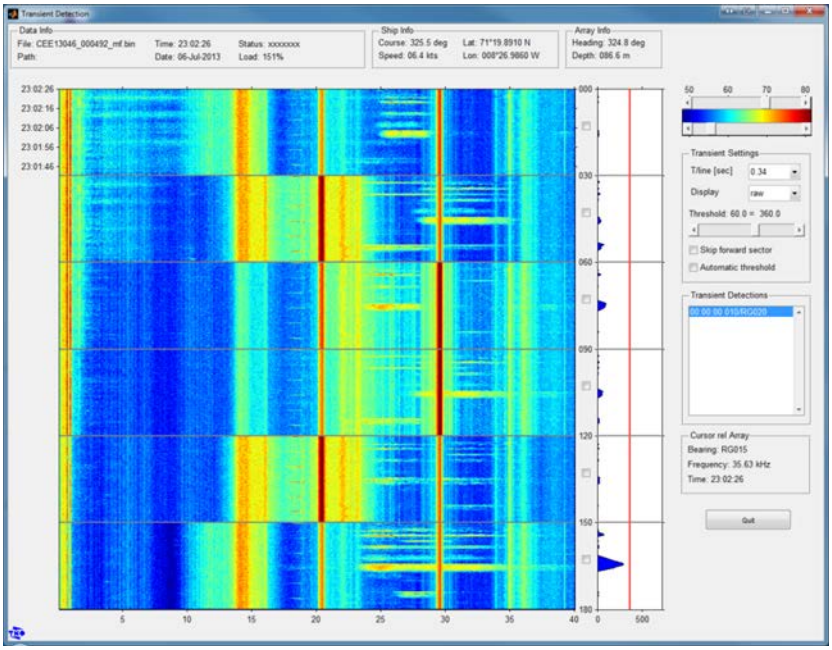


Figure 3.10 Screenshot of the Carcharodon transient detection display showing six time-frequency plots for six horizontal bearing sectors. This screen was mainly used for the initial detection and classification of NBW vocalizations.

Table 3.4 Overview of acoustic recordings and transmissions (Delphinus and SOC) during 3S-2013.

Exp Name	Sys	Date (start time)	Start Time (UTC)	Duration [HH:MM]	Size [GB]	Summary
CEE13000	Delp Soc Buoy	17-06-2013	15:30	00:20 01:00 07:00	9 17	MinkeDinky system test
CEE13001	Delp	18-06-2013	05:10	06:35	175	Search for minke/pilot whales, tagged pilot whales, did 1 of 3 kw playbacks.
CEE13002	Delp	18-06-2013	11:45	03:15	87	Tagged pilot whales, did 2 of 3 kw playbacks.
CEE13003	Delp	20-06-2013	15:38	03:32	95	Survey shelf break and slope while on transit to Jan Mayen
CEE13004	Delp	21-06-2013	21:07	11:58	343	Survey for and some boxing of NBW
CEE13005	Delp	22-06-2013	09:05	00:55	24	High speed transit to Jan Mayen
CEE13006	Delp	23-06-2013	08:05	02:55	79	Survey for NBW
CEE13007	Delp	23-06-2013	11:01	07:12	192	Boxing + tagging NBW
CEE13008	Delp	23-06-2013	18:23	05:21	143	Boxing + tagging NBW
CEE13009	Delp	23-06-2013	23:45	06:19	169	Boxing + tagging NBW
CEE13010	Delp	24-06-2013	06:05	05:50	157	Boxing + tagging NBW
CEE13011	Delp	24-06-2013	12:00	07:04	188	Boxing + tagging NBW
CEE13012	Delp	24-06-2013	19:04	04:55	130	Boxing + tagging NBW (tag on)
CEE13013	Delp	25-06-2013	00:02	06:52	183	Boxing + tracking NBW
CEE13014	Delp Soc	25-06-2013	06:54	06:54	184	Boxing + tracking + exposure NBW
CEE13015	Delp	25-06-2013	13:49	04:41	125	Post-exposure + search for exposed NBW.
CEE13016	Delp	25-06-2013	18:42	11:16	302	Search for tag.
CEE13017	Delp	26-06-2013	06:02	02:35	68	Search for tag (and found it).
CEE13018	Delp	26-06-2013	08:40	08:51	237	Survey for NBW in rel. bad weather
CEE13019	Delp	26-06-2013	17:32	05:18	137	Survey for NBW in rel. bad weather
CEE13020	Delp	26-06-2013	22:57	07:15	190	Survey for NBW in rel. bad weather
CEE13021	Delp	27-06-2013	06:13	06:06	159	Survey for NBW in rel. bad weather
CEE13022	Delp	27-06-2013	12:28	06:50	180	Survey for NBW in rel. bad weather
CEE13023	Delp	27-06-2013	19:20	05:48	160	Search for NBW
CEE13024	Delp	28-06-2013	01:08	06:12	163	Search for NBW
CEE13025	Delp	28-06-2013	07:21	07:26	198	Search for NBW
CEE13026	Delp	28-06-2013	15:18	03:30	93	Search for NBW
CEE13027	Delp	30-06-2013	19:02	07:15	209	Boxing + tagging NBW
CEE13028	Delp	01-07-2013	02:18	06:42	193	Boxing + tagging NBW
CEE13029	Delp	01-07-2013	09:00	06:06	175	Search for NBW
CEE13030	Delp	01-07-2013	15:07	06:33	189	Boxing + tagging NBW
CEE13031	Delp	01-07-2013	21:41	06:20	183	Survey + transit
CEE13032	Delp	02-07-2013	04:07	06:10	178	Survey while taking shelter west of JM
CEE13033	Delp	02-07-2013	10:17	02:13	64	Survey while taking shelter west of JM
CEE13034	Delp	03-07-2013	06:40	09:24	272	Survey + Boxing + tagging NBW
CEE13035	Delp	03-07-2013	16:05	06:05	176	Boxing + tagging NBW
CEE13036	Delp	03-07-2013	22:11	05:52	169	Boxing + tagging NBW
CEE13037	Delp	04-07-2013	04:04	06:31	188	Search for NBW + Minke
CEE13038	Delp	04-07-2013	10:36	02:46	80	Search for NBW + Minke
CEE13039	Delp	04-07-2013	13:53	01:06	35	Search for NBW + Minke
CEE13040	Delp	05-07-2013	11:11	06:44	195	Searching + boxing NBW
CEE13041	Delp	05-07-2013	17:55	05:53	170	Search for NBW + Minke
CEE13042	Delp	05-07-2013	23:49	06:12	179	Searching + boxing NBW
CEE13043	Delp	06-07-2013	06:01	06:10	178	Searching + boxing NBW + minke
CEE13044	Delp	06-07-2013	12:11	06:09	177	Searching + boxing NBW
CEE13045	Delp	06-07-2013	18:21	03:59	112	Searching + boxing NBW
CEE13046	Delp	06-07-2013	22:28	07:26	214	Searching + boxing NBW
CEE13047	Delp	07-07-2013	05:54	05:54	166	Searching + boxing NBW
CEE13048	Delp	07-07-2013	11:40	03:03	88	Searching NBW + minke
CEE13049	Delp	07-07-2013	15:06	03:08	90	Searching NBW + minke
CEE13050	Delp	08-07-2013	08:00	09:29	275	Searching + boxing NBW + minke
CEE13051	Delp	08-07-2013	17:30	05:14	150	Searching + boxing NBW + minke
CEE13052	Delp	08-07-2013	22:44	06:01	174	Searching + boxing NBW + minke
CEE13053	Delp	09-07-2013	04:46	06:13	180	Searching NBW + minke
CEE13054	Delp	09-07-2013	10:59	06:41	194	Searching NBW + minke
CEE13055	Delp	09-07-2013	17:51	02:50	82	Searching NBW + minke
CEE13056	Delp	10-07-2013	03:37	06:00	173	Searching NBW + minke
CEE13057	Delp	10-07-2013	09:39	11:29	332	Searching + boxing NBW
CEE13058	Delp	10-07-2013	21:09	02:51	83	Searching + boxing NBW
Total				341:10	9484	

Delp = Delphinus system. Soc = SOCRATES II sound source. Buoy = Drifting buoy tracked by satellite, recording ambient noise and/or received level. NBW = Northern Bottlenose whales (*Hyperoodon Ampullatus*). LF pilot whale = Long-finned pilot whale (*Globicephala melas*).

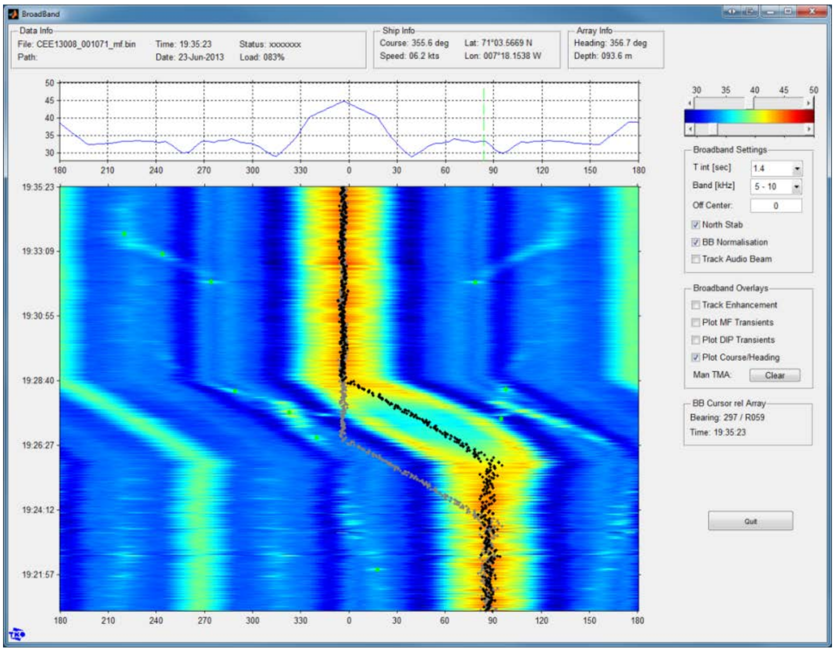


Figure 3.11 Screenshot of the Carcharodon broadband display showing an Amplitude-Bearing plot (top) and Bearing-Time plot (bottom). This display was mainly used to determine the bearing of the NBW vocalizations. The main beam is the track of Sverdrup, making a 90-degree turn around 19:25. Dots are GPS-positions of the vessel (in gray) and modeled "delayed" array position (in black). Several tracks of NBW show up in the graph against the background. The green dots along those tracks are positions that are marked and passed on to the GIS-display for TMA-purpose (see Fig. 3.13 below).

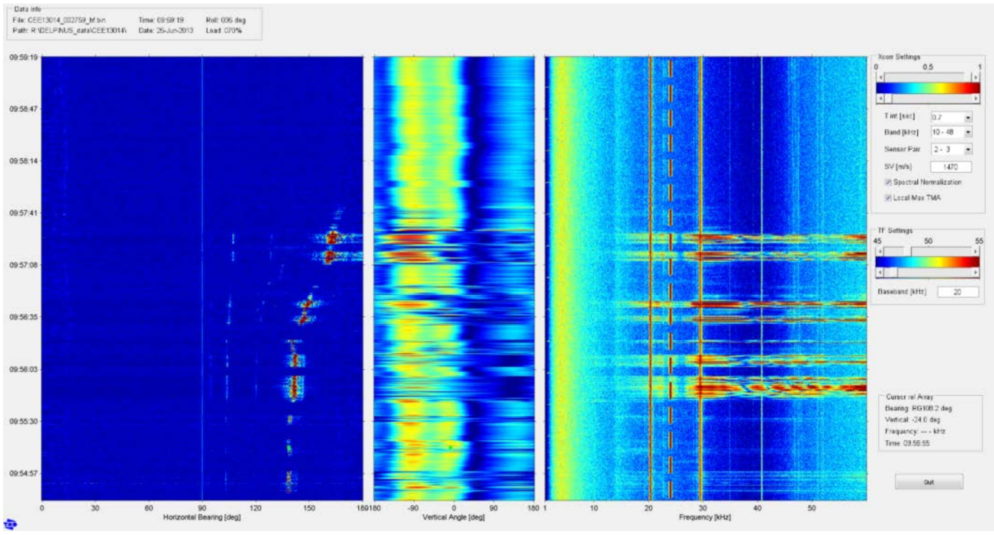


Figure 3.12 Screenshot of Thetis showing a horizontal bearing-time plot (left), vertical angle-time plot(middle) and time-frequency plot (right). The middle panel in particular shows that the detection was at port-side, using the information of the triplet-element.

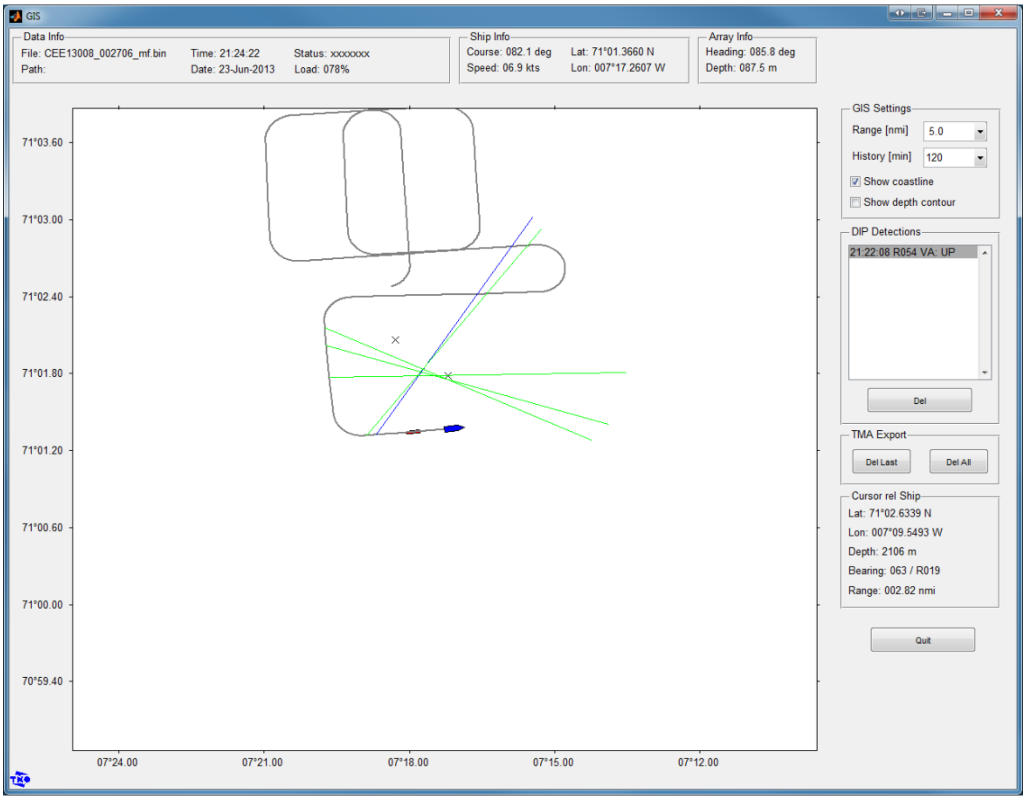


Figure 3.13 Screenshot of the Carcharodon GIS or TMA display. Own ship (track) and array (track) are depicted by the blue ship symbol and red box on the grey line. Bearings of the detected NBW vocalizations are shown in blue (Thetis) and green (Carcharodon). The estimated NBW location is marked by the cross (x), which is then exported to the second GIS display at the marine mammals observer station (Fig. 2.1).

3.8 Sonar exposure experiments on bottlenose whales

One bottlenose whale was tagged (Ha13_176) and one sonar exposure experiment was conducted. Because we lost track of the tagged whale during the exposure experiment, we did not have an exact location of the whale and therefore could not follow the exposure protocol strictly.

During ramp up and full power transmission the source ships sailed the planned three legs of the 1 by 1 nmi box, but retrospectively we discovered that the tagged animal was not inside the box during the exposure as intended. However, the main goal of the experiment was to expose the animal to an escalating sonar dose and this was achieved up to received sound pressure levels of 150 dB (re 1μPa) (Fig.. 3.14).

Until four min into the ramp up, foraging clicks were detected by the Delphinus system and 2 sightings of whales were also recorded during ramp up. After this there were no visual nor acoustic detections of bottlenose whales for hours. After end of the exposure no signal was picked up from the tag, and we therefore initiated a systematic ship based search for the lost tag. A 24 nmi search area were determine based on estimate of travel speed of the whale and assumed time until release, drift direction and speed of the tag and detection range of the VHF receivers onboard. The entire search area was covered systematically and the tag was relocated and recovered 24 nmi east of the last known fix 22 hrs later. Upon recovery we discovered that the GPS-logger detached from the DTAG and was lost.

The dive record showed that the tagged animal performed an unusual deep dive down to 2400m during the sonar exposure (Fig. 3.14), and the dead-reckoned track showed that during this dive the animal moved out of the area on an unusually straight course (Fig. 3.15). After the exposure the animal kept moving away from the exposure site without doing any more deep dives until the tag detached about 7 hrs later.

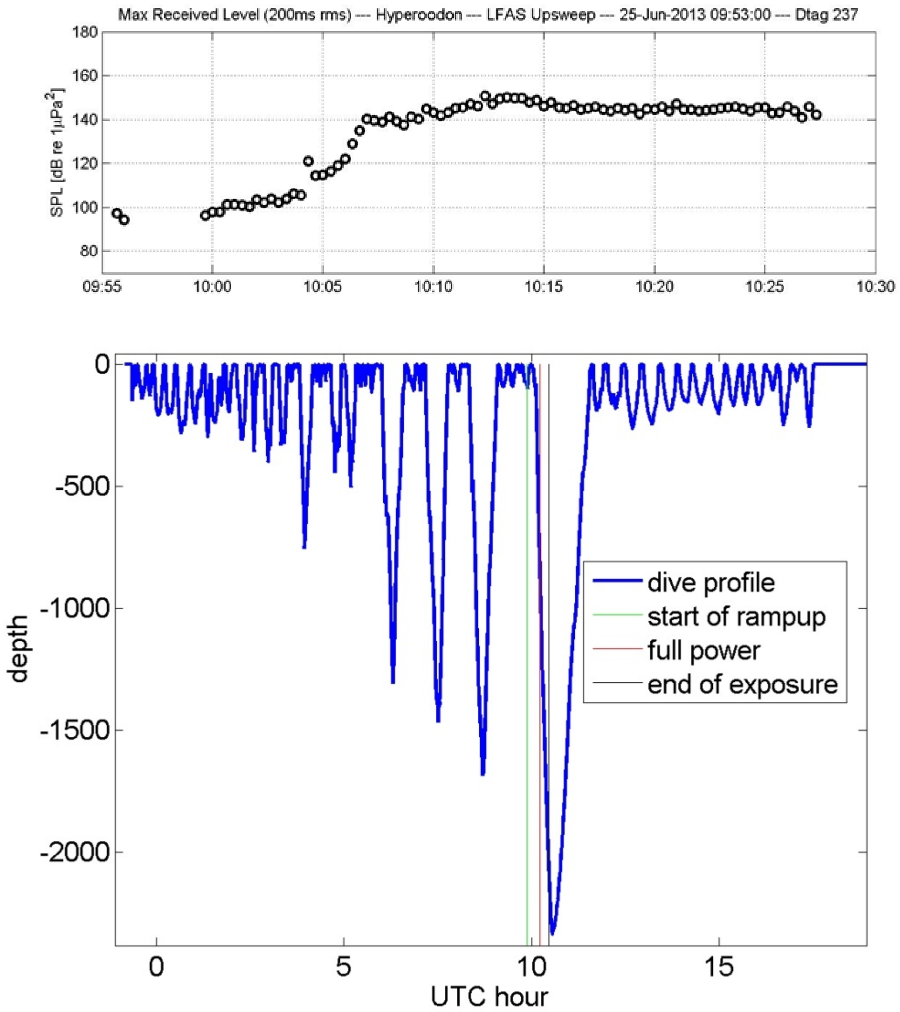


Figure 3.14 Upper panel: Measured received sound pressure levels on Ha13_176 during sonar exposure. Lower panel: The 17 hr dive record of bottlenose whale Ha13_176. Vertical green line shows start of ramp up, red and black lines shows start and stop of full power transmissions.

During the operation, as long as weather permitted, there was a constant survey effort, both visually (chapter 3.4) and acoustically (chapter 3.7). In the 24 hr period before the tag was deployed we had been working in the same area to tag whales. The same survey effort was then continued in the same area after tag on, until 6 hrs after sonar exposure when the ship left the area to look for the lost tag. The survey data indicate a dramatic reduction in the number of both visual and acoustic detections of bottlenose whales after sonar exposure compared to the period before sonar (Table 3.4, Fig. 3.16). This observation is consistent with the tag data showing that the focal whale also left the area and stopped vocalizing. The combined, although preliminary, result of the tag data and the survey data indicate that naval sonar has a long term and large scale effect on bottlenose whales.

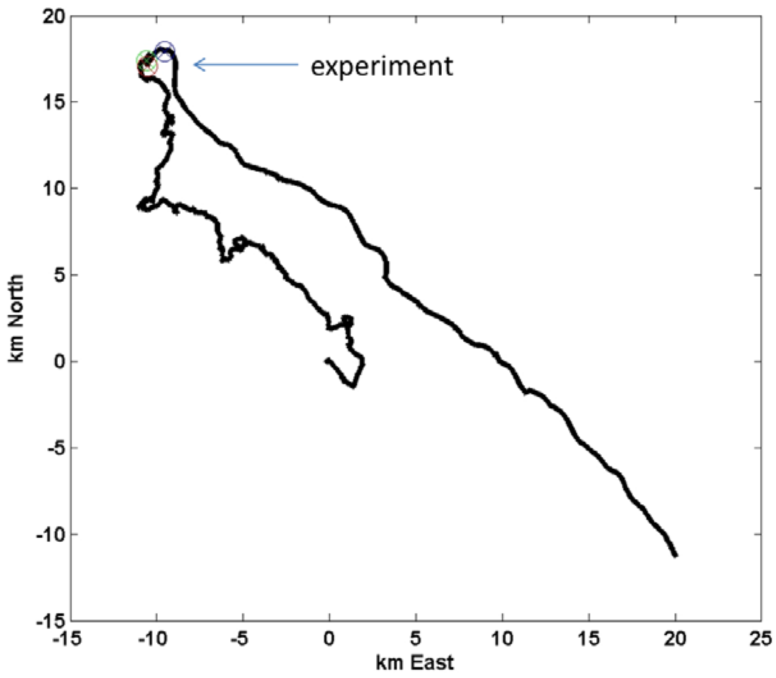


Figure 3.15 Non-georeferenced pseudotrack of tagged bottlenose whale Ha13_176. The location of the sonar exposure experiments is indicated. During the exposure the animal became very directional and moved away from the area on a straight course until the tag released 7 hrs later.

Table 3.5 Results of the visual and acoustic observations 24 hrs before and after the sonar exposure.

	Before	After
Nr Visual Observations	57	8
Nr Acoustic Observations	169	1
Nr Combined observations	226	9
Area Surveyed [km^2]	106	398
Average observations / km^2	2.1	0.02
Average observations / hour	9.4	0.38

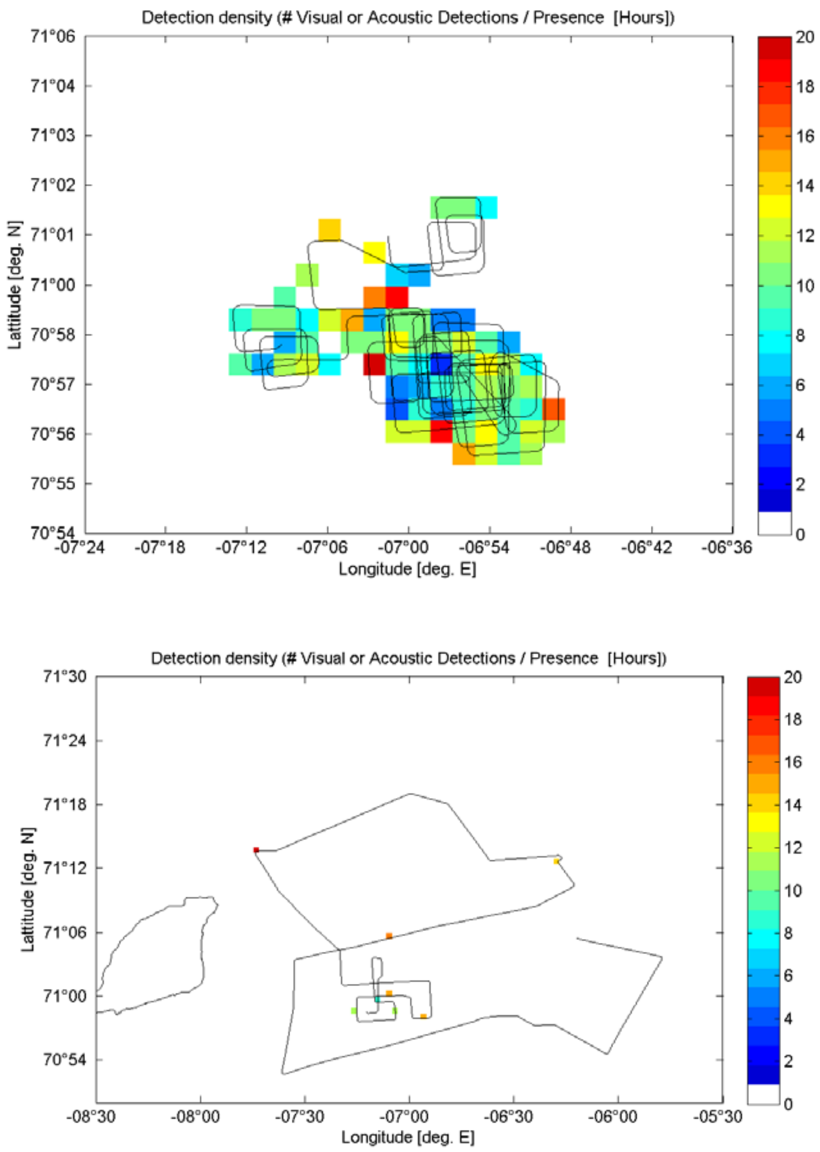


Figure 3.16 Combined Visual and Acoustic detection rate (number of visual or acoustic detections) in each 1x1 km grid cell per surveyed hour in the 24 hours before (top panel) and 24 hrs after the sonar exposure (bottom panel).

3.9 Environmental parameters

Measurements of sound propagation conditions were made in connection with the sonar exposure experiment. The DTAG has a hydrophone in it, which measures the sound levels on the animal during the sonar exposures. However, in order to understand the response of the animal, it is imposrtant in our analysis to have an idea of the overall sound picture in the environment. To achieve this without measuring the sound levels at different depth and positions during the experiments (which would be impossible), sound speed profiles are used as input to sound propagation models (Fig. 3.18). CTDs are collected after every sonar exposure experiments. In addition temperature profiles (XBT) are collected during sonar transmissions, and also occasionally when towing Delphinus to keep an overview of acoustic propagation conditions

(Table 3.6). This year we conducted 1 sonar exposure experiment, and thus only collected 1 CTD profile. However, since we lost contact with the tag after the exposure experiment on June 25th we had to prioritize to relocate the tag and therefore could not follow the regular procedure of collecting the CTD immediately after the experiment. The CTD was therefore not collected until July 9th when we were back in the same area where we conducted the experiment. However, XBTs where collected both during the experiments on June 25th and also in the same position as the CTD on June 9th (Fig 3.17).

Table 3.6 List of XBT and CTD profiles collected during the trial.

XBT/CTD File name	Date	Time UTC	Position North	Position East	Ecco depth (m)	Cast depth (m)
XBT T7_00029.EDF	17.06.2013	20:48:00	68°53,0662’	16°50,4385’		250
XBT T7_00030.EDF	23.06.2013	13:00:00	71°1,7158’	-7°42,6473’	>1000	600
XBT T7_00031.EDF	25.06.2013	10:17:00	70°59,3789’	-7°12,4952’	>1000	600
XBT T7_00032.EDF	05.07.2013	21:02:00	71°6,6504’	-7°29,0751’	>1000	600
XBT T7_00033.EDF	06.07.2013	19:03:00	71°17,1700’	-7°14,2298’	>1000	600
XBT T7_00034.EDF	09.07.2013	22:18:00	70°59,3320’	-7°11,6126’	>1000	600
CTD BW1.SD2	09.07.2013	22:11:00	70°59,4000’	-7°12,0000’	1300	1200
XBT T7_00035.EDF	10.07.2013	19:10:00	70°56,4976’	-5°7,0096’	>1000	600

New this year was the intended use of a sonar buoy to measure the ambient noise level and propagation loss (see Fig. 3.19 for the configuration of the sonar buoy). The buoy was mostly intended to be used during experiments on minke whales, if we ended up using the CTAG which did not have acoustic sensor in it. In such a scenario it was intended to be used as a reference point for sound propagation models to estimate received level on the animal. Since we never conducted any experiments on minke whales the buoy was only used during the test trial in the beginning of the cruise. However this test demonstrated that the concept is working and that it could provide valuable data before, during and after a controlled exposure experiment.

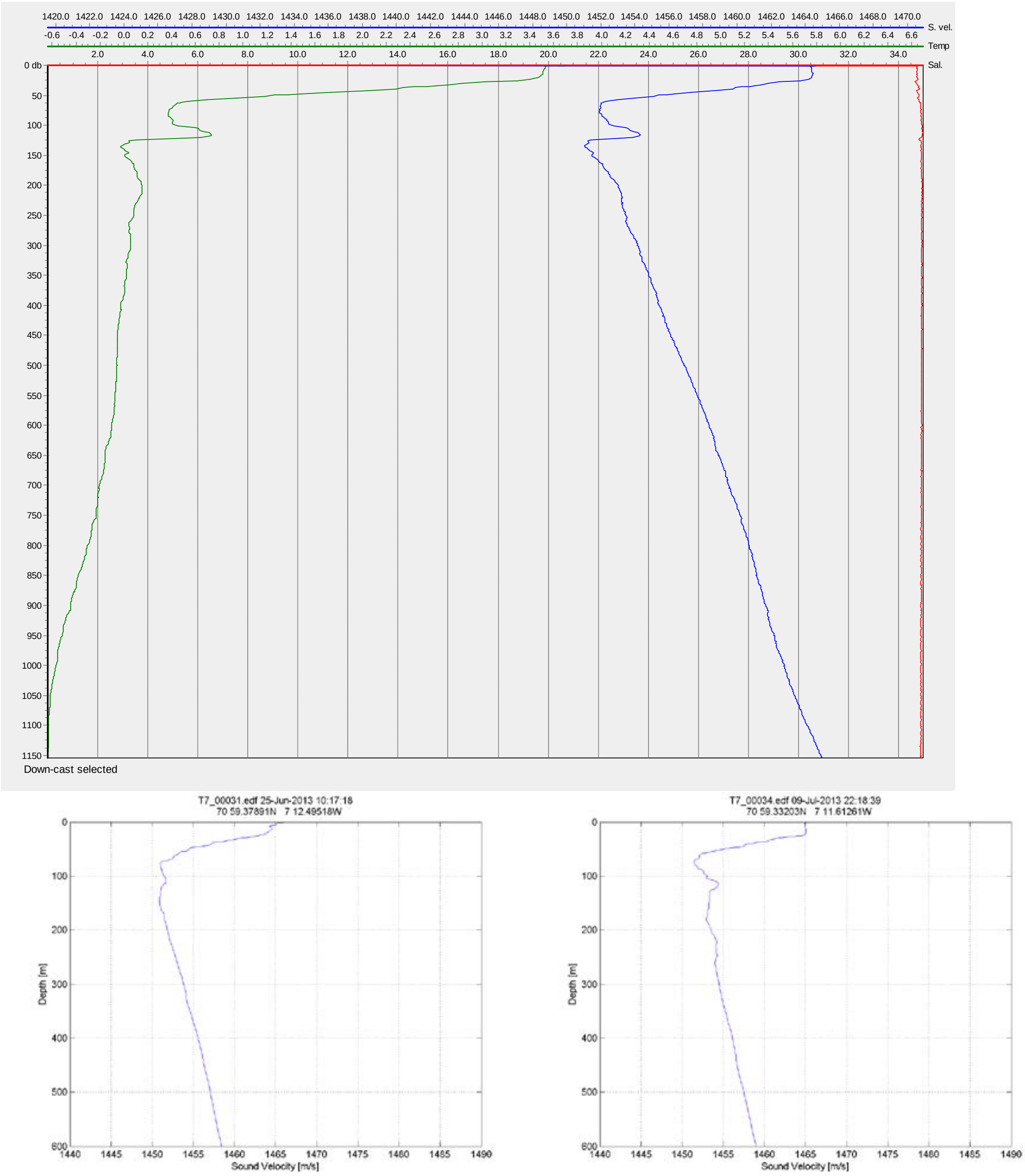


Figure 3.17 Upper panel: Profiles of temperature (green) salinity (red) and sound speed (blue) through the water column in the position of the exposure experiment on bottlenose whale (Ha13_176). The CTD was collected on July 9th, but the experiment was conducted June 25th. However, XBT temperature profiles collected during the experiment (lower left)and in parallel with the CTD indicate that there is little spatial variation. The constant salinity versus depth shown in the CTD profile also implies that sound speed profiles could reliably be measured based on the XBT temperature profiles. All profiles indicate a minimum sound speed around 80m

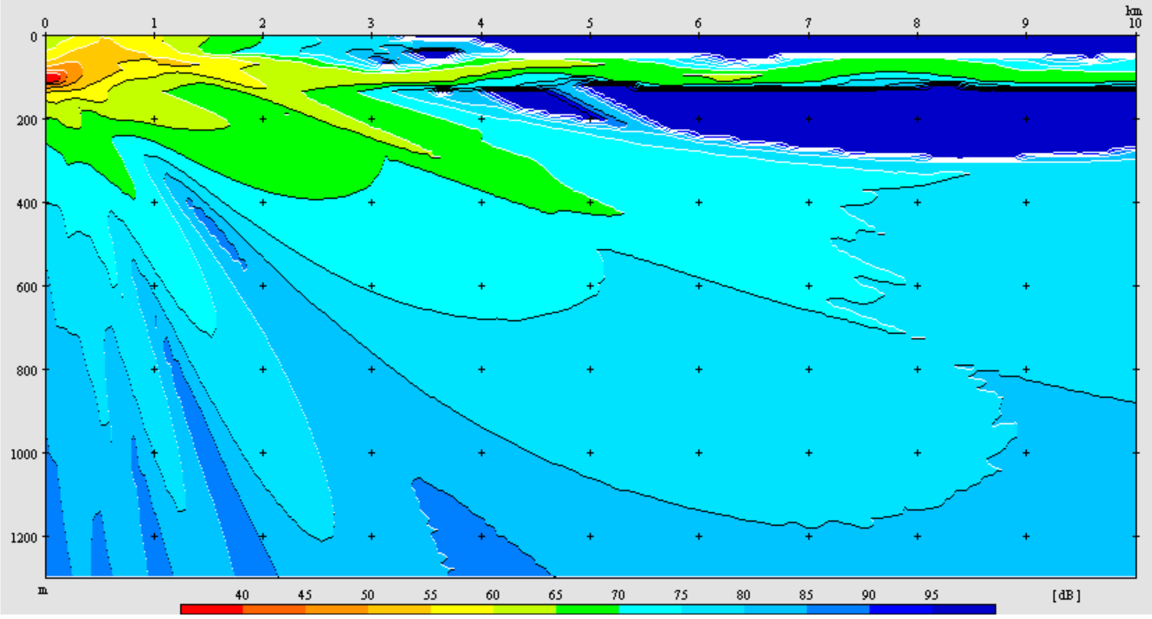


Figure 3.18 Transmission loss estimate by the propagation model Lybin (Dombestein and Gjersøe 2012) based on the transmission characteristics of SOCRATES and the sound speed profile measured in the position of the bottlenose whale experiment (Ha13_176). Source depth was 100m, and water depth was 1300m.

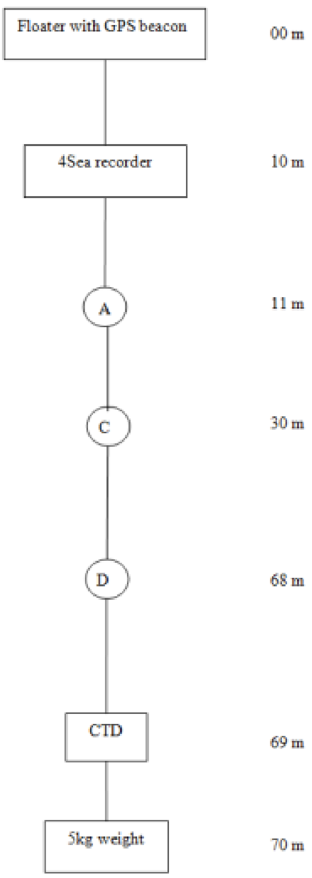


Figure 3.19 Configuration of the sonar buoy used during 3S-2013 (left). Positions of the hydrophones are marked A, C and D. Deployment of the buoy (above), the hydrophones are attached at a later stage using one of the tag boats (photo F.P. Lam).

3.10 Photo-identification and documentation of tagging

Photographs of northern bottlenose and minke whales approached for tagging were collected with the aim of individual photo-identification (photo-ID) and thus to eliminate, as far as possible, re-tagging of individuals or groups previously exposed to 3S sonar trials. Sequence photographs of tagging attempts were collected to document the tagging process, as well as to collect images of the location and orientation of tags on whales and obtain photo-ID images of the tagged whale.

Photo-ID images of other species (pilot, killer, humpback and blue whales) were also collected opportunistically from the tag boats and from H.U. Sverdrup II.

3.10.1 Northern bottlenose whale

Bottlenose whales were photographed during 43 encounters in the Jan Mayen region during 3S-2013 (Table 3.7). An initial photo-ID catalogue of individual bottlenose whales was developed following examination of photographs and identification of individual whales based on unique markings. Due to time constraints, an initial attempt at developing a catalogue was undertaken during the voyage; photographs from two, of the four, 6-hour daily watch periods were examined (thus, approximately half of the encounters of bottlenose whales from each day were candidates for the initial catalogue). Successful development of the catalogue was possible because most bottlenose whales that were photographed from close range (less than about 50 metres) and in good lighting conditions possessed unique individual marks (Fig. 3.20). Marks included: nicks and tooth rake scars on dorsal fins and tooth rake scars (presumably from intra-specific interactions) on the flanks and caudal peduncles of whales, body pigmentation patterns, variations in dorsal fin shapes as well as ectoparasites and marks/scars resulting from them.

Not all the whales encountered could be included in the catalogue as, by chance, it was not possible to obtain images of all individual whales from all groups. Also, a small proportion of individuals (usually juvenile whales - based on smaller body size) with uniform brown pigmentation and with no apparent scars were not recognizable in photographs. Furthermore, it was not always possible to distinguish unique markings of individuals, putatively of all ages, because of poor image quality due to low light levels, rain and rough sea conditions.

The initial photo-ID catalogue of bottlenose whales includes 46 individual Left sides and 45 individual Right sides of whales. For 5 individuals, the Left and Right sides were matched; however, for the remainder (41 Left and 40 Right sides) the relationship of Left and Right sides is unknown.

The tagged bottlenose whale subject to the sonar experiment was encountered in the daily watch periods not included in the initial catalogue, however, probable images of the Right side of the tagged individual were compared to the catalogue – no matches were found.

No re-sightings of individuals between days (24 hour periods) were discovered when the 46 Left sides and 45 Right sides of individuals in the initial catalogue were compared.

Figure 3.20 Examples of features which can be used to identify individual bottlenose whales. Top picture shows an animal with a clear nick on its dorsal fin. Bottom picture shows another animal with a white dot on tip of the fin, mark on base of fin and scars and dots on the body. Photos: Paul Ensor

No quantitative assessment of either the quality of photographs or their usefulness for long-term photo-ID studies was made for the initial catalogue. The longevity of the markings used for the initial catalogue, or its utility for further research on this species, in this area are unknown. However it is assumed that tooth rake scars would have considerable long-term persistence and any re-sightings of such marked individuals, would perhaps aid an evaluation of temporal changes in the other markings. The initial catalogue (and particularly if expanded to encompass all groups) could facilitate studies of social structure and group dynamics of bottlenose whales encountered during 3S32013. Also, any re-sightings of individuals in a longer term study would provide insight into patterns of habitat use on a variety of spatial scales and based on mark-recapture techniques could also potentially contribute to an abundance estimate for this poorly known population.

Table 3.7 Summary of photo-identification of northern bottlenose whales, minke whales, pilot whales, killer whales, blue whales and humpback whales during 3S 2013. Number of animals is the best estimate from visual observations.

Species	Date	Sighting number	Number of animals	Area	Latitude		Longitude		Photographer
Bottlenose whale									
	23/06/2013	81	5	Jan Mayen	71.01204	N	7.62053	W	PE
	23/06/2013	Near 86	(8)	Jan Mayen	71.0459	N	7.306412	W	EG
	23/06/2013	Near 86	(8)	Jan Mayen	71.0459	N	7.306412	W	EG
	23/06/2013	89	8	Jan Mayen	71.0311	N	7.210933	W	EG
	24/06/2013	91	4	Jan Mayen	71.01181	N	7.21275	W	PE
	24/06/2013	114	3	Jan Mayen	70.97457	N	7.01558	W	PE
	24/06/2013	101	6	Jan Mayen	71.083	N	7.075506	W	EG
	24/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	24/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	24/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	24/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	24/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	24/06/2013	133	1	Jan Mayen	70.9449	N	6.964504	W	EG
	25/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	25/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	25/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	25/06/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	25/06/2013	110	2	Jan Mayen	71.0176	N	7.10314	W	EG
	30/06/2013	215	5	Jan Mayen	71.1577	N	8.453715	W	EG
	01/07/2013	205	-	Jan Mayen	71.08466	N	8.43263	W	LH
	01/07/2013	215	5	Jan Mayen	71.15765	N	8.45372	W	LH
	01/07/2013	205	-	Jan Mayen	71.08466	N	8.43263	W	PE
	01/07/2013	Near 205	-	Jan Mayen	71.08466	N	8.43263	W	PE
	01/07/2013	215	5	Jan Mayen	71.15765	N	8.45372	W	PE
	01/07/2013	236	2	Jan Mayen	71.2158	N	8.170144	W	EG
	01/07/2013	246	4	Jan Mayen	70.83463	N	6.02442	W	PE
	03/07/2013	277	5	Jan Mayen	71.28378	N	8.89486	W	PE
	03/07/2013	277	5	Jan Mayen	71.28378	N	8.89486	W	LH
	03/07/2013	279	3	Jan Mayen	71.28796	N	8.94792	W	PE
	03/07/2013	289	3	Jan Mayen	71.2564	N	8.963458	W	EG
	03/07/2013	291	5	Jan Mayen	71.2675	N	8.74793	W	EG
	06/07/2013	331	5	Jan Mayen	71.13718	N	7.7627	W	LH
	06/07/2013	331	5	Jan Mayen	71.13718	N	7.7627	W	PE
	06/07/2013	339	3	Jan Mayen	71.19296	N	8.10694	W	PE
	06/07/2013	356	4	Jan Mayen	71.2524	N	8.26275	W	PE
	06/07/2013	339	3	Jan Mayen	70.9472	N	8.534697	W	EG
	06/07/2013	356	4	Jan Mayen	71.2524	N	8.262746	W	EG
	06/07/2013	360	4	Jan Mayen	71.2805	N	8.278872	W	EG

	07/07/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
	08/07/2013	382	1	Jan Mayen	71.1535	N	7.632968	W	EG
	08/07/2013	394	2	Jan Mayen	71.2303	N	7.746368	W	EG
	08/07/2013	385	2	Jan Mayen	71.14487	N	7.571408	W	PE
	08/07/2013	387	1	Jan Mayen	71.19102	N	7.611234	W	PE
	09/07/2013	397	4	Jan Mayen	71.27186	N	8.005796	W	PE
	09/07/2013	Near 397	(4)	Jan Mayen	71.27186	N	8.005796	W	PE
	10/07/2013	428	5	Jan Mayen	70.92121	N	5.227958	W	LH
	10/07/2013	428	5	Jan Mayen	70.92121	N	5.227958	W	PE
	11/07/2013	Unknown	-	Jan Mayen	-	N	-	W	EG
Minke whale	19/06/2013	58	1	Outer Vestfjorden	67.5646	N	13.02208	E	EG
	19/06/2013	Unknown	1	Outer Vestfjorden	-	N	-	E	EG
	19/06/2013	Unknown	1	Outer Vestfjorden	-	N	-	E	EG
	20/06/2013	52	1	Vestfjorden	67.58569	N	13.33551	E	PE
	20/06/2013	56	1	Vestfjorden	67.53562	N	12.95891	E	PE
	20/06/2013	58	1	Vestfjorden	67.56458	N	13.02208	E	PE
	23/06/2013	79		Jan Mayen	70.9744	N	7.641381	W	EG
	25/06/2013	Unknown	1	Jan Mayen	-	N	-	W	EG
	04/07/2013	308	1	Jan Mayen	70.7793	N	8.06457	W	EG
	05/07/2013	326	1	Jan Mayen	70.9472	N	8.534697	W	EG
	06/07/2013	340	1	Jan Mayen	71.18768	N	8.15745	W	PE
	06/07/2013	341	1	Jan Mayen	71.17886	N	8.12609	W	PE
	06/07/2013	353	1	Jan Mayen	71.1389	N	8.42396	W	EG
	06/07/2013	357	1	Jan Mayen	71.20204	N	8.2657	W	PE
	07/07/2013	Unknown	1	Jan Mayen	-	N	-	W	EG
	07/07/2013	367	1	Jan Mayen	71.2568	N	8.157351	W	EG
	07/07/2013	Unknown	1	Jan Mayen	-	N	-	W	EG
	07/07/2013	Unknown	2	Jan Mayen	-	N	-	W	EG
Killer whale									
	19/06/2013	36	5	Vestfjorden	67.96406	N	13.199204	E	EG, PE, LH
Pilot whale									
	18/06/2013	29	35	Tranøy, Vestfjorden	68.26396	N	15.88759	E	EG, LH, PE, PM
	18/06/2013	30	15	Tranøy, Vestfjorden	-	N	-	E	EG, LH, PE, PM
Humpback whale									
	05/07/2013	321	2	Jan Mayen	70.72903	N	8.3681	W	PE

Blue whale								
27/06/2013	197	1	Jan Mayen	71.2425	N	8.08776	W	EG
28/06/2013	199	1	Jan Mayen	-	N	-	W	LH
04/07/2013	298	2	Jan Mayen	71.1047	N	7.853965	W	EG

3.10.2 Minke whale

Minke whales were photographed in Vestfjorden (6 individuals) and in the vicinity of Jan Mayen (12 individuals) during approach attempts for tagging during 3S 2013 (Table 3.7).

3.10.3 Pilot whale

Two groups of pilot whales were photographed during tagging attempts and playback experiments in Vestfjorden on 18 June (Table 3.7). Images included the two individuals that were tagged (Appendix F).

3.10.4 Killer whale

One group of killer whales was photographed in Vestfjorden on 19 June (Table 3.7).

3.10.5 Blue whale

In the Jan Mayen region blue whales were encountered infrequently and photo-ID images were collected opportunistically of 3 individuals during 3S-2013. (Table 3.7).

3.10.6 Humpback whale

Humpback whales were also encountered infrequently in the vicinity of Jan Mayen; photo-ID images of the flukes of 2 individuals were obtained from HU Sverdrup (Table 3.7).

4 Discussion

4.1 3S-13 trial outcome

The primary objectives of the trial were to tag bottlenose whales and minke whales and thereafter conduct controlled sonar exposure experiments on them and record potential behavioral responses. We did tag one bottlenose whale and conducted one exposure experiment. This experiment is the first experiment on a beaked whale far from a naval training range, and the first ever conducted on this species. Even though we lost track of the whale during the experiment, it still ended up being successful in the sense that we did achieve a sonar dose escalation on the whale from barely audible levels to levels were the animal had clearly decided to avoid the source. The tag data is of high quality and we have been able to use it to reconstruct the behavior of the animal during the experiment. In combination with the larger scale acoustic and visual survey conducted in the area before and after the exposure, this dataset will contribute with valuable new information. Based on this experiment one should consider if the *"beaked whale sonar issue"* should not be broadened out to also include other species of beaked whales and new ocean basins, than previously considered (Tyack *et al.* 2011; De Ruiter *et al.* 2013). We did not tag any minke whales during the trial. However, the single experiment on bottlenose whale seems to add such great value to the overall objective of the 3S-project that the trial as such should be considered successful. Other groups trying to do behavioral response studies on beaked whales have also experienced similar low data sampling rate with only 1-2 experiments done per field season (Tyack *et al.* 2011; De Ruiter *et al.* 2013).

The 3S-13 trial also had a number of secondary tasks (section 1.1). However, given our struggle to achieve our primary task, we could not prioritize these tasks. Some of the secondary tasks could however be addressed in parallel with the primary task. E.g. we did collect a significant dataset on group behavioral data to look at the effects of tagging of bottlenose whales. We also collected a significant amount of bioacoustics data on bottlenose whales and were successful in combining acoustic detections with visual sightings for tracking groups of bottlenose whales. Finally, based on our trial we know a lot more about the feasibility of doing cetacean research in the area around Jan Mayen (se section 4.2 below).

4.2 Jan Mayen field site

We have identified Jan Mayen to be a unique area for research on bottlenose whales, where such research can also be combined with research on baleen whales. However, this area does challenge both the personnel and equipment involved, mainly because of the unstable and harsh weather conditions. Because of this, there will always be some risk of not being successful in achieving the set objectives when operating in this area. However, there also seems to be a great potential for major achievements in cetacean research and these pros and cons needs to be carefully balanced when planning any future trials. During the 3S-13 trial we seemed to encounter more wind than usual, and this likely affected our success rate. However, we did conduct a very important experiment on bottlenose whales, and even though we hoped for more data both on this species and on minke whales, we still think it was the right decision to go to Jan Mayen, given the situation for the 3S2-project with an imbalanced dataset, with total lack of data on bottlenose whales after two trials off Spitsbergen (Kvadsheim *et al.* 2012).

4.2.1 Considerations for future trials to Jan Mayen

At the last day of the trial the science group did a *"hot wash up"* session to evaluate the trial. Since this was the last planned trial under the 3S2-project, no specific actions came out of this session, but we did note some useful consideration for anyone who wants to conduct similar type of research in the waters off Jan Mayen.

Jan Mayen is a remote field site with very limited support facilities ashore. Future users of the trial should consider the following:

4.2.1.1 Safety

Although there is a Norwegian meteorological and military station on the island, there is no port or reliable landing site available, and anybody operating near Jan Mayen should be completely independent of support from the island. Meteorological conditions (see chapter 3.2.) can change very quickly, and there are large local variations in weather conditions and strong local wind effects of the Jan Mayen mountains (most notably near the northern part because of the Beerenberg). Therefore there should be a high margin of safety, when operating in this area.

Small boats can run into trouble if conditions change very quickly and the mother ship is not close. During 3S-2013 we used a *"3 nmi rule"* that made sure that small boats were always close to the mother ship and could assist them quickly if needed.

Training on recovery/launching small boats is essential for these kinds of operations under these conditions. Use of kill-switch on the small boat engine should be mandatory.

Suitable safety gear needs to be worn. The 3S-crew used flotation suits in the small boats, but use of survival suits or dry suits might improve the margin of safety in these cold waters.

Modern navigation and communication equipment (e.g. GPS/AIS/VHF) on small boats adds to safety and increases operability.

4.2.1.2 Communications

There is no mobile telephone net on the island, and the only way to have telephone or internet connectivity is by satellite communication.

4.2.1.3 Research on cetaceans

For research on bottlenose whales and minke whales this could be an important area, both species were regularly sighted, particularly bottlenose whales in the deep waters at the North side of the island, extending to the North-West and South-East.

Suitable weather conditions for working with minke whales were rare, and often only in very small areas, in the lee of the island. For this type of work with minke whales, 3S cannot confirm that suitable conditions will be available sufficiently to justify a dedicated campaign on minke whales.

There is still very little information about basic biological conditions around Jan Mayen.

Only a limited part of the Jan Mayen water was exploited by the 3S-2013 team. There may still be an enormous potential to work in other areas around, particularly south of the island.

4.2.1.4 Search phase

3S used a combination of visual and acoustic detection for searching and tracking bottlenose whales. This proved to be a good choice, and 3S were often able to get close enough to bottlenose whales to start tagging operations. Neither a visual only nor acoustic only is optimal for either searching or tracking of animals.

Passive acoustic detectability of bottlenose whales remains problematic during dives. Even if animals were echolocating, detections were only received intermittent. Tracking of bottlenose whales by acoustic systems during foraging dives was found to be impossible most of the time and should not be expected using surface or towed systems.

Dedicated systems were made to enable combining acoustic and visual information and tag boat position information (chapter 2.3). This proved to be very useful for tracking groups over time and for bringing tag boats close to animals.

4.2.1.5 Tagging

During previous trials we have struggled to tag minke whales with acoustic and motion sensor DTAGs, used very successfully with other species, and therefore a lot of effort was invested in improving tagging techniques prior to this trial. We were very close many times, but we did not manage to tag any minke whales. Given our total effort (also during 3S-11 and 3S-12 [Kvadsheim *et al.* 2011;2012]) and lack of success, we therefore conclude that with this species smaller tags which can be launched at longer distances should be used to improve the tagging success rate, even if this means using simpler sensor equipment on the tag which reduce the quality of the data.

Bottlenose whales often approached ships and showed investigative behaviour, but generally did not approach ships or tag boats at very short ranges. Tagging proved to be difficult. It was observed that tagging with pole was difficult. Use of the ARTS system increased range and tagging efficiency. However, still tagging was most of the time not possible because animal remained just outside tagging range. There are a number of options to further improve tagging efficiency:

1) Decrease the range that animals keep to boats by investigating the usability of other boats that are smaller and more silent.
2) Increase the tagging range. Improvements can be still be made to the ARTS system, and this might increase the tagging range possibly just enough to increase tagging efficiency significantly. Suggested improvements could be:
    a. Smaller or more streamlined tags that can be launched over larger ranges.
    b. Use of more pressure (higher speed) would increase range and accuracy but implies that tags are robust enough and shock absorbers good enough to prevent tag damage or re-bounce.
    c. To reduce the rate of missed shots; perfect the equipment and tagger at a specific tagging range, and then stick to that range.
    d. Implement button to switch pressure on the ARTS quickly would be useful to increase flexibility in tagging range.

4.2.1.6 Protocol

A protocol was designed before the trial on how to execute the sonar exposure experiments on bottlenose whales, but since no experience was available it was not certain that this was actually the best experimental design. Also, the design conditions might be difficult to meet, and some flexibility in protocol is needed to prevent losing opportunities. The 'SOCAL style protocol' implying that an exposure would start during the foraging phase could not be achieved, because actually detecting the foraging dive was not feasible.

The 3S-2013 protocol used was designed to detect onset of behavioural change, but the post-exposure phase was not sufficiently long to record the total response, and return to baseline behaviour, by the animal. A longer post exposure phase should therefore be considered.

For recording baseline behaviour one should also consider other types of tags, including satellites tags.

4.3 3S-2 project outcome

The 3S-13 trial was the last of the planned trial under the 3S-2 project, and even though there is still a possibility that more baseline data on bottlenose whales will be collected near Jan Mayen in 2014, it is time to summarize. During 3S-13 we only conducted 1 experiment, but during two previous 3S-2 trials we tagged a total of 28 animals, and did 21 sonar exposure experiments and 31 control experiments (Table 4.1) (Kvadsheim *et al 2011; 201*2). The total achievement of the project in terms of the amount of data collected is therefore highly acceptable.

We conducted 20 sonar exposures experiments to humpback whales during 3S-12 (Kvadsheim *et al*. 2012) and 3S-11 (Kvadsheim *et al.* 2011). The total dataset on humpback whales is therefore expected to give conclusive results on how sensitive this species is to sonar and the effectiveness of ramp up. However, we conducted only a single sonar exposure experiment on minke whales (during 3S-11; Kvadsheim *et al.* 2011) and a single experiment on bottlenose whales (during 3S-13; Miller *et al.* 2014). The total 3S-2 dataset is thus very unbalanced, and more data on minke whales and bottlenose whales are clearly needed to draw firm conclusion about their sensitivity to sonar. However, the single experiments on minke whales and bottlenose whales do indicate that these species seem to be very sensitive to sonar, much more sensitive than humpback whales. Retrospectively, we should therefore maybe have focused more on the most sensitive species earlier. However, minke whale and bottlenose whales have very different habitat preferences, and in the original 3S-2 field site (Barents Sea and Spitsbergen), they could not be easily combined (Kvadsheim *et al*. 2011). The Jan Mayen field site seems to be a unique area were research on these two sensitive species can be combined.

Table 4.1 Summary table of all 3S data collected between 2005 and 2013. Control experiments include playback of killer whales sounds or control sounds and the silent approaches of the sonar source vessel. Killer whales, pilot whales, sperm whales and herring were studied as part of the 3S-project (2005-2010, light blue), whereas minke whales, bottlenose whales and humpback whales, were studied in the current 3S-2 project (2010-2013, dark blue).

Species	# Tags deployed	#Sonar exp.	#Control exp.	Trials/year
Killer whales	22	8	3	3S-05, 3S-06, 3S-08, 3S-09, ICE-09
Pilot whales	34	14	28	3S-08, 3S-09, 3S-10, 3S-13
Sperm whales	10	10	9	3S-08, 3S-09, 3S-10
Herring	0	38	25	3S-06, 3S-08
Minke whales	2	1	2	3S-10, 3S-11
Bottlenose whales	1	1	0	3S-13
Humpback whales	27	20	29	3S-11, 3S-12
SUM	**96**	**92**	**96**	

Despite the very unbalanced 3S-2 dataset, the effort to study the three different species was clearly much more balanced. The experience from the 3S-2 project as well as from the first 3S-project, where a lot of effort was focused on killer whales, is that the species which are most sensitive to anthropogenic disturbance are also the most difficult species to study, but probably the most important species to study. This should clearly be taken into consideration when evaluating the successfulness of behavioral response studies.

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Appendix A 3S-13 data inventory

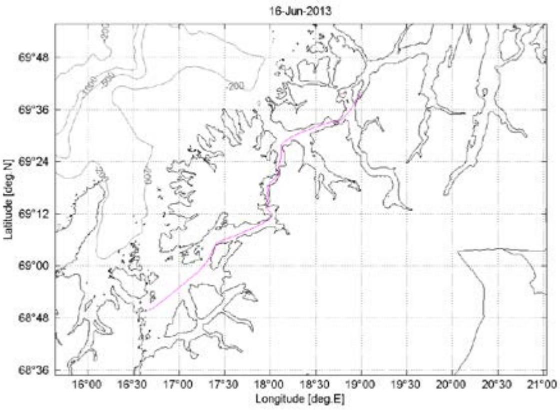
Folder	Subfolders/files	Summary of content
Documents	root	Cruise plan and SMRU-to-TNO shipping list
	Acoustics	Dephinus and Socrates logbook kept by TNO with details about deployments and events, overview table of recordings, and screenshots of Dephinus acoustic tracking and detections
	Boxing screenshots	Photos of boxing patterns in track
	Briefs	Notes and PPTs of NBW experiment and cruise debriefs
	Cruise report	Cruise report outline and personal tasks
	Daily work plans	Daily workplans that were put up every day to inform the team about weather, work area, etc
	Event logger HUS	Daily text files created by cruise leader with the GPS event logger on the bridge, screenshots of boxing and tag search patterns, overall activity record, and some specific event summaries.
	Maps	Various high-resolution marine charts of Jan Mayen and Northern Norway areas
	Maria files	Files created in the Navigational software package MARIA.
Buoy	Sound, CTD, GPS	Data collected during minke-dinky tests by TNO's acoustic buoy.
Calibrations	Subfolders for each sound recorder. Excel table	Files of pre-trial acoustic calibrations in the test pool at TNO of the DTAGs, Microtracks, Roland R-44, and single hydrophones. Includes script to read files from TNO's data acquisition system (APx), cal sheets of reference hydrophones and an Excel table with the overview of all recordings.
CTD	Raw data	Raw CTD data and program to open the files.
	Manuals	Software manuals
DTAG	Data sheets and forms	Scanned tag data sheets for DTAG deployments and preparations. Pictures and PPT of damaged tag. Tag deployment Excel tables,
	DTAGv2	DTAG version 2 files, including raw sensor and audio, cal, prh and raw files
	DTAGv3	DTAG version 3 files, including raw sensor and audio for two test recordings.
Echosounder	Raw data	Raw echosounder data
GPS tag	Excel tables, matlab script	Deployment overview, matlab script for reading processed data files, and table with GPS positions for pilot whale experiment
	1 subfolder per GPS logger	Subfolders include raw (.raw, .dat) and processed GPS data from the loggers
Logger backup	Access databases , Excel tables	The raw and checked Logger databases from the two observer platforms, the experimental timelines created from the logger data, screenshots of logger maps stored in word file
Mobhus GPS	Garmin files and gpx	Mobhus 1 and Mobhus 2 tracks logged during tagging recorded with Garmin handheld GPSs.
Orca playbacks	Photos, movies and sounds, data tables	Photos taking during pilot whale experiment, Go-pro movies during playback experiments, recordings from monitoring hydrophone, playback stimuli, recordings of encounter with killer whales in Vestfjord, test recordings, and data table with playback details
Pics and videos	For cruise report	Selection of photos made by Paul E for the cruise report
	Fun pics	Non-work photos organized by name of maker
	Photo ID	Photo ID organized by name of maker and Paul E's initial photo ID catalog for NBW
	Videos	Videos organized by name of maker
SMRU array	.wav sound	Two SMRU array recordings made during test run
Socrates logs	1 subfolder per transmission run	Transmission logs with details about Socrates transmissions (time, source level) and Non-acoustic sensor data (depth, pitch)
Software tools	Executables	Various software programs and drivers for equipment
Sound samples	.wav sound	Selection of interesting sound recordings from Delphinus and DTAG
TNO GPS	.asc text files	GPS data from receiver on TNO container as text files with GPS strings.
	mat-files	Subfolder including scrips and GPS data in matlab format
TNO tracks	Figures	Daily and full-trial plots of tracks from TNO GPS, including color coding for Delphinus and Socrates deployment.
Visual tracking	Figure	Figure for big-eyes protractor
XBT	Figures, raw data, excel table	Sound speed profiles and raw data from XBT. XLS table provided with location, time, etc.

Appendix B Diary with daily sail tracks

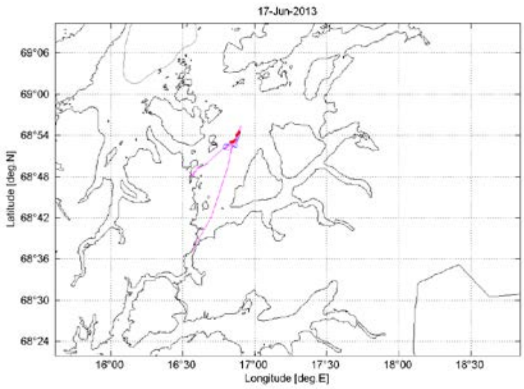
This appendix contains a short description of the day by day activity (diary) with a figure illustrating the sailed track that day. Sail track in red indicates active sonar transmission using the Socrates system, and sail track in blue indicate towing of the Delphinus array.

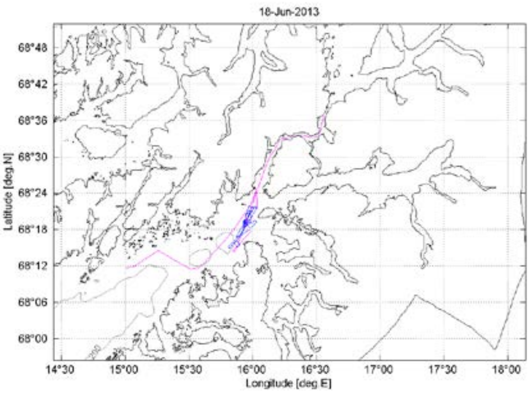
June 15th 3S-13 kick off in Tromsø. Technical installation, Dinner out.

← **June 16th** Technical installation, joint brief, transit from Tromsø to Harstad



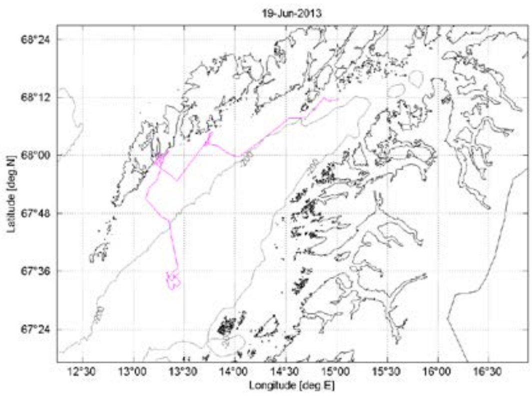
June 17th Fuel and supplies in Harstad, drill of the operation, transit to Vestfjord. →

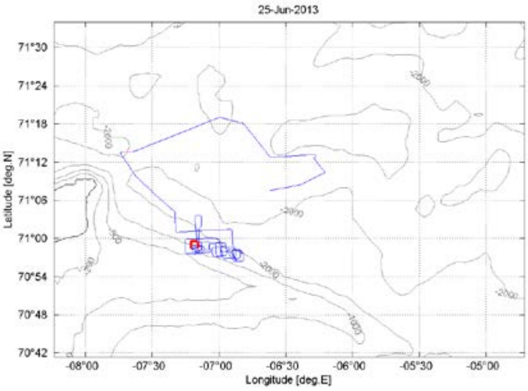




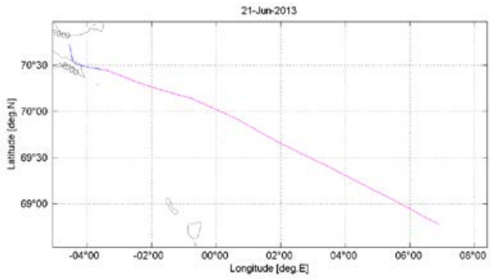
← **June 18th** Fully operational, pilot whale experiment south of Lødingen.

June 19th Searching along northern shore of Vestfjorden. Minke whale tagging attempts. →

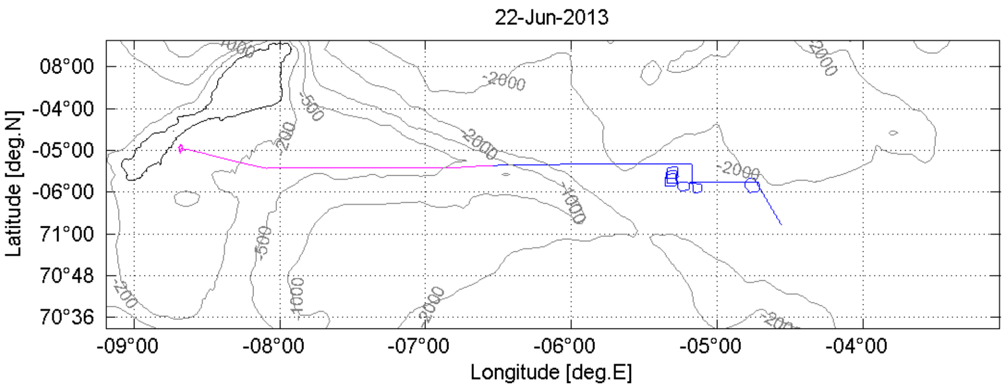




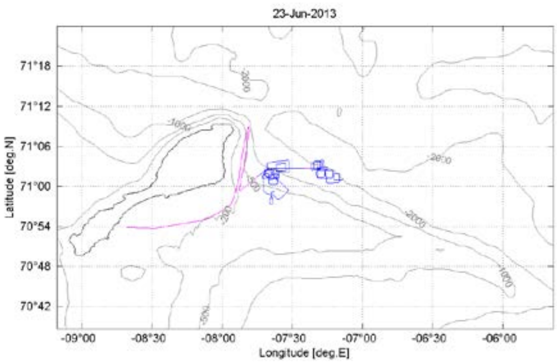
← **June 20th** Minke whale tagging attempts mid fjord in Vestfjorden. Starting transit towards
Jan Mayen.



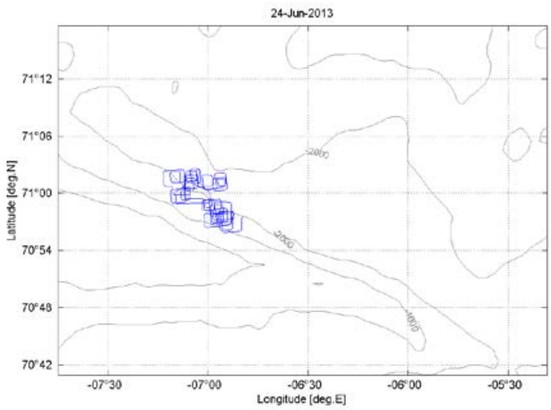
June 21th Transiting to Jan Mayen →



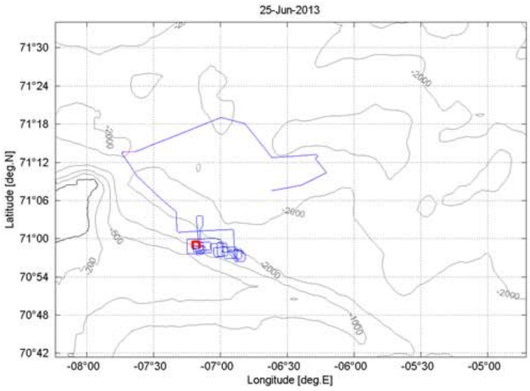
June 22nd Arriving deep water canton east of Jan Mayen streaming Delphinus. Beaked whale detections and sightings but no tagging attempts. Midsummer eve celebration on Jan Mayen.



← **June 23rd** Working with beaked whales east of the Island, nice acoustic and visual tacking in boxing mode, several close tagging attempts.

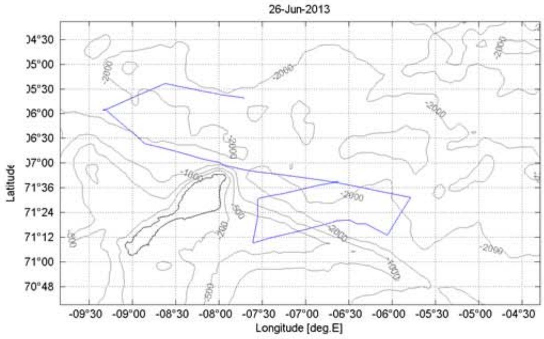


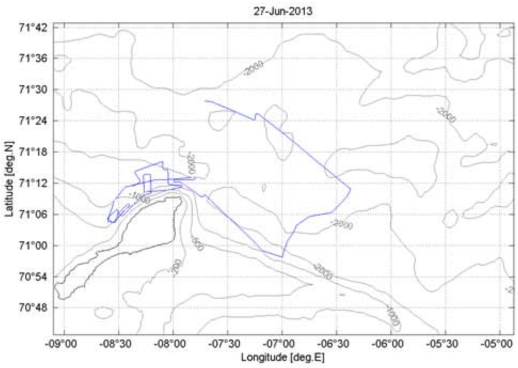
June 24th Continue tracking and tagging attempts on beaked whales. Using DTAGv3 with pole tagging seem to be inefficient →



← **June 25th** Switch to v2 DTAGs and ARTS tagging. Tag on after 1 hr. Sonar exposure experiment conducted despite bad tracking. Lose track of the whale.

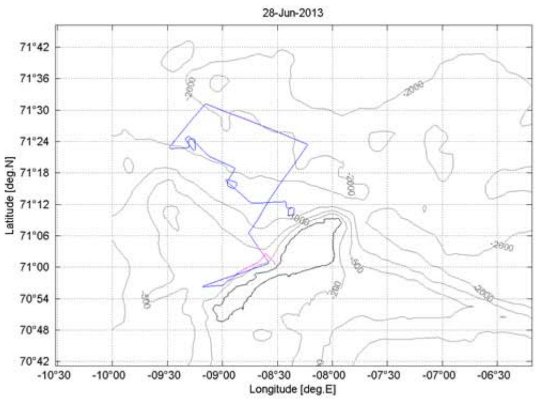
June 26th Search for lost tag NE of Jan Mayen. Recover tag, Start acoustic survey along the Jan Mayen deep water canyon→

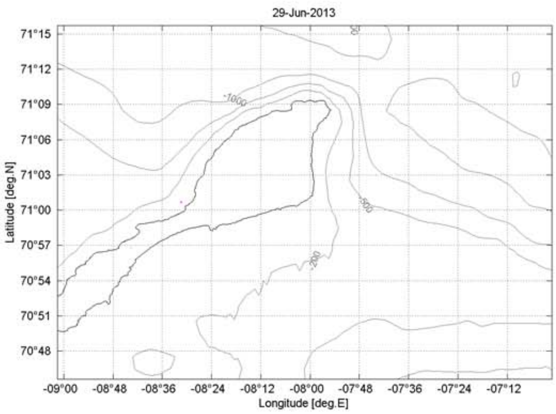




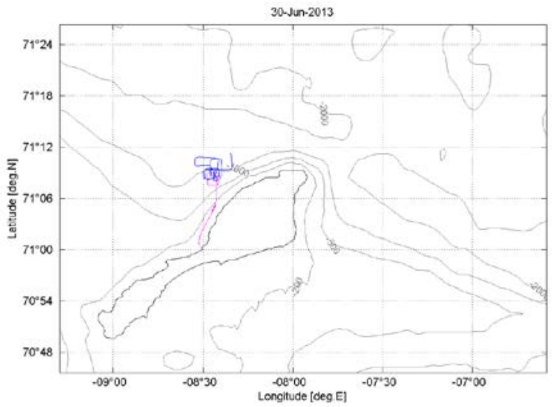
← **June 27th** Continue acoustic survey along Jan Mayen Canyon. Tagging attempts NW of the Island. Checked out landing site at North Cape.

June 28th Continue search along NW shore. Non workable conditions, anchor in Walrus Bay →



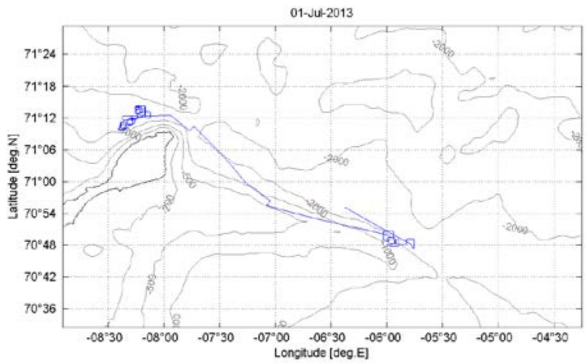


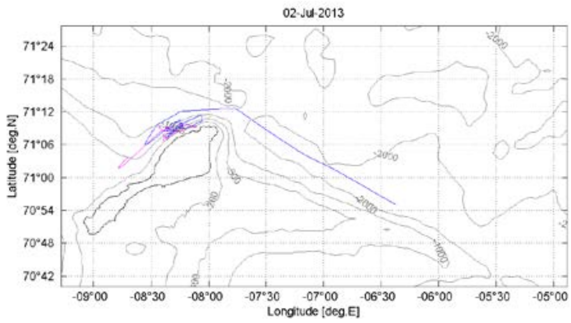
← **June 29th** Anchored in Walrus Bay



← **June 30th** Still anchored in Walrus Bay. Data quick look from beaked whale experiment led to some changes to experimental procedures.

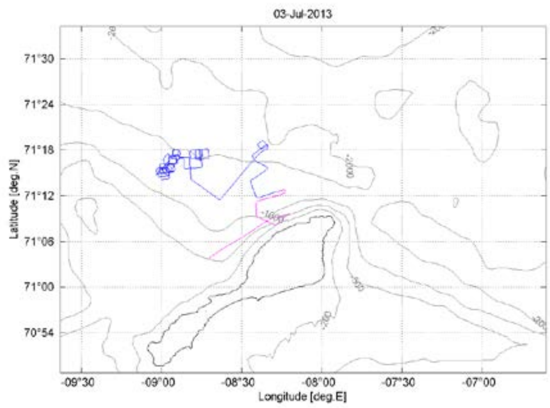
July 1st Tracking and tagging attempts on beaked whales north of Jan Mayen. Searching eastwards in the Canyon, then back east →

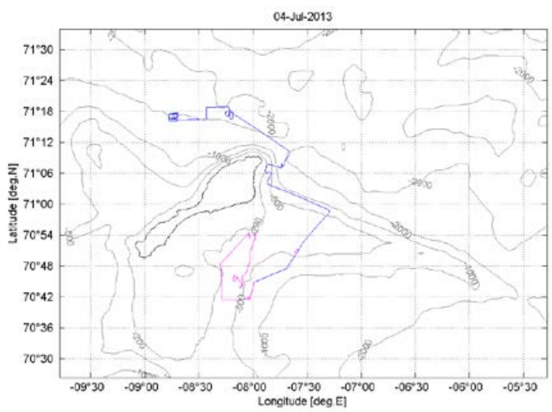




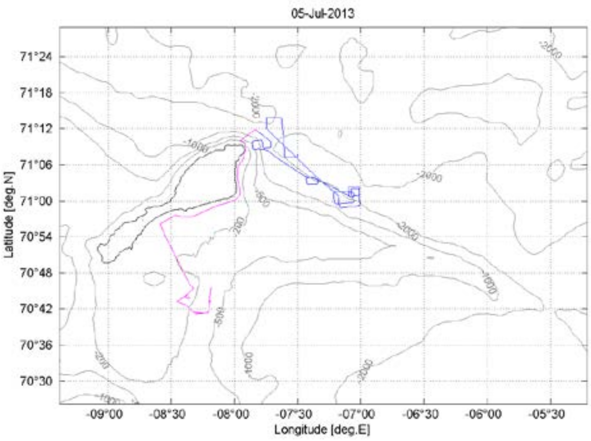
← **July 2nd** Searching in a small area NW of Jan Mayen in the only area with some protection from the strong southern winds.

July 3rd Searching NW of Jan Mayen in gradually improving conditions. Tracking and tagging attempts on a group of beaked whales →



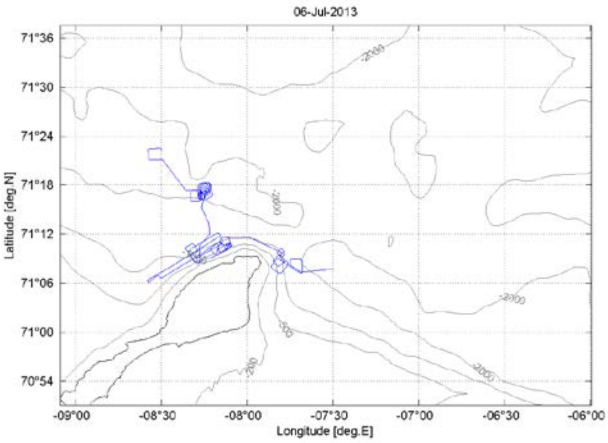


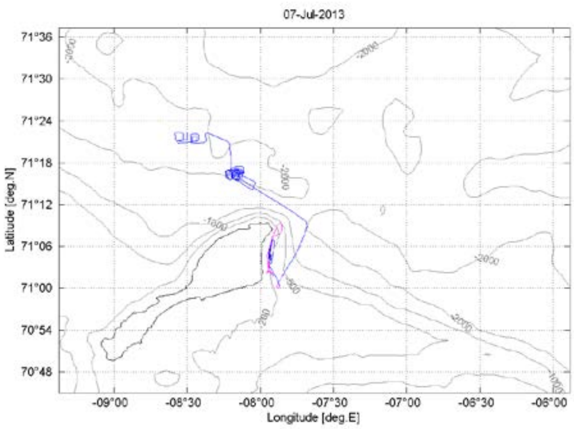
← **July 4th** Working to tag beaked whales NW of Jan Mayen in the Canyon. Weather detoriats. Moved to the Jan Mayen bank to tag minkes. No success



← **July 5th** Continue to work with minkes on the Jan Mayen bank. Weather detoriates. Complete shore search from Sverdrup and MOBHUS to look for stranded animals on the SE-coast. Negative result. Searching for beaked whales east in the Jan Mayen Canyon.

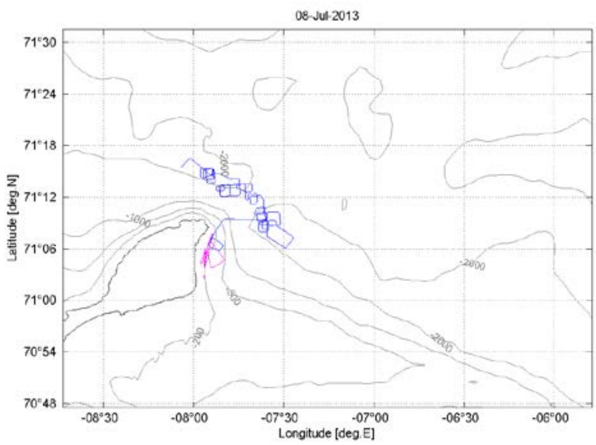
July 6th Strong winds. Working in small weather pocket along NE shore. Sightings of many minkes, a group of bottlenose whales and humpbacks. Thus, all 3S2 species in one spot at the same time! Almost continues tagging effort, but no success. →

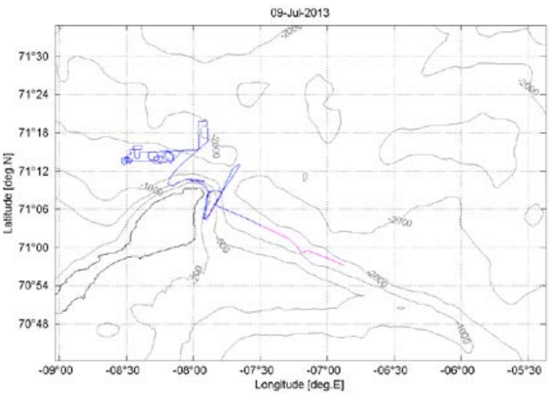




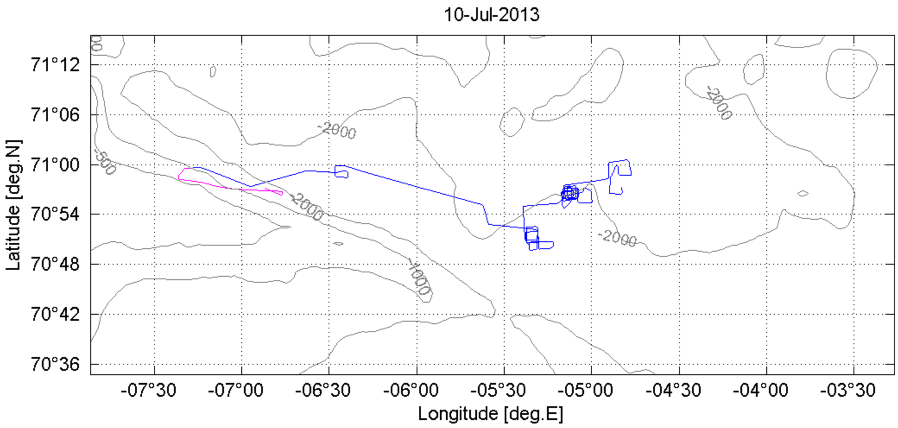
← **July 7th** Very low visibility because of fog. Searching for bottlenose whales and minkes north of north cape. Tagging attempts difficult because of visibility. Wind increases and forces us to seek shelter on the east side of Beerenberg. Working in a small area along the coast between Northeast Cape and North Cape.

July 8th Working north of North Cape in very difficult wind conditions. Sightings of several minke whales and smaller groups of bottlenose whales, but they are difficult to track under these conditions. →

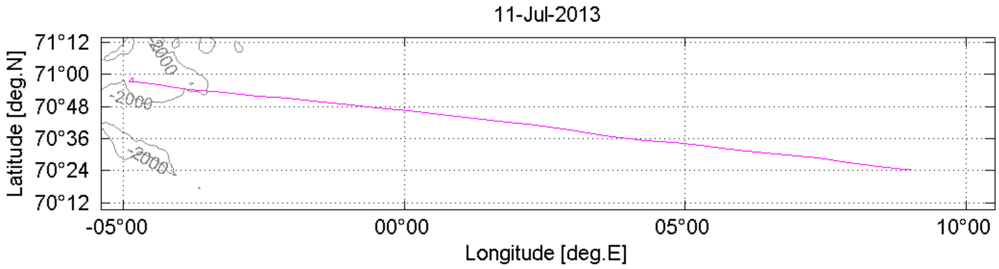




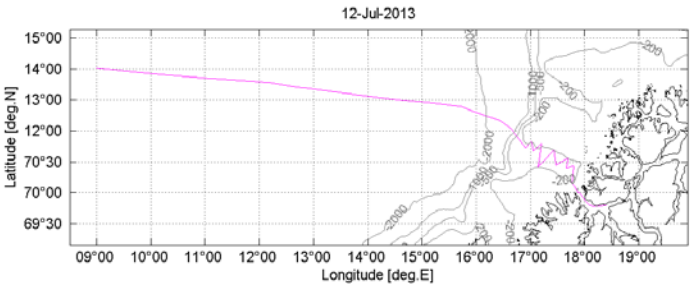
← **July 9th** Working in the deep water canyon north of Jan Mayen with bottlenose whales and minkes. Wind increases and we therefore seek shelter in a small weather pocket on the west side of the Island. The wind turns and the pocket collapses. We therefore sailed around to the east side and established a new pocket there.



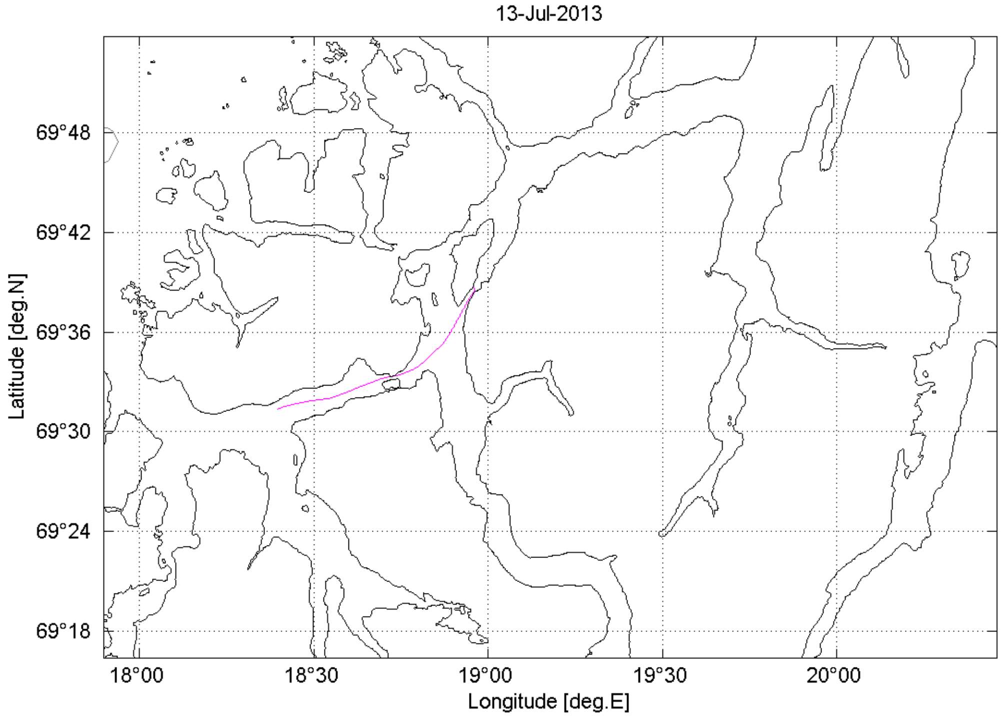
July 10th Sailed down to experimental site 15nmi east of Jan Mayen to collect CTD and XBT. Searched eastwards through the Jan Mayen Canyon. Not much wind, but the sea is still rough, but gradually improving. Maximize effort to tag bottlenose whales until cut off for transit.



July 11th Transit towards Tromsø.



← **July 12th** Transit towards. Arrive at the banks off Tromsø. Searching for minkes, humpbacks whales or pilot wales to use all available time.



July 13th Last minute desperate attempts to tag. Cut off at 02:00LT. Transit to Tromsø. Docked at 04:00. Joint de-brief, dinner and celebration.

July 14th De-mobilization, packing and cruise report.

July 15th Off-loading and disembarkment. END OF TRIAL

Appendix C 3S-13 Cruise plan

3S-2013
Cruise Plan

FINAL

René Dekeling

The 3S-13 research trial is conducted by the 3S-consortium as part of the $3S^2$-project

3S-2013
Cruise Plan

FINAL

René Dekeling

The 3S-13 research trial is conducted by the 3S-consortium as part of the 3S²-project

CONTENT

PROJECT OBJECTIVE

Investigate behavioral responses of cetaceans to naval sonar signals, including studies of the effectiveness of Ramp Up, sensitization or habituation, in order to establish mitigation measures for sonar operations.

CRUISE TASKS

Primary tasks:

- Tag minke whales and northern bottlenose whales with DTAG and record vocal-, movement- and surface behavior, and thereafter carry out sonar dose escalation experiments (SDE) where the tagged animals are exposed to LFAS sonar signals and control experiment without any active transmissions.
- Tag humpback whales with DTAGs and record vocal -, movement- and surface behavior, and thereafter carry out sonar Ramp UP experiments where the tagged animals are exposed to LFAS sonar signals and control experiment.

Secondary tasks:

- Carry out control experiments where tagged animals are exposed to a playback of killer whale sounds and a reference sound.
- Tag animals and record natural undisturbed behavior of target species.
- Collect group behavioral data to investigate the effect of tagging.
- Collect information about the environment in the study area. Ambient noise, CTD and XBT measurements, acoustic propagation modeling and prey field mapping using echosounders.
- Biopsy sampling of target species.
- Collection of bio-acoustic data using towed arrays.
- Evaluation of feasibility of doing baseline research on bottlenose whales on Jan Mayen

Priority:

Species priority at the start of the trial is:

1. Minke whales and bottlenose whales
2. Humpback whales

The highest priority for the 3S-13-sonar trial will be to replicate the minke whale experiment from 2011. This priority will be reconsidered as data collection progresses during the trial. However, effort to collect data on humpback whales, will be on a not to interfere with the higher priority species basis only.

The primary tasks have a higher priority than the secondary tasks. We will try to accomplish as much as possible also with the secondary tasks, and some of them are incorporated in our regular experimental protocol. However, secondary tasks will be given a lower priority if they interfere with our ability to accomplish the primary tasks.

3S-CONSORTIUM

The main partners of the 3S^2-project conducting the 3S-12 trial are:

- The Norwegian Defense Research Establishment (FFI), Norway
- The Netherlands Organization for Applied Scientific Research (TNO), The Netherlands
- Sea Mammal Research Unit (SMRU), Scotland
- Woods Hole Oceanographic Institution (WHOI), USA

In addition the following organizations are contributing to the project through their association with one or several of the 3S-partners:

- Institute of Marine Research (IMR), Norway
- LK-ARTS, Norway
- Kelp Marine Research (KelpMR), The Netherlands
- Balena Research Ltd, New Zealand
- Field Biologist Grøningsæter, Norway
- Open Ocean Consulting, UK

The 3S^2 research project is sponsored by;

- The Royal Norwegian Navy and the Norwegian Ministry of Defense
- The Royal Netherlands Navy and the Netherlands Ministry of Defense
- Office of Naval Research, USA
- DGA, French Ministry of Defense.

SAILING SCHEDULE

Date	
Fri June 14.	3S Scientific crew embarks RV HU Sverdrup II in Port Brevika, Tromsø.
Sat June 15.	08:00 Start of 3S-13-trial. Technical installation commences. Loading of fuel and food supplies for 30 days at sea, Joint dinner in Tromsø.
Sun June 16.	Continued installation and testing of equipment. Brief of ship's crew, tag boat safety training, ship's safety brief, joint meeting with all scientific crew members. Sail off at 20:00 – transit to Harstad.
Mon June 17.	Port call in Harstad if needed, drill of operation (off Harstad), transit to Vestfjord
Tues June 18.	Fully operational in Vestfjord. Regular operation in Vestfjord
TBD	Transit to Jan Mayen Regular operation around Jan Mayen
Sat. July 13.	Transit from field site to Tromsø, packing and de-brief ETA Tromsø 18:00
Sun. July 14.	Continued packing and cruise report
Mon July 15.	09:00-Off loading and 16:00-Dissembarkment

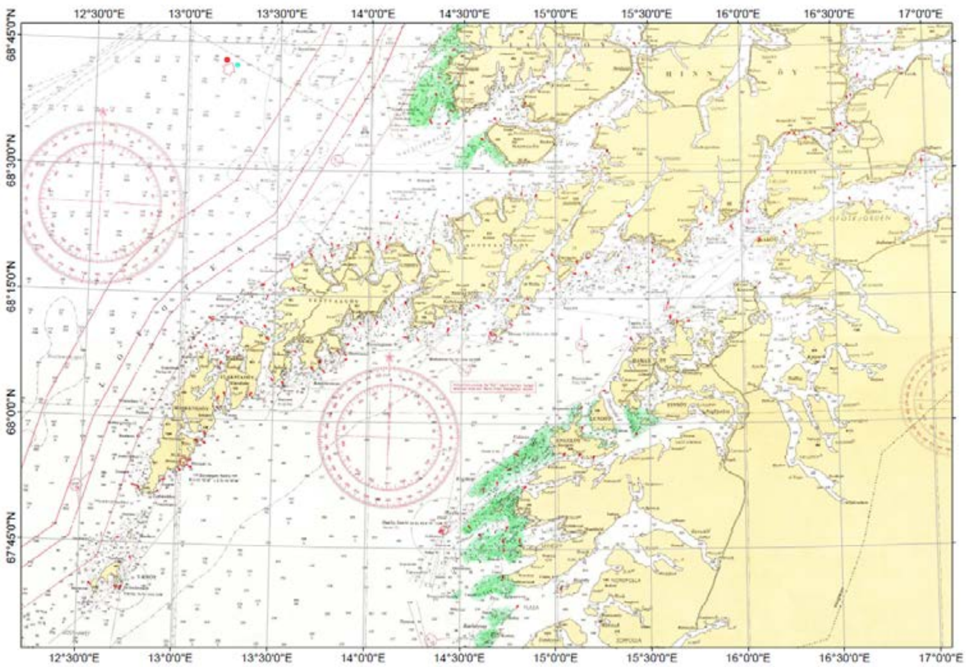
OPERATION AREA

During the previous 3S^2-trials we have been operating between Bear Island and Spitsbergen. During 3S-11 and 3S-12 we did not manage to conduct any experiments on bottlenose whales and also collected little data on minkes whales in that area. To optimize our chance of balancing the total 3S^2-dataset better, these two species are our primary targets this year, and we have therefore decided that the operation area for 3S-13 will be partly the Vestfjorden basin including the shelf outside of Vestfjorden and partly the area around Jan Mayen. This is based on the original assessment of alternative field sites for 3S[2] (Kleivane et al 2011). Within the Vestfjorden field site we don't expect to find bottlenose whales, but we do expect to find minke whales in relatively high numbers. Around Jan Mayen we expect to find all priority species, but primarily bottlenose whales and minke whales.

The operation area for 3S-13 is Vestfjorden and Jan Mayen. The distance from Vestfjorden to Jan Mayen is about 600nmi or a 48 hrs transit.

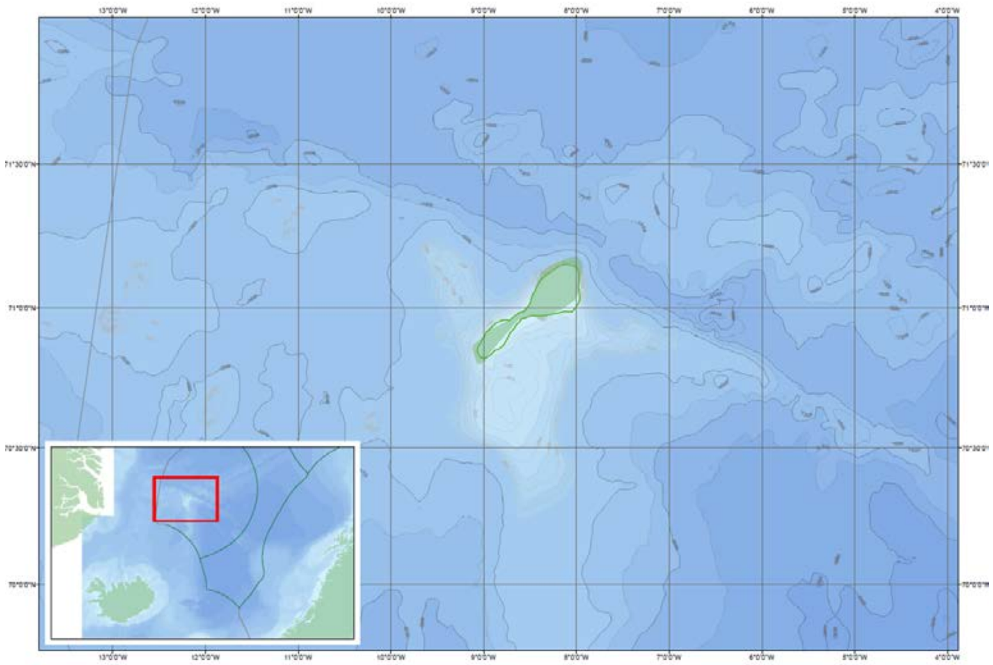
Vestfjorden

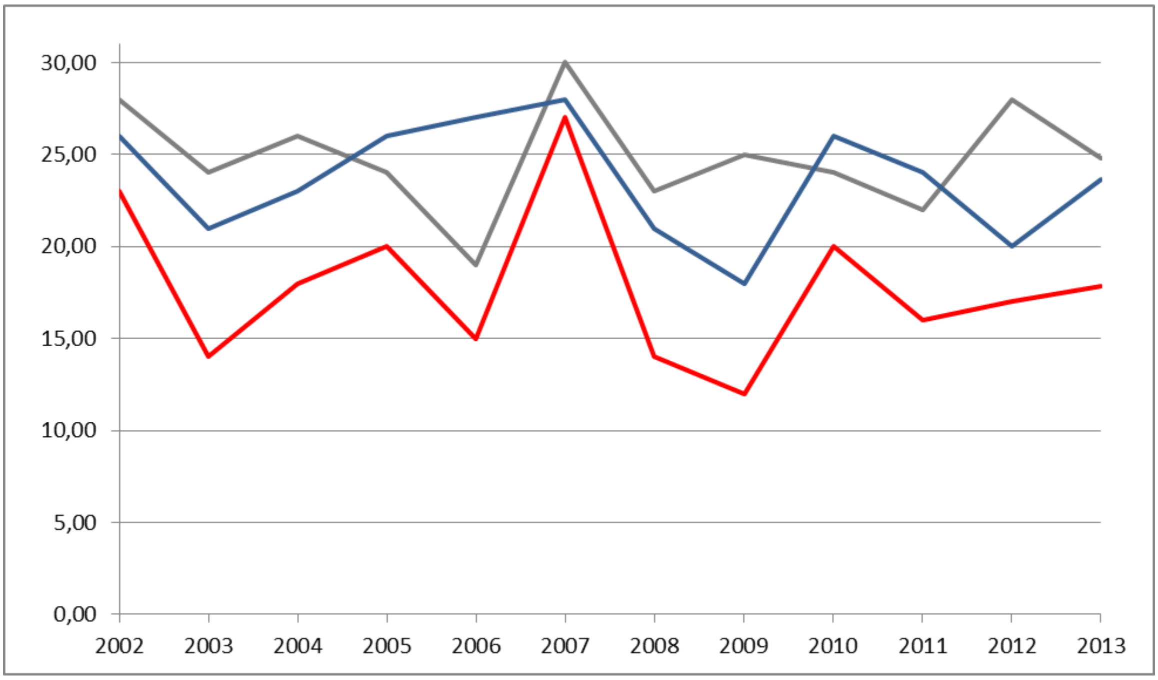
At the start of the trial we will operate in Vestfjorden. This is a very well-known field site to the 3S-team. Minke whales are essentially found within the entire basin, but particularly along the northern shore. The 3S team conducted a baseline trial in the same area in May, and based on the experience from this trial we will have a good idea of where to find whales and also what tagging success rate we might expect. At the end of the trial we might also decide to spend a few days operating in this area, because it gives us more flexibility near the end if we are closer to Tromsø.



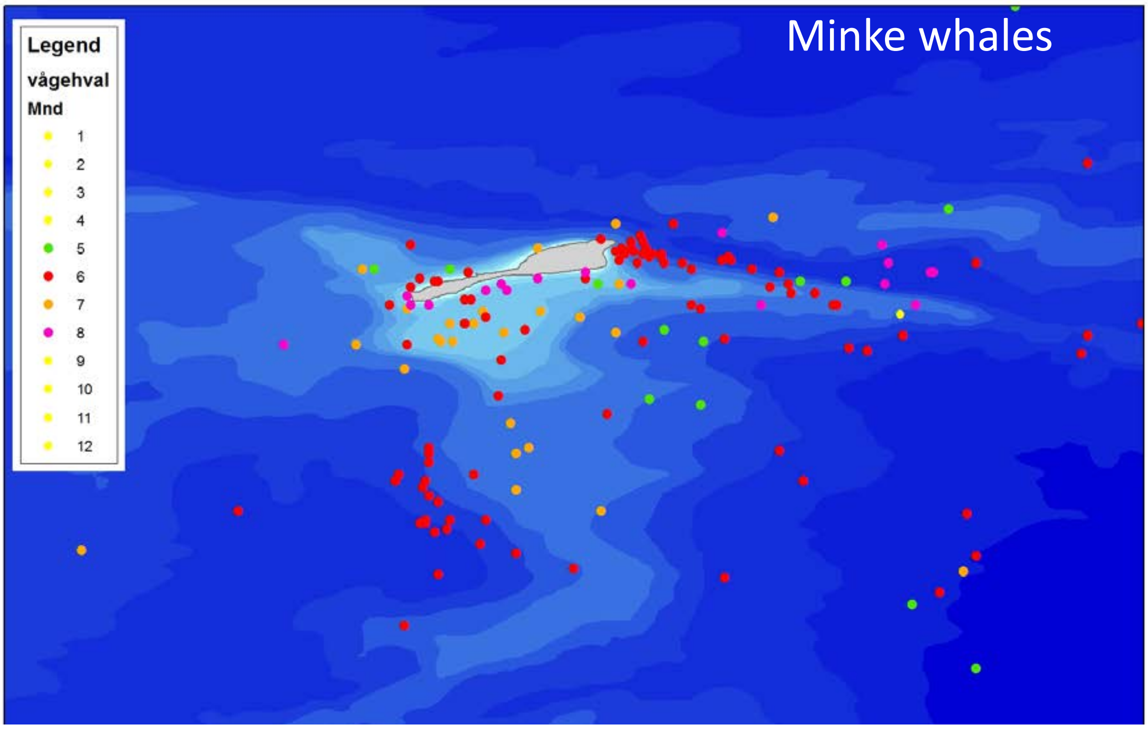
Jan Mayen

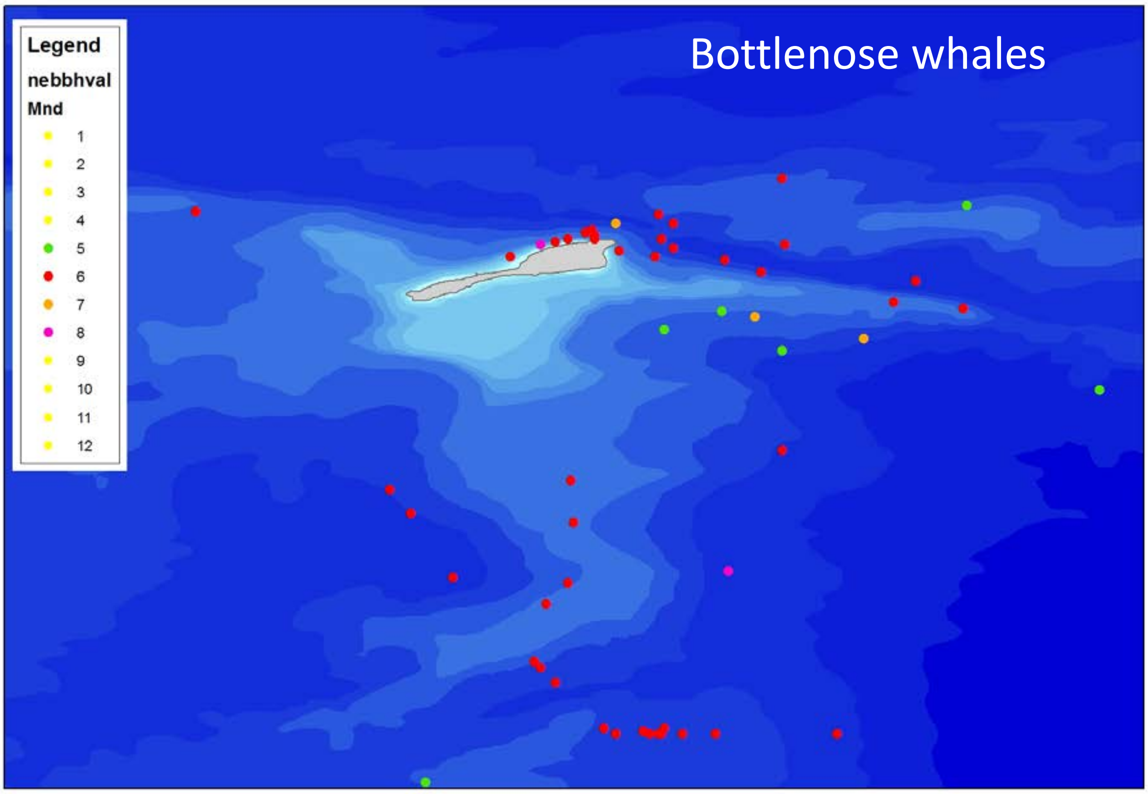
Jan Mayen is a volcanic island of Norwegian dominion, located in the North Atlantic Ocean, 950km west of Norway, 600 km north of Iceland. Current number if inhabitants are 18 people, running a Loran-C navigation station. The island itself offers some protection against bad weather, but there is no port on the island, and very strict regulations for going on shore, except to visit the station. As field site for cetacean research this area is not very well known. Preparing for the trial we have collected information about weather conditions from the Norwegian Metrological Institute and about target species sightings from the Institute of Marine Research (IMR).





Our operation requires both good visibility and calm sea. We expect that fog could be an issue in this area, particularly close to the island. Curves show number of days within a month (July) with acceptable sea condition (wind <6m/s, blue line), acceptable visibility (grey line) and acceptable both visibility and sea condition at the same time (red line) at Jan Mayen the past 10 years. The extrapolated values for 2013 are average values.





Sightings of the two primary target species around Jan Mayen the past 10 years as recorded in the IMR database. The color codes are months of the year. Minke whales are typically sighted on the slopes of or on the relatively shallow shelf of Jan Mayen, whereas bottlenose whales are typically sighted in the deep water areas off the shelf or in the steep trench close to the island on the northern side.

Criteria for the decision to leave Vestfjorden and go to Jan Mayen are;

a) The expected weather situation in Vestfjorden.

b) The expected weather situation on Jan Mayen

c) Whale availability in Vestfjorden.

d) Current success rate or expected success rate in Vestfjord based on the experience from 3S-13 baseline II.

Criteria for the decision to leave Jan Mayen and go back to Vestfjorden are;

a) The expected weather situation on Jan Mayen

b) The expected weather situation in Vestfjorden

c) Whale availability on Jan Mayen

d) Success rate on Jan Mayen

e) Days left of the trial, maintain flexibility near the end of the trial.

MAIN LOGISTICAL COMPONENTS

R/V H.U. Sverdrup II (HUS)
Length: 180 feet
Max speed 13 knots
Crew: 7
Scientific crew: 17

Captain*; Bernt. *Second officer*; Johan. Chief engineer; Magne. *Matros;* Thor. *Matros; Leidulf. ***Steward*;** Morten. ***Catering assistant*;** Ann.

Sverdrup will be outfitted with the Socrates source and operating software, Delphinus towed array system, Digital Direction Finder VHF tracking system, two tag boats with cradle for loading/off-loading. Fuel for the tag-boats. In addition Sverdrup will also carry CTD probes.

Visual and acoustic search for marine mammals, VHF- and visual tracking of tagged animals, recording of behavioral observations of tagged animals, operation of sonar source and preparation of the tags will be done from the Sverdrup. Sverdrup will also lodge the entire research team and be the command center for the operation.

Tagging boats

Two tag boats can be deployed from HUS. Tag boat 1 is a four stroke outboard engine fibre glass work boat, and tag boat 2 is a water jet propulsion Man Over Board boat. Tag boat 1 is deployed using the ships derrick crane, and tag boat 2 is deployed using a dedicated davit. Tag boat 1 can be deployed and operate at sea conditions up to sea state 2, while tag boat two is a heavier more robust system which can be deployed and operated up to sea state 3. The tag boats will be launched when whales are sighted and weather permits tagging attempts. In the tagging phase they will carry tagging gear (ARTS, pole, tags with necessary accessories), documentation sheets, GPS and camera. Both tag boats are installed with navigation system, VHF and AIS. The tag team will usually consist of three people; a driver, a tagger and someone in charge of photo id/documentation.

Tag boat 1 (top) and Tag boat 2 (bottom). Tag boat 1 will be equipped with a swivel in the bow for the cantilever pole. Tag boat 2 has a 2 person elevated MMO-station behind the driver for the tracking phase, and an elevated shooting platform in the bow for the tagging phase.

Tag boat 1 will primarily be used for hand pole and long pole tagging. It will therefore be equipped with a cantilever swivel in the bow. Tag boat 2 will primarily be used for ARTS-tagging, and is therefore equipped with an elevated platform in the bow.

Tag boat 2 will also be used in the tracking phase. It will therefore be outfitted with an observation platform in the aft with space for two observers. It will also be equipped with VHF-tracking antennas and DDF receiver in addition to compass, binoculars, range finders and a data recording system which consist of a fully ruggedized laptop running the Logger software. During tracking the crew will consist of 4-5 people, a driver, a data recorder and 2-3 marine mammal observers.

Sonar source – SOCRATES

The multi purpose towed acoustic source, called SOCRATES II (Sonar CalibRAtion and TESting), will be used and operated from the Sverdrup. This source is a sophisticated versatile source that is developed by TNO for performing underwater acoustic research. Socrates has two free flooded ring transducers, one ring for the frequency band between 0.95 kHz and 2.35 kHz (source level 214 dB re 1 µPa @ 1m), and the other between 3.5 kHz and 8.5 kHz (source level 199 dB re 1 µPa @ 1m). It also contains one hydrophone, depth, pitch, roll, and temperature sensor. All these sensors can be recorded. Because of risk of cavitation and damage to the source, it must stay below cavitation depth during operation. A minimum of 200 m water depth is required. Appendix A describes further details of SOCRATES and gives detailed operational instruction.

The sonar source SOCRATES was raised out of the water as part of the opening ceremony for the Girlsday event, promoting technical careers for schoolgirls. This ceremony at the TNO test basin took place on 25 April 2013 by her NL Majesty Máxima (from 30 April Queen of the Netherlands) in the presence of the Minister of Science and education, Dr.Jet Bussemaker and a large group of schoolgirls (left). The same SOCRATES safely recovered on the Sverdrup during 3S-12 (right).

Acoustic array – Delphinus

During the trial, the TNO developed Delphinus array will be used. It will be deployed from the Sverdrup to primarily acoustically search for marine mammals and track bottlenose whales during experiments. The Delphinus is a single line array, 74 metres, long containing 18 LF hydrophones used for the detection and classification of marine mammal vocalization up to 20 kHz. Three UHF hydrophones with total baseline of 20m are used for the detection, classification and localization of marine mammal vocalizations up to 160 kHz. Additionally there is a single triplet (consisting of 3 UHF hydrophones), which will be used to solve the left-right ambiguity for the localization. The array is also equipped with depth and roll sensors.

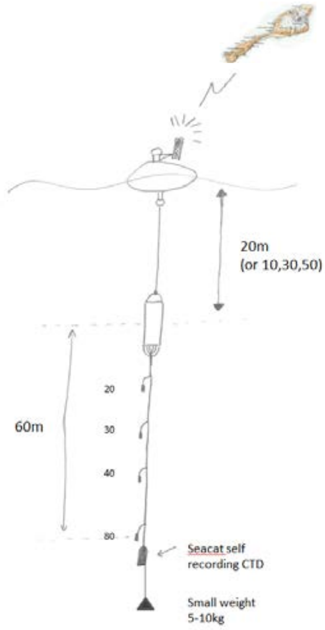
In the early phase of the trial, we want to do tests and practice the challenging maneuvering during experiments with bottlenose whales (Appendix A).

Delphinus needs to be deployed before Socrates and Socrates will be recovered out of the water before Delphinus. When a CTD sensor or the hydrophone buoy is being recovered the Socrates and Delphinus need to be out of the water. More information about sailing and deployment restrictions can be found in Appendix A.

Acoustic array - SMRU-array

The SMRU-array will be used from the observation boat (tag boat 2/ MOBHUS). It's primary function will be to record sonar transmissions near the tagged whale. The SMRU-array weighs 16kg and can be hand-deployed and recovered during ongoing operations off MOBHUS. The array plugs into a rugged, self-standing pelican case which contains a power-supply, breakout box and a Tascam stereo recorder at 96 kHz with a real-time monitoring capability. The array consists of stereo HS/150 hydrophones each with a Magrec HP02 pre-amplifier. The sensitivity of the SMRU array has been calibrated in a tank facility at TNO prior to the research trial.

Hydrophone buoy

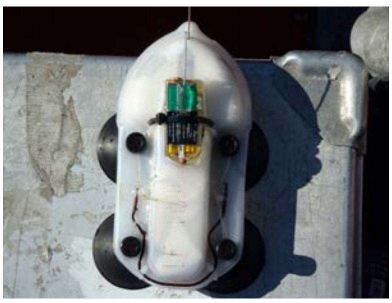


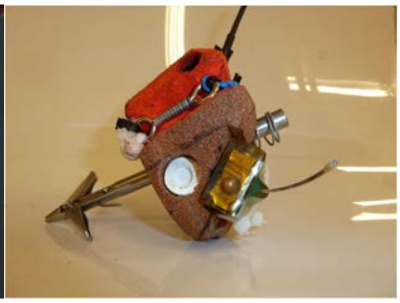
In order to make background noise measurements and to record the sonar levels in the water column when using the CTAG without built in acoustic sensor we will deploy a floating buoy with satellite communication and with hydrophones extended to 20-30-40-80m. This will cover most of the diving depth range of minkes whales, and also the depth of any expected sound channels. The buoy will be placed in the transmission path of the sonar exposures on minke whales. During experiments with bottlenose whales and humpback whales the buoy will be deployed in the end of the experiment to record background noise. This buoy will have to be deployed from a tag boat.

Whale tag – DTAG2

The version 2 DTAG is the main tool used to record the behavior of the whales. The DTAG, is a miniature sound and orientation recording tag developed at WHOI. The tag is attached to the whale using a hand held or cantilever operated carbon fibre pole, or a pneumatic remote deployment system (ARTS). For deployments on humpback whales and bottlenose whales the tag is attached to the animal with four suction cups. At a pre-set time of 16 hrs the vacuum is released from the suction cups and the tag floats to the surface. Our experience from 3S-11 and 3S-12 was that suction cups do not stick to skin of minke whales. Therefore, for DTAG deployments on these species the suction cups are replaced by four small 50mm long invasive arrows with barbs. Different anchors have been tested on dead and live animals (Kleivane & Kvadsheim 2013) to arrive at an anchor which is minimum invasive, but still remains attached for the desired duration. After 18-20 hrs a galvanic time release detaches the tag from the attachment and the tag floats to the surface. The galvanic releases are less accurate than the electronic releases used with suction cups. The invasive DTAG can be used with all deployments systems.

The tag contains a VHF transmitter used to track the tagged whale during deployment and to retrieve the tag after release. All sensor data are stored on board the tag and the tag therefore has to be retrieved in order to obtain the data. DTAGs record sound at the whale as well as depth, 3-dimensional acceleration, and 3-dimensional magnetometer information. DTAG audio will be sampled at 96 kHz and other sensors at 50 Hz, allowing a fine reconstruction of whale behaviour before, during, and after sonar transmissions.





DTAG2 with suction cups (left), DTAG2 with small 50mm invasive barbs (midle), and CTAG (right). All tags will have a Sirtrack GPS logger piggybacked to them.

Whale tag DTAG3

A newer generation DTAG (DTAG3) will be used as back up tags for the DTAG2 tags in case we experience technical problems or loss of tags. DTAG3 mostly have the same functionality as DTAG2, but is smaller and therefore can not carry a GPS-logger.

Whale tag - CTAG

Previous attempts to tag minke whales with suction cups tags has shown that this might be very difficult. It's difficult to get whales within DTAG tagging range, and suction cups do not seem to attach to their skin. We will try to use small invasive attachments of the DTAG, but this has not been fully tested on minkes. This will be done in May-June during the 3S-13 Baseline II trial (Sivle et al 2013). We have therefore developed a small and light invasive tag, to be used as back up if "DTAGing" turns out to be too difficult. The CTAG is developed to be deployed using the ARTS system at distances up to 15m. Compared to the DTAG the CTAG contains a simpler set of sensors; a VHF-transmitter, and a Star Oddi Centi time depth recorder. In addition the CTAG will also contain a GPS-logger. It is attached to the whale by a small barb (55 mm long) which penetrates the skin and anchors in the blubber. The tag is released from the animal using a galvanic time release. The tag does not contain acoustic sensors. The CTAG will be used more opportunistically this year than previous year to increase our chance of getting tags on minke whales. We will also try to use CTAG and DTAG in parallel during minke whale tagging.

GTR-table	Jan Mayen	Vestfjord	Release time
CTAG	A1	A2	18-20 hr
DTAG	A1	A2	16-22 hr
Sea temp	3-5°C	5-10°C	

Table of galvanic time releases (GTR's) planned to be used and expected release time for CTAG and DTAG in Vestfjorden and Jan Mayen.

Whale tag - GPS tags

During 3S-11 and 3S-12 we successfully tested SirTrak Fastloc GPS loggers by attaching them to the back of the DTAG. This tag is a valuable back up, which keeps collecting data of surfacing positions of the tagged animal, even if the tracking boat looses track of it for a while. This year all tag deployments (suction cup and invasive DTAGs and CTAGs) to all species will therefore include a GPS tag piggybacked to the main tag. Accurate positioning of the tag high on the back of the animal is crucial for the GPS tag to work properly.

Biopsy sampling

In the end of the experiment, after sonar exposure but before the tag detaches, a biopsy sample will be taken from the experimental animal. A standard Finn Larsen biopsy tip will be used for this. It is a hollow and sharp needle, which samples a small piece of skin and blubber tissue from the back of the animal. The biopsy tip is 8mm in diameter and penetrates 60mm into the blubber. The tissue is used to sex and i.d. the animals, to assure that they have not been exposed before. Tissue samples will be made available for other projects to look at e.g. biochemical composition, presence of environmental pollutions or for genetic analysis. Since the biopsy sample is taken before the tag detaches, we will use the stored data to also look at possible behavioral changes related to the biopsy sampling.

Tag deployment systems

The tags will be deployed using three different techniques, the ARTS-system, the hand held pole and the long cantilever pole.

The ARTS pneumatic tag launcher launches the tags through the air on to the animals. It was developed to be used with the DTAG during the 3S-project to enable longer tagging ranges, rapid changes of directions and to ease approach of animals which avoid the pole. During this trial it will be used to deploy DTAGs to all target species. In addition the ARTS system will be used to deploy the CTAG and for biopsy sampling.

The hand held pole techniques for deployments of DTAGs have been used in many previous field trials, and are therefore an established and robust technique. The pole is a 7m long carbon fibre windsurfer board mast, with the tag placed on a straight robot arm in one end. The limitation of this system is however, that you have to be very close to the animal (within 5-6 m) to tag it, and tagging efficiency is a limiting factor during controlled exposure experiments. The hand held pole will be used for deployments of DTAGs on bottlenose whales and minke whales.

Tag deployment systems: The ARTS system (left) and the hand held pole (right) used to deploy DTAGs. When deploying the tag with the ARTS the tagger shoots from the elevated platform in the bow of tag boat 2. The pole techniques will primarily be used from tag boat 1.

The cantilever long pole technique is also well established technique used in many previous trials. The pole is 15 m long and placed on a swivel in the bow. Because of the length, the pole is counterbalanced and placed in a bracket. This technique will be used to tag humpback whales.

Visual tracking and data collection

To visually search for animals in the search phase, and to observe the behavior of the animals during tagging and tracking, a marine mammal observer platform will be installed on the roof of the bridge of Sverdrup. This platform will be equipped with two baby big eyes, a wind shield, binoculars, protractor, intercom to the bridge, a ruggedized computer running Logger and a VHF digital direction finder system.

On tag boat 2 there will be a small elevated station for two observers, and space for a data recorder beneath them. This platform will be equipped with binoculars, laser range finders, compass, protractor, VHF direction finder, and a fully ruggedized computer running Logger. The Logger software is used on both Sverdup and on tag boat 2 to record the position of the animals and social behavior based on the input of the marine mammal observers.

Detailed instruction for the marine mammal observers are found in the 3S-Observer Handbook distributed to all Marine Mammal Observers (MMOs) before the trial (Alves *et al*. 2011).

Naked eye, baby Big Eyes and binoculars will be used by MMOs on the marine mammal observer platform on Sverdrup.

The MOBHUS/tag boat 2 tracking boat equipped with an elevated observation platform (right) and antennas for radio tracking of the tag.

Responsibilities:

FFI

Personnel: Cruise leadership, marine mammal observers, local knowledge, oceanographic measurements, tag-boat driver, ARTS tagging.

Equipment: Research vessels with crew, 2 tag boats, CTD's, 2 VHF-tracking systems, CTAGs, ARTS-DTAG (barbs, carriers and robots), VHF-communication equipment, Ruggedized computer.

SMRU

Personnel: PI, pole tagger, marine mammal observers, photo id/documentation, acoustic recordings.

Equipment: GPS tags, SMRU-array, VHF receiver and direction finder, VHF cables, hand-held GPS, killer whale playback equipment, Logger software for two platforms, tracking equipment (laser range finders, compass, protractor etc), hand held tagging poles, cantilever tagging poles, digital camera.

WHOI

Personnel:

Equipment: 2 LF DTAGv2 + 2 HF DTAGv2, 2 DTAGv3, DTAG accessories, VHF receiver and cable, DTAG3-antennas, 2 baby big eyes, cantilever arm and robots.

TNO

Personnel: Software and hardware operators and technicians for Socrates and Delphinus, marine mammal observer.

Equipment: Socrates source, Delphinus array including processing, real-time displays and recording, XBTs, GPS recorder, AIS-recorder, ambient noise recorder, 2 ruggedized computers, wireless network and data server, additional calibrated reference hydrophone with Pelican case recording system.

KelpMR

Personnel: Marine mammal observer

Equipment: Ruggedized computer

IMR

Personnel: Marine mammal observer

Equipment:

LK-ARTS

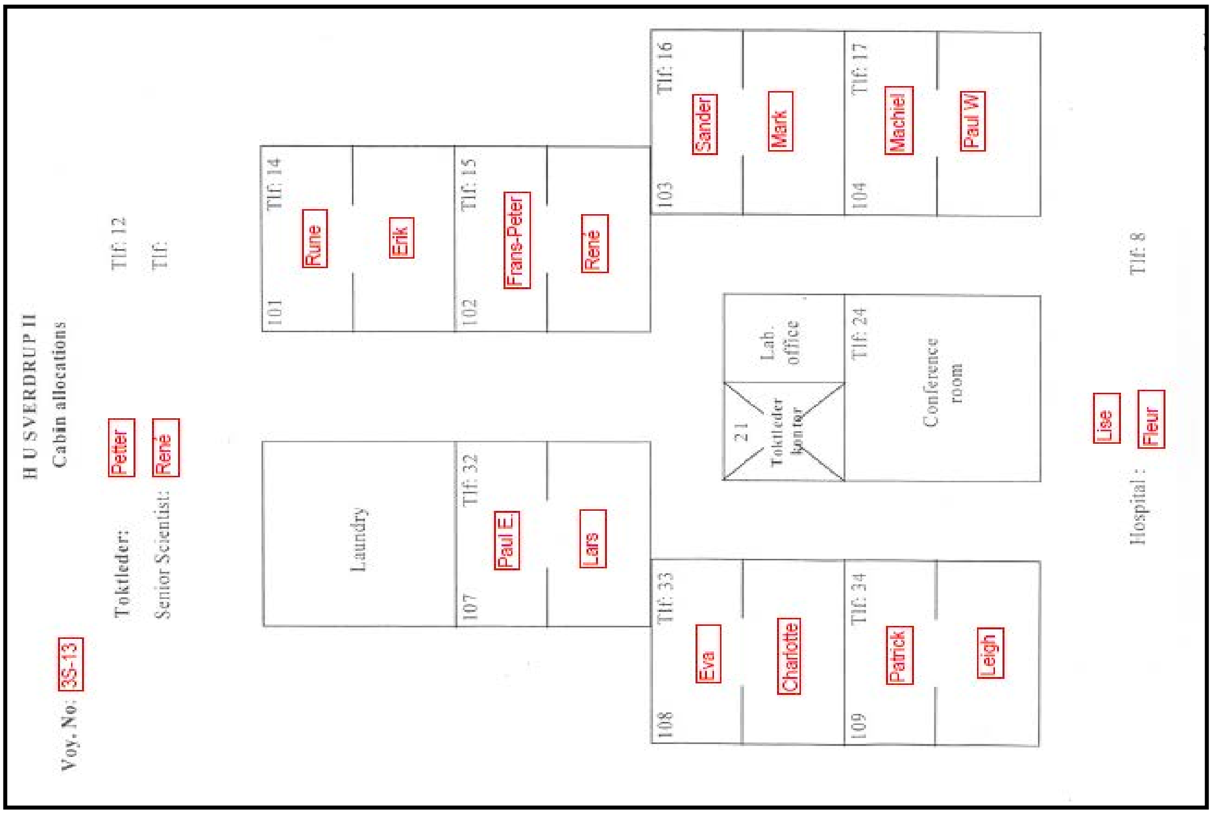
Personnel: Tagger and marine mammal observer

Equipment: 2 ARTS units, digital camera, Handheld GPS, tagging and biopsy equipment, dogfinder.

CREW PLAN

The ship will be bunkered with fuel and food supplies for 30 days at sea. There will be no scheduled port calls and therefore no crew changes during the trial. The total number of scientific crew is 17 people:

Name	**Main role**	**Secondary roles**	**Affiliation**	**Nationality**
Petter Kvadsheim	Executive chief scientist (CO)	MMO	FFI	NOR
René Dekeling	Executive scientist (XO)	Sonar/MMO	RNLN	NL
Patrick Miller	PI/Tagger	MMO/ acoustics TB2	SMRU	US
Frans-Peter Lam	Chief scientist sonar	MMO	TNO	NL
Mark van Spellen	Sonar operator	Hardware engineer	TNO	NL
Sander van IJsselmuide	Sonar operator	Software engineer	TNO	NL
Lars Kleivane	Tagger/Biopsy	Tag boat driver/MMO	FFI	NOR
Leigh Hickmott	Tag boat driver TB1	MMO	SMRU	UK
Rune Roland Hansen	Tag boat driver TB2	MMO/ARTS-tagger	FFI	NOR
Eva Hartvig	Tag technician DTAG/CTAG	MMO HUS	SMRU	DAN
Lise Doksæter	Lead MMO HUS	Data management	IMR	NOR
Fleur Visser	Lead MMO HUS	Data management	KelpMR	NL
Erik Grønningsæter	MMO	Photo id.	FFI	NOR
Machiel Oudejans	MMO	Data management	SMRU	NL
Paul Ensor	MMO	Photo id./management	FFI	NZ
Paul Wensveen	MMO/Sonar	Data management	SMRU	NL
Charlotte Curé	MMO/killer whale playback	Data management	SMRU	FR



Cabin plan

DAILY WORK PLAN

The 3S-trial is a complicated operation which requires different teams to work together in a highly coordinated manner. The different teams include, visual teams, acoustic teams, tagging teams, cruise management and the ship's crew. In addition, the crew is divided between different platforms (Sverdrup, Tag boat 1 and Tag boat 2), depending on which phase of the operation we are in. The operation goes through different phases which require very different staffing from the different teams. The main phases are; search phase, tagging phase, pre-exposure phase, exposure phase and post exposure phase. Finally, the operation is conducted in an area and at a time where the sun does not set, which enable us to operate 24 around the clock. This is a challenge but also a great opportunity we have to make the most of the time available.

The complexity of all this requires a structured watch plan, which considers a minimum staffing requirement from the different teams, but we also have to be flexible when the operation moves into the more labor demanding experimental phases. It also requires a well defined chain of command and communication plan.

Main phases of the operation

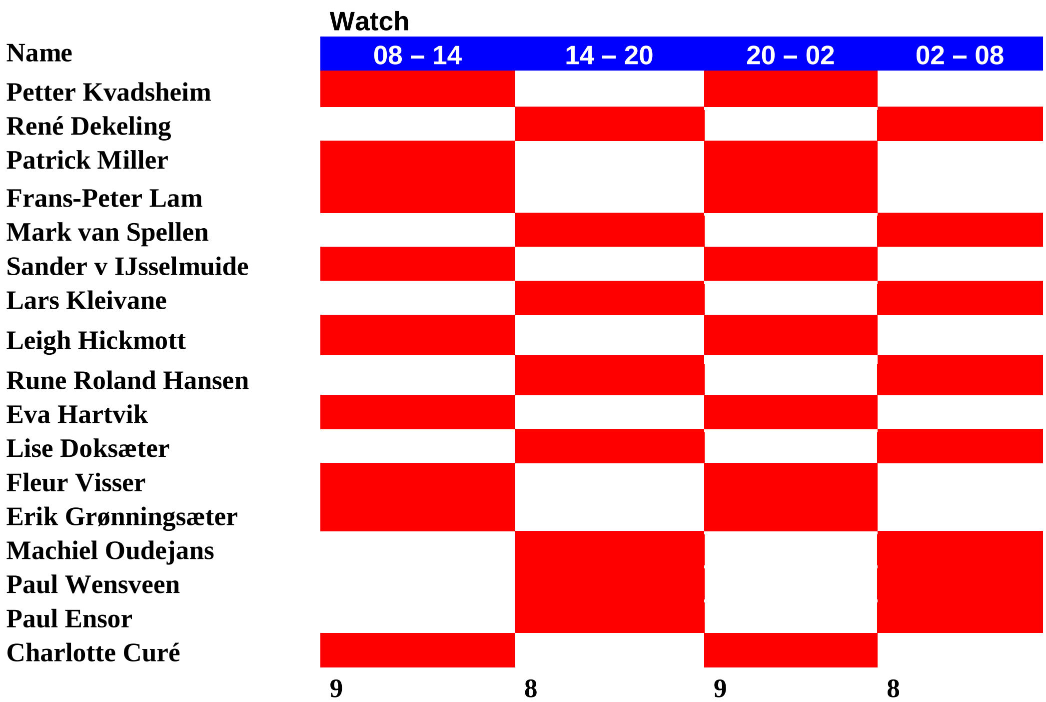
Planning meetings

Every morning before breakfast (0700), the chief scientists from the main 3S partners and the XO (Kvadsheim, Lam, Miller, Dekeling) will convene to plan the activities for that day. Search areas and patterns, species priority, logistical constraints, crew dispositions etc will be discussed and implemented in the daily plan. The plan for the day will be announced on a poster board on board before 09:00. Every evening at 2030, the chief scientist will meet again to make adjustments to the daily plan, and plan activities for the coming night. If you have an idea or would like to bring something to the attention of the cruise management team, you might address one of the chief scientists at any time. Occasionally, the cruise leader may call for a plenum meeting with the entire scientific crew.

Watch plan in search and tagging phases

The entire crew will follow a basic regular seamen's watch plan of 6 hrs on and 6 hrs off, with change of watch at 8 and 2 am and pm, coordinated with the meals on-board. This will cover the basic staffing requirement during the search and tagging phases. Secondary MMO's might be instructed to also support the visual search during part of their watch, depending on their other tasks. At the start of the watch the CO/XO and lead MMO will organize the watch and make a watch plan for the MMO's which also includes the secondary MMO's.

As part of our positive and pro-active 3S-culture, and to avoid any gaps in the effort the full team is expected to arrive on its post 10 min prior to the start of your watch. This allows for organized information exchange between teams, the new team will be ready and the retiring team is dismissed in time.



Basic watch plan used in the survey phase. The entire crew will follow a regular 6 hrs on and 6 hrs off seamen's watch plan. This watch plan implies that there are 3 dedicated MMOs and 4 secondary MMOs on watch at any time. Secondary MMOs should support the primary MMOs as much as possible!

Watch plan in experimental phases

The default timing of the experimental phases is illustrated in the figure below. As soon as an animal has been tagged and until the tag is recovered (pre-exposure, exposure and post-exposure phases), extra manpower is needed, and therefore a separate watch plan will be implemented. In the 15-20 hrs from tag on to tag off, the tagged animal will mostly be tracked from MOBHUS, except if we are working with bottlenose whales, were we will do the tracking from HUS and mostly follow the regular 6 hrs watch rotation from tag on until tag off. When working with the baleen whales a watch plan of two MMO-teams of 4-5 people, which takes turns and rotate every third to fourth hour between MOBHUS and resting “duty” will be established. In addition a separate watch plans for the remaining MMOs, who will stay on the Sverdrup as well as for the acoustic team will also be established.

Watch	MOBHUS	HUS	SOCRATES
A	MOBHUS 1	HUS 1	SOC 1
B	MOBHUS 2	HUS 2	SOC 2
C	MOBHUS 1	HUS 1	SOC 1
D	MOBHUS 2	HUS 2	SOC 2
E	MOBHUS 1		

Watch plan used in the experimental phases from tag on (T0) until tag recover (T0+15-20 hrs). As soon as a tag is successfully deployed on an animal, it will be determined who is on which teams for the coming experiment. The duration of each watch depends on which species is tagged.

Operational status

In extended periods of good weather, and if we are successful in finding animals and tagging them, there is a risk that the work load on the team will be too high, and that eventually we will all suffer from collective exhaustion. In these periods, the basic watch plan has to be considered to be normative. It is better to have some level of search effort all the time than periods with no effort at all. On the other hand, increased risk to personnel in some phases of the operation, and increased risk of reduction in the quality of the data collected in other phases are factors which also have to be considered carefully in these periods of intense work load. Thus, the cruise leader may decide to reduce effort during search and tagging phase to rest the crew. Because of this risk of crew exhaustion, the cruise leader may also reduce effort in periods of bad weather. To make sure everyone is aware of the operational status a traffic light system will be implemented. The operational status will be clearly indicated in the main operation room and the bridge of the ship.

Operational status green – we are fully operational with continuous full visual, acoustic and tagging effort. Operational status yellow – we are partly operational with reduced effort on visual, acoustic and tagging effort. Operational status red – we are not operational, everyone can rest!

DATA COLLECTION

The data collection protocol used will vary from species to species. The protocol and procedures used during ramp-up experiments on humpback whales and during the dose escalation experiments with minke whales are well established during previous trials and will be kept the same as during the 3S-2012 trial (Kvadsheim et al 2012). With bottlenose whales, we have very little experience, and although we have a firm plan of how to conduct the experiments, we might realize that this plan must or should be changed as we gain more experience.

Minke whales

Time		**Tag on = T0**			**T2**	**T5 T7**		**T8**				**T12**			**T16**	**T20**	Tag off! Tag recovery CTD Data checking Resting Search
Phase	Search-Sighting	NO pre-tagging	Tagging ?	NO 2nd tagging	Post tagging	Pre exp.	Silent	1 hr	**Sonar 1**	2hr	**Sonar 2**	2hr	K W 1	2hr	K W 2	Post exp. Biopsy	
Tracking from	HUS					MOBHUS											
Watch/ Team	Regular 6 hrs on/off watches					A (3 hrs) Team1	B (3 hrs) Team2		C (4 hrs) Team1				D (4 hrs) Team2			E (4 hrs) Team1	

Bottlenose whales

Deep dive	**Continuous acoustic monitoring from T0**						**1st /2nd**		**3rd**	**4th**		**5th**		**6th**			Tag off! Tag recovery CTD Data checking Resting Search
							Deep dive cycle at start of clicking										
Time			**Tag on = T0**	**T1**	**T2**	**T5 T8**		**T9**				**T13**				**T16 T17**	
Phase	Search-Sighting	Pre tagging 1 hr	Tagging ?	2nd tagging	Post tagging	Pre exp.	Silent	1 hr	**Sonar 1**	1hr	**Sonar 2**	1hr	K W 1	1hr	K W 2	Post exp. Biopsy	
Tracking form	HUS																
Watch/ Team	Regular 6 hrs on/off watches																

Humpback whales

Time			**Tag on = T0**	**T1**	**T2**	**T5**		**T6**	**T7**		**T9**	**T10**	**T11**			**T13 T17**	Tag off! Tag recovery CTD Data checking Resting Search
Phase	Search-Sighting	Pre tagging 1 hr	Tagging ?	2nd tagging	Post tagging	Pre exp.	Silent	1 hr	**Sonar 1**	1 hr	**Sonar 2**	1 hr	K W 1	30 min	K W 2	Post exp. Biopsy	
Tracking from	HUS					MOBHUS											
Watch/ Team	Regular 6 hrs on/off watches					A (4hrs) Team1			B (4 hrs) Team2			C (3 hrs) Team1				D (4 hrs) Team2	

Protocol table: Default timing of the different phases of the experiment for the different target species. The grey row on top is a time scale (in hrs). T0 is time of first tag on. For bottlenose whales there is also an additional time axis defined by the sequence of deep dive cycles. This time axis is the default scheme to be used with bottlenose whales. However, if the focal group has not done any deep dives at T8, we start the sonar exposure anyway. Blue row indicate the different phases of the experiment. Sonar is either dose escalation LFAS-exposures of bottlenose whales and minke whales or LFAS Ramp up exposures of humpbacks. The yellow row indicates from which platform the tracking of the focal animal is conducted. The green row indicates which MOBHUS, HUS and Socrates teams is on watch.

Search phase

When operating in Vestfjord we will use a network of local contacts to request information about possible marine mammal sightings. At Jan Mayen, we have to be prepared to operate alone, but we will be able to access online AIS information covering the entire operation area through an AIS-satellite service and thereby see any other ships which can be contacted. Weather forecast and knowledge of sightings (historical or current) will determine where we search for whales, visually and acoustically. We have established communication with the station on Jan Mayen to get information about conditions and weather forecast. Since we have 24 hours of daylight, visual and acoustic search for whales will continue around the clock.

The Sverdrup will search for whales in the specified locations using towed array acoustics and visual observations. During search for the baleen whales we will not use the Delphinus system to allow for more manoeuvrability of the Sverdrup. When a target species marine mammal is detected, a decision will be made whether or not to attempt tagging. If yes, the tag boat(s) will be launched with taggers and photo-id capability.

Minke whales and northern bottlenose whales are the primary target species. However, we may opportunistically also try to tag humpback whales. Particularly if weather is borderline, since this specie may be easier to tag in “bad” weather. Humpback whales will only be engaged when the consideration is that this does not interfere with our ability to work with the primary species. Part of this consideration will therefore also be to assess not only current weather conditions but also expected conditions during the entire time period from a possible tag deployment until the crew is rested and ready to re-engage with new animals after tag off. We might therefore decide to do shorter deployments, particularly on humpbacks, to opportunistically use shorter periods of borderline conditions. Such tag deployments could involve just low effort baseline data collection. A rule whether or not to attempt to tag and do an experiment for each species will be made the day prior and stated on the daily order.

Pre-tagging, tagging and post-tagging phase

Pre tagging observation should be initiated from the MMO platform on Sverdrup as soon as the sighted animals are approached using the established protocol described in the *3S MMO Observer Handbook* which is distributed to all MMOs on the team (Alves *et al*. 2011). When tracking animals from Sverdrup, a tracking distance of about 1000 m from the animals should be maintained. Before the tag boats are allowed to approach the animals and start tagging attempts the visual observers on Sverdrup will collect group behavior data for 60 min. Pre-tagging observations will not be done with minke whales, except opportunistically until the tag team is ready. The observation period should be reduced to 30 min if we encounter humpback whales which are feeding.

If the detected focal species is bottlenose whales we will primarily keep the Delphinus system in the water, and keep the animals within a relatively large (e.g. 2*2 nmi) box while sailing at 6 knots. This hopefully enables us to monitor when the animals go into deep diving mode, and acoustically track them through that phase. We might also try not to use the Delphinus during the tagging phase to assess the advantage of manoeuvrability instead of acoustic detection capability.

During tagging, the MMOs on Sverdrup should continue to track the focal animal and collect group behavior data according to the established protocol. In addition they should also provide support to the tag-boats. For safety reasons the tag boats should stay within 3 nmi of the Sverdrup at all times, depending on visibility and sea conditions.

Version 2 DTAGs with GPS logger attached to it will be used as the primary tag with all target species. For minke whales we will use the invasive attachment and with the other species we will use suction cup attachment. With minke whales we will try parallel CTAG-DTAG tagging effort, with a tagger using CTAG in the bow of the tag boat and another tagger using DTAG in an aft position, both using ARTS. For the other species, both the ARTS system and the pole tagging system will be used on equal terms to deploy the DTAGs to all species. For humpbacks the cantilever pole will be used, for minkes the long hand held pole, and for bottlenose whales the short hand held pole will be used, in addition to the ARTS. Which tag team and deployment system is attempted first will primarily depend on which tag team is on duty. The pole system will be used from tag boat 1 and the ARTS from tag boat 2. One or two tag boats will be used at the same time depending on group structure and spacing.

Once a tag has successfully been deployed on an animal, the 2nd tag boat will move to the tagged animal and attempt to tag a 2nd animal, but only if we are working with bottlenose whales or humpbacks and we feel comfortable that the animal will stay together. Attempts to put a second tag on the same animal will also be made, but not with invasive tags. Tag boats will take photo-identification photographs and track the tagged animal initially, until tracking is picked up by

HUS using the VHF digital direction finder system. Tagging might continue for a maximum of 1hr, attempting to tag more animals. The other tag boat should move to assure that it is working with the same group of animals as the tagged animal. If we manage to deploy more than one tag, this increases the total number of whales tested (and helps assure that a tag will remain attached for the full duration of the experiment), but has the cost of taking time attempting to tag from the pre-exposure time. The decision to cease attempting to tag should be made within one hour of initial tag deployment. Any decision to further extend tagging attempts should be based on considerations such as the success of the first attachment (in terms of VHF tracking and likelihood of long attachment) and the behavioral state of the animals in the group. The MMOs on Sverdrup should continue to collect post-tagging group behavioral observations until the end of the post tagging period.

Once the tracking from the Sverdrup is reliable and tagging efforts cease, tag boat teams will transfer back to Sverdrup. Care will be needed during the recovery not to lose the tagged whale.

Pre-exposure phase

Minke whales and humpback whales

When one or two animals have been tagged and the decision is made to stop tagging, both tagging teams will transfer back to HUS. At this point, the first MOBHUS team should prepare the boat and equipment for tracking, while the first HUS team keeps tracking the focal animals. The first MMO team of at least four people will be re-deployed in MOBHUS, and take over tracking the tagged animals and also do the group behavior data recording, until the tags are recovered in the end of the experiments. The reason for not doing the tracking from Sverdrup is that our experimental protocol with a moving source approaching the animal, does not allow tracking from the source ship during exposures of the baleen whales. In order to collect a dataset which is consistent from pre- to post exposure, we therefore have to do the tracking from MOBHUS also in the pre-exposure period.

The MMO team on MOBHUS will consist of four people, a driver, a data recorder and two MMOs. They should alternate between these roles. At least every 4 hour the entire MMO team on MOBHUS will be replaced. Tag boat 1 will be used to transfer the MMO teams between MOBHUS and Sverdrup. When MOBHUS has taken over tracking of the animal, the MMO team on the Sverdrup will be relieved. However, there should be a reduced effort on the Sverdrup as well to serve as back up in case the MOBHUS team loose contact with the tagged animal. As soon as MOBHUS takes over tracking of the tagged animals and until the “tag off message”, HUS should maintain a minimum distance of 1nmi from the tagged animal, except during the approaches. The MMOs on Sverdrup should also make sure they continue to record sightings of other animals, since they have a better view of the larger picture of animal activity in the area. It is very important to document the behavioral context of the exposures, i.e. what type of behavior are the animals involved in prior to exposure. In the pre-exposure phase, Sverdrup will also do systematic prey field mapping. The pre-exposure phase last 2-6 hours depending on the need for baseline data from the specific species and behavioral context.

Bottlenose whales

The protocol planned to be used during experiments with bottlenose whales is very different than for the other species, because we want to replicate the experiments done by the BRS-groups on other beaked whales as much as possible. However, we are using a towed moving source while they are using a stationary dipping source. The other basic difference between the traditional 3S-design and the BRS experimental design on beaked whales is that BRS standardize the behavioral context of the exposures, whereas 3S have used a random context design. With the BRS-design sonar exposure is supposed to start as soon as possible after start of echolocation during deep feeding dives. The implication of this is that we need to do continuous acoustic monitoring of the focal group from tag on until tag off using the Delphinus array. The HUS will therefore be close to the animal the entire time. Therefore we can collect a consistent dataset on this species from pre-exposure through post exposure by tracking from the Sverdrup. Thus, we are not planning to use the MOBHUS for tracking bottlenose whales. The MMO platform on the Sverdrup is preferred because it is higher and more stable, it has big eyes mounted, and we avoid a lot of boat transfer operations which makes us more vulnerable to the weather.

After the tag boat teams have returned to HUS, the MMO-team on watch should just continue to record sightings and behavior according to the established protocol, maintaining the regular 6 hrs watches. The tag boat team on watch will support the MMOs in this phase.

From tag on until tag off the Sverdrup will maneuver in a 1*1nmi box around the animal at a constant speed of 6 knots to optimize acoustic performance. Based on acoustic localization of the animals from the Delphinus team and sightings of the focal animal reported by the MMO-team, the experimental coordinator (CO/XO) will place the box to keep the animal inside of it. Thus, the box will constantly move with the focal animal, and ideally Sverdrup should always be within 1nmi of the focal animal. The navigator (CO/XO) will coordinate closely with the MMO's to keep them oriented about the expected relative position of the tagged whale. The pre-exposure phase last until the end of the first deep dive cycle with recorded echolocation. However, if we have not recorded echolocation at depth within the first 8 hours after tag on, we will automatically move on to the exposure phase, and from then on the experiment is run by the clock according to the protocol table above (random context).

We will not do prey field mapping during experiments with bottlenose whales.

Exposure

When minke whales or bottlenose whales are tagged, the dose escalation (Silent-LFAS-LFAS) protocol should be used for the sonar exposure. However, the dose escalation protocol will not be the same for these species. When humpback whales are tagged, the Ramp Up protocol should be used. Because of depth limitations of the source, two different frequency bands will be used depending on the species and type of experiment. Both signals are transmitted as hyperbolic up-sweeps. Prior to full power transmission a ramp up procedure will always be used, starting at 152 dB and increasing to full power at 214 dB. After the sonar exposures we will conduct another experiment where the animals are exposed to playbacks of killer whale sounds and a control signal.

Target species	*Signal*	*Bandwidth (Hz)*	*Ramp up*	*Protocol*	*Approach distance*	*Playback control sound*
Bottlenose whales	$LFAS_{deep}$	1000-2000	Linear 152-214dB in 20min, 20s IPI	Dose escalation	1*1 nmi box	Broadband noise
Minke whales	$LFAS_{shallow}$	1300-2000	Linear 152-214dB in 10min, 20s IPI	Dose escalation	5 nmi	Humpback whale sounds
Humpback whales	$LFAS_{shallow}$	1300-2000	Non-linear 152-214dB in 5min, 20s IPI (specified in Kvadsheim et al 2012)	Ramp up	1250 m	Broadband noise

During exposure experiment two types of signals and three different ramp-up schemes will be used as specified in the table.

Dose escalation experiments on minke whales

The MMO team on the MOBHUS will continue to track the tagged animals visually and using the VHF-direction finder throughout the experiments. Miller will be a 5th MMO on the MOBHUS during the exposure to act as mitigation observer. In preparation for the exposure, the Socrates will be deployed and HUS will distance itself from the observation vessel (MOBHUS) and the tagged animals. During the exposure phase, 5 different exposure runs will be carried out:

1.) SILENT: silent vessel approach with Socrates deployed but not transmitting.
2.) LFAS: hyperbolic Up-sweep of 1000ms duration with 20s PRT.
3.) LFAS: hyperbolic Up-sweep of 1000ms duration with 20s PRT.
4.) Playbacks of killer whale sounds
5.) Playback of humpback whale sounds

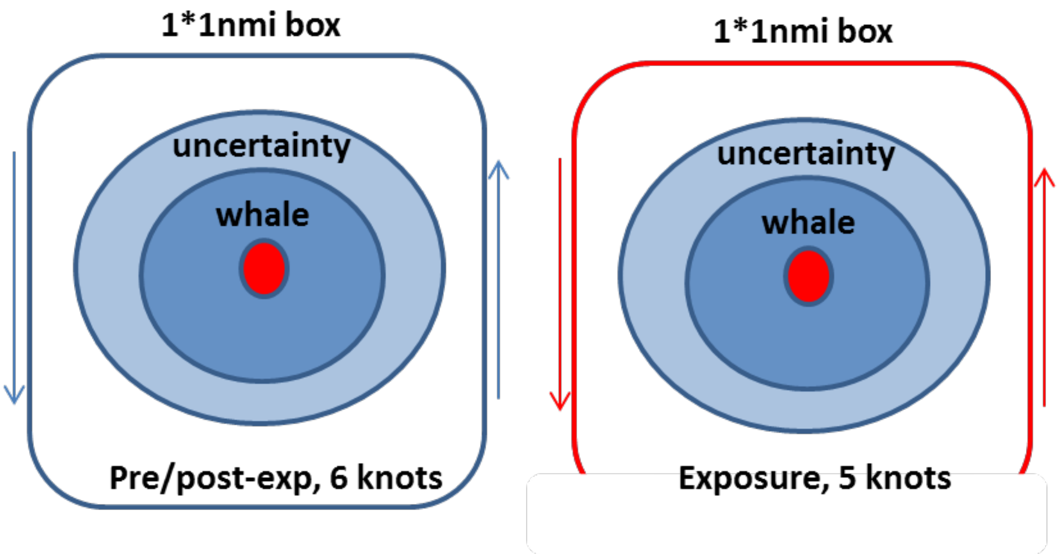
The order of the exposures is fixed except for the two playback signals, for which the order is randomized. The silent control approach is always conducted first to avoid sensitizing the animal towards the source ship. The two repeated LFAS sonar exposures allow us to look at possible sensitization or habituation to the sonar. Prior to full power transmission a 10 min linear ramp up scheme from 152 dB to 214 dB is transmitted. This ramp up is longer than during the ramp up experiment because in addition to being a mitigation measure for non-focal animals in the area, it is also part of the dose escalation. The playback of killer whale sounds are always conducted after the sonar exposures and will be cancelled if the animals respond strongly to the sonar to allow for a longer post-exposure period.

During LFAS HUS will approach the position of the tagged animals, as reported from the MOBHUS, head on at 8 knots starting with ramp-up from a distance of 5nmi. The primary goals of the start location are to place the source to the side or in front of the whale's direction of movement. The final decision to start sonar transmission is made by Kvadsheim after consultation with Miller and the Socrates operator. The course of the source ship will be adjusted if the animals change position, to continue to approach them head on, until the source ship is 1000m from the animals. After this the course will not be changed to allow the animals to avoid the signals. During the exposure, behavioral changes will be recorded from the MOBHUS, who will stay close to the animals. However, visual observations also from the source ship are an important part of the risk mitigation protocol, because other animals might be in the area. After about 30 min the HUS will pass the tagged animals and continue on a straight course, still transmitting for another 5 min. If the animal is clearly avoiding the sonar, the course should be locked before we reach the 1000m distance. If after 30 min of transmission we have still not approached the animal within 1000m, the course should be locked independent of the current distance. Transmissions should continue until 5 min after CPA, but never longer than 60 min of full power transmissions. After end of the exposure the HUS will re-position for the next exposure. The second exposure will start two hours following the end of the first exposure, once the source vessel is in a new acceptable location. All protocols will be identical for the first, second and third exposures (except for the missing active transmissions during Silent). After the final exposure, tag boat 1 will be deployed to conduct a playback of killer whale sounds and humpback whale sounds.

This protocol might be subject to last minute revisions if the experience from the baseline trial in May-June (Sivle et al 2013) implies that the tag attachment does not work as expected.

Dose escalation experiments on bottlenose whales

At the start of echolocation (as determined by the Delphinus operators), the experimental coordinator will have to make a decision on a predetermined 1*1nmi box around the animal, based on the expected movement from the previous sightings. The source ship will instantly turn towards that box and sail the shortest distance to the box, reduce speed to 5 knots and then complete ¾ of the box with while transmitting. That should take 30-40 min, which gives us time to do 20 min ramp up and 10-20 min of full power transmission. Exactly 5 min after the reported start of echolocation sonar transmission will start with ramp up (20 min) and then continue with full power transmission until the pre-determined exposure track is completed. During the first and second deep dive cycles we will do a Silent exposure run, and at the third and fourth deep dive cycle, we will do active sonar exposures. If the focal group has not done any deep dives with echolocation within 8 hours of tag on, we will start the exposure phase anyway, following the timing in the protocol table above, but using the same geometry of the exposures.



Sail tracks during pre- and post-exposure (left) and during exposure (right)

The exposure protocol used on bottlenose whales might have to be adapted when we learn more about the diving and vocal behavior of the animals, behavioral responses and the detection and localization performance of the array.

Ramp up experiment on humpback whales

After tagging and a post tagging and pre-exposure period the tagged animal will be exposed to the following experimental conditions: SILENT - RampUp - NO-RampUp - Playbacks of killer whale sounds and broad band noise signals.
The order will be kept constant to avoid sensitize the animal towards the source ship. The playback of killer whale and control sounds are always conducted after the sonar exposures.

Time between exposures will be 1 hr and each exposure will have a duration of 10 min. During the Ramp Up approach, sonar transmissions will be initiated approximately 1250 m from the tagged animal, and the source ship will approach at 8 knots on a straight and constant course while gradually increasing the transmitted source level within 5 min from a minimum level of 152 dB to the maximum level of 214 dB at the closest point of approach, and then continue to transmit at full power for another 5 min while moving away from the animal after passage. A CPA of 0m will be estimated based on the moving pattern of the animal in the pre-exposure phase. From the point of first ping and throughout the transmission scheme the source ship will maintain a constant course independent of the animal's movement. The Silent approach and the

NO-Ramp Up approach will follow the exact same procedure, except that there is no active transmissions during silent, and that transmissions only starts at full power at CPA during NO-Ramp UP.

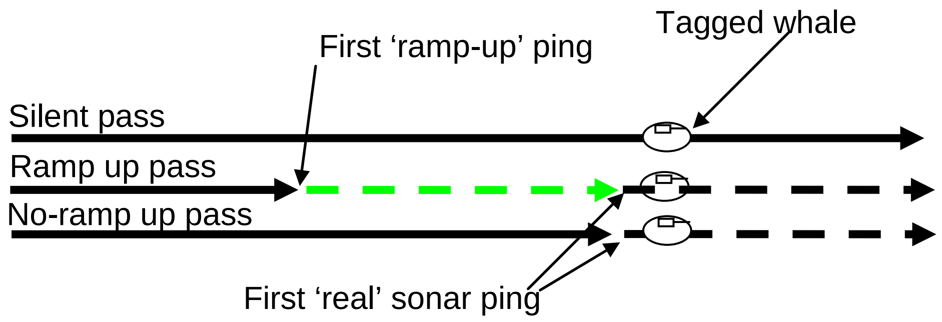


Diagram of the Ramp Up experimental deign. The oval represents a tagged subject whale, and the pointed lines represent the source vessel course. In all three runs the animal is approached as directly as possible, and the course of the vessel is fixed at a pre-determined distance, before the planned start of ramp-up signals. In the silent pass, no sonar transmissions are made. In the ramp-up pass, a ramp-up sequence is transmitted in addition to full-level signals. In the no-ramp-up pass, transmission starts with the first full level ping at the closest point of approach.

The Ramp-up experiments have a very strict design established during previous trials, and it is very important that this is replicated as closely as possible. Details of the design with detailed RampUp scheme is specified in Kvadsheim et al. 2012.

Playback of killer whale and control sounds

The killer whale playbacks will require 2-4 hr to complete. The playback will be done from one of the tag boats, with the transmission starting slightly ahead and to the side of the tagged whale, at a planned distance of 800m.

Two stimuli will be played as part of each playback as follows (15 min control sound, 30 min-2 hr gap, 15 min orca). The gap between the playbacks and the type of control sound will vary between the species as specified above. The order of the Orca and control sounds is always random. 'Orca' stimulus contains natural vocalizations of mammal eating killer whales, recorded in similar behavioral contexts, i.e. when the killer whales were foraging. 'Control' (as a negative control) is either A) a sequence of background noise selected from previous recordings (2005), amplified up to get the Average RMS Power equal to the stimulus, and repeated until getting the same duration than the stimulus (15 min), or B) a recording of singing humpback whales. All acoustic signals have a similar Average RMS Power and duration of 15±2 min. Amplitude is low at the beginning of the stimulus and progressively increased up to its normal value to simulate an approaching source. At the end of the stimulus, amplitude progressively decreases to simulate a source leaving.

Minke whale and humpback whales

Killer whale playback to baleen whales will be done by a dedicated playback team deployed in tag boat one after the sonar exposure. When deployed, they will also bring equipment and expertise to conduct background noise measurements.

<u>*Bottlenose whales*</u>
Killer whale playback to bottlenose whales will be done by a dedicated playback team deployed in tag boat two after the sonar exposure. When deployed, they will also bring equipment and expertise to conduct background noise measurements, collect biopsy of the tagged whale and to recover the tag after release.

If we are using a fixed context exposure protocol it is preferable that also the killer whale playback is conducted in the same behavioral context for the animals, i.e. soon after start of clicking during deep dives. Whether this is feasible or not will have to be assessed when we learn more about the deep diving frequency of bottlenose whales. It is not realistic however, to do both killer whale and control sound playback, unless we are using a random context exposure.

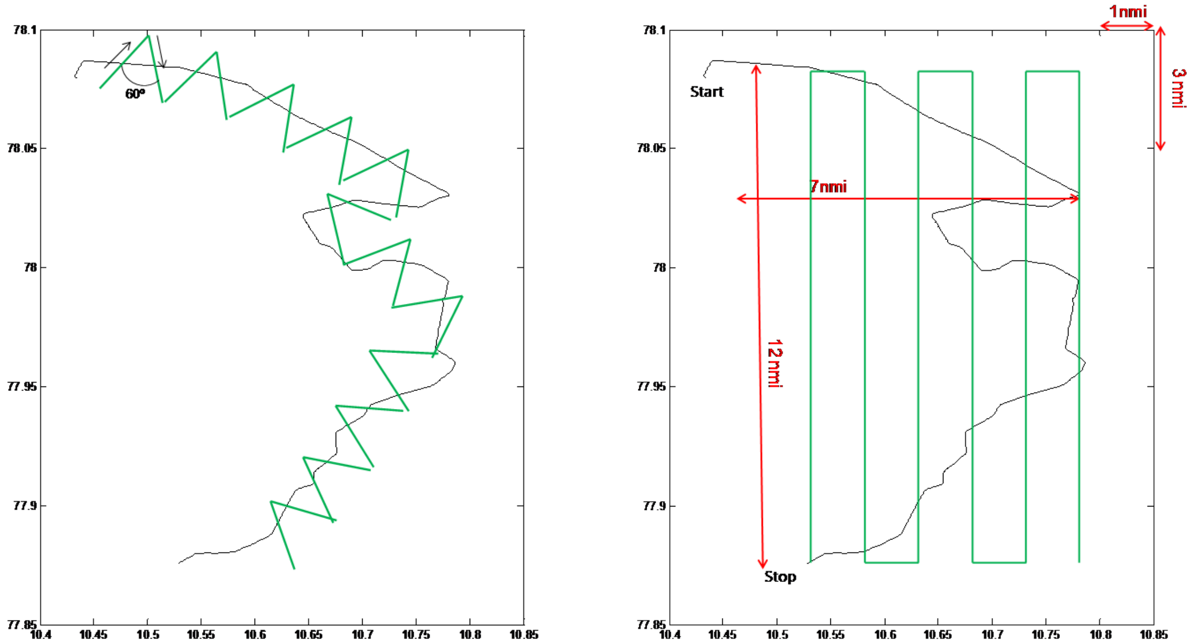
If there is less than 3 hours left of the expected tag duration after the last sonar exposure, the control sound playback will have to be cancelled. If there is less than 2 hours left, also the orca playback will have to be cancelled. If there is time after the last sonar exposure, tag boat 1 will be deployed with the playback team. If the animals have not performed another deep dive within two hours after the last sonar exposure we will just initiate the playback sequence.

Post-exposure
After termination of the exposure phase, we will go back to an operational modus similar to the pre-exposure phase. Towards the end of the post exposure phase, when tag release is just 30 min away, a biopsy team will be deployed (if not already on the water doing the tracking) to sample a biopsy of the tagged animal(s). The total duration of suction cup DTAGs using the electronic release of the tag will usually be set to 16 h. Invasive DTAGs and CTAGs have a galvanic release expected to release after 18-20 hours. When all tags have been retrieved, the MMO team will transfer back to HUS to download and secure the data. Visual and behavioral data will also have to be checked, corrected and secured (backed up). Then after at least a 6 hr period of resting the troops, we return to the search phase.

Mitigation during transmission
During transmissions, MMOs on Sverdrup will assure that no whales are too close enough to the source that they might be exposed to sounds over 180 dB re 1μPa as required by the permit. The stand-off range between source and animals during full power transmission is 50m. If any animals are approaching this safety zone an emergency shut-down of sonar transmission will be ordered. Transmission will also be ceased immediately if any animal shows any signs of pathological effects, disorientation, severe behavioral reactions, or if any animals swim too close to the shore or enter confined areas that might limit escape routes. The decision to stop transmission outside the protocol is made by Kvadsheim or by someone he appoints to be responsible for permit compliance.

Prey field mapping
To give us an idea of the prey field in the area we are working in we will keep the 38 kHz and 200 kHz single beam echosounder of Sverdrup on monitoring mode during search phase, when we are primarily searching for baleen whales in relatively shallow water. In the experimental phases (from tag on to tag off) we also want to record prey field data on the echosounder, primarily using the 38kHz, except that during the experimental approaches the echosounder will be turned off. However, when searching for or working with bottlenose whales we will not

do any prey field mapping because both the 12 kHz and the 38kHz could interfere with the animals and the 200 kHz does not give any useful information of the deep prey field.



Example of track of the minke whale (black line) in the first part of the pre-exposure period of the experiment in 2011. The left figure show how a zig-zag grid could be sailed by Sverdrup following the MOBHUS in the pre-exposure to post exposure phases. The right figure show how the relevant general are can be mapped out by Sverdrup during the resting period after an experiment. Line transects are separated by 1nmi.

When MOBHUS takes over tracking of minke whale or humpback whales, Sverdrup will follow behind at minimum 1nmi distance, while moving in a systematic manner in order to collect echosounder data for prey field mapping.

Based on the track of Mobhus, Sverdrup will move in a zig-zag grid to cover the area travelled by Mobhus, which are indicative of the movements of the focal whale. The grid should be made by Sverdrup sailing straight lines of 1 nmi, than turning at an angle of approximately 60º, followed by a new line of 1 nmi and so on. Angles should be around 60º, but slightly adjusted to follow and cover the track of Mobhus. See example figure above.

After the experiment has finished, and the tag is retrieved, there is usually a resting period for the scientific crew. This time may potentially be used to do some more systematic prey field mapping of the most relevant general area where the focal animal travelled during the experiment. This area is defined by the longitudinally and latitudinal extension of the whale track from pre-exposure to post exposure, and will be covered by line transect separated by 1nmi. If there is not enough time to complete the entire grid, the distance between the transect lines must be increased.

Sound speed profiles (CTD and XBT)

A temperature profile (XBT) should be taken as soon as possible after end of transmission during all animal approaches of the source ship, including silent approaches. This is particularly important during the Ramp Up experiments with humpback whales. In addition, sound speed profiles should be taken whenever acoustic transmissions (sonar signals or killer whale playback) have been used in an area. CTD profiles will be taken form the Sverdrup, but

Sverdrup cannot reduce speed beyond 3 knots when towing Socrates or Delphinus. After an exposure experiment, Socrates and Delphinus are usually recovered on the Sverdrup, which allows Sverdrup to collect CTD profiles along the exposure path (close to CPA) using the CTD probe. CTD profiles should preferably also be collected on a routine basis to monitor the acoustic propagation conditions in the operation area. This will enable us to plan the acoustic experiments using transmission loss models (e.g. LYBIN).

Ambient noise and received levels in the water column

During this cruise we will also measure levels of ambient noise in relation to the exposure experiments to better describe the environmental context of the exposure. After the killer whale playback experiments the hydrophone buoy will be deployed by the source boat for the killer whale playbacks for 30 min to measure background noise. The buoy should be placed at least 2nmi from the HUS and the tag boat will also have to distance themselves 1000m from the buoy and turn off the engine during recording.

Minke whales

If a minke has been tagged with a CTAG, there is no acoustic sensor on the animal to record received levels. The MOBHUS team tracking the whale will be towing the SMRU array at 3-10 m depth close to the position of the animal. These measured received levels will be used to benchmark the acoustic propagation modeling used to estimate the received level on the animal. Minke whales typically dive to 120m max, and in order to also get reference received levels also in the water column we will also deploy the hydrophone buoy. After the second crew change (between watch B and C) tag boat 1 will deploy the buoy along the expected transmission path during positioning of Sverdrup for the 1st sonar exposure run. TB1 will then return to the Sverdrup, leaving the buoy in that position until it is recovered after the end of the experiment.

Videos and photos

A structured protocol for collection of photos and videos is adapted to maximize the applicability of these in data analysis.

Photo

During tagging there will be dedicated staff (Erik and Paul E) to take pictures of the tagging process, and tag placements as well as photo id pictures of the back of the focal animals. As much as possible someone should also try to collect photo i.d. pictures of the tagged animal and other animals in the focal group in the tracking phase, but the tracking and social behavior data collection has priority. Photo information should be reported to data logger.

Photo/Video	***Purpose***	***When***	***Details***
Photo/video	Documentation of tagging and tag placement.	Tagging	Important to document movements of the tag on animal, important also to assign vocalizations to individual
Photo	Photo i.d. picture of focal whale and all other member of focal group	Tagging and tracking	Report photo information at end of first following data record to data logger during tracking
Video	Documentation of behavioral display events	Tagging and tracking	Provide a short summary of videos of interest

Structured use of photo and video.

Video
There is no project video camera, but private cameras (handheld or head mounted Go-Pros) can be used to document tagging and behavioral display events (by the whales not the researchers!). There is no one dedicated to collect and structure such data and therefore owners of the video must provide a short summary of videos of interest to the 3S group, stating duration, date time start and end, species, experiment phase, and a short summary of what the record shows. All collected footage of interest must be copied to the 3S-13 central server, and can be used for analysis purposes.

Fog activities

Jan Mayen is well known for its fog. During the summer there might be extended periods of almost no wind and thus very nice sea conditions, but around the island dense fog banks might form. This will off course reduce visibility and thus our chance of spotting target species. If this happens we might try to operate further off-shore, looking for better conditions there. Tagging in fog is possible, but the tag boats should stay within 1-2 nmi of Sverdrup. Whenever tag boats operate outside of visual range of Sverdrup the following safety procedure will be implemented.

- Radio contact every 30 min, initiated from Sverdrup.
- AIS transmitter in tag boat on.
- Bring active radio transponder, which can be triggered in an emergency.
- HUS will continuously transmit VHF homing beacon which can be tracked from the tag boats.

Fog will also impact our ability to track tagged animals visually. Before tagging is initiated, our ability to conduct experiments and risk of loosing tags has to be assessed. The regular experimental protocol could be replaced by baseline data collection with tracking from HUS. If fog conditions prevent all tagging and visual tracking we can spend the time doing passive acoustic survey in deep water (looking for and tracking of bottlenose whales) or prey field mapping in shallower water using echosounders.

MANAGEMENT AND CHAIN OF COMMAND

Operational issues

Operational decisions such as decisions on sailing plan, decisions to deploy tag boats/Socrates/ Delphinus, crew dispositions etc are ultimately made by the cruise leader. The cruise leader is also the coordinator and leader of the exposure experiments. However, the cruise leader is obliged to consult with the chief scientist of the 3S-partners on decisions affecting their area of interest or responsibility.

Safety issues

The captain of the ship makes final decisions on safety issues.

Permit issues

The permit holder is Petter Kvadsheim. He makes final decisions on permit issues. However, Lise Sivle, Lars Kleivane and Patrick Miller also have responsibility for permit compliance during tagging and exposure.

Sonar operation safety issues

A Risk Management Plan for the operation of Socrates and Delphinus is specified to minimize risk to this high value equipment (Appendix A). Final decisions on issues related to the safety of Socrates and Delphinus are made by the chief scientist of TNO (Lam).

Scientific issues

Final decisions regarding the protocol for execution of the exposure experiments lies with the PI.

DATA MANAGEMENT

A central server will be placed in the operation room and connected to the wireless network on-board. A file structure will be specified and all data should be uploaded to the server as soon possible. In the end of the trial the entire data record will be copied to all partners.

Folders in root:

Documents – CTD – DTAG – Echosounder - GPS tag - Logger - Orca playbacks - OWID recordings - Pics and videos - SMRU array - Social behavior -Socrates logs - Software tools - Sound samples - Tagboat GPS - TNO GPS - TNO tracks – XBT

COMMUNICATION PLAN

In all phases of this trial the crew will be split in different groups (acoustic teams – marine mammal observation teams – tag teams - coordination/management) and platforms (Sverdrup – tag boat 1 – tag boat 2). Coordination and thus clear communication between these units will be crucial, especially in critical phases. To ensure good communications there are VHF-communication equipment on all units. Tag boats must bring a spare handheld VHF. In Vestfjord cell phones can be used as back up, but on Jan Mayen there is no coverage.

The radio call signals for the different units will be:

“Sverdrup”	Sverdrup (HUS) bridge (HQ) (answered by CO or XO)
“Tag boat I”	4 stroke outboard engine work boat
“Tag boat II”	Water jet propulsion MOB (MOBHUS)
“Socrates”	Sonar operator on Sverdrup (Socrates and Delphinus)
“Obs deck ”	Marine mammal visual observation deck on Sverdrup

A main working channel (channel A), and an alternative channel (channel B) in case of interference, will be specified.

During the tagging phase, communication to and from the tagging teams must be limited as much as possible. An intercom channel between Sverdrup, Socrates and Obs deck will be implemented to reduce radio traffic.

Tag boats must report in to “Sverdrup” to confirm communication lines every hour! We are mostly operating in open ocean, and this safety procedure is an invariable rule. Tag boat teams who fail to comply with this will be called back and recovered without further warning.

If not otherwise specified in the daily work plan the following channels should be used:

Main working channel	**Channel A**	**Maritime VHF channel 73**
Alternative channel	**Channel B**	**Maritime VHF channel 67**

RISK MANAGEMENT AND PERMITS

FFI has obtained necessary permits from appropriate civilian and military authorities for the operation described in this document. The operation area is entirely within Norwegian territorial waters or the exclusive economic zone of Norway. We will transit through international water between Vestfjorden and Jan Mayen, but will not do any tagging or active transmissions in this area. The operation is considered a military activity under the jurisdiction of Norwegian military authorities. RV HU Sverdrup II will carry a Royal Norwegian Navy Ensign and be placed under command of government official from The Norwegian Defense Research Establishment. Principle scientist Petter Kvadsheim is the commanding officer ultimately responsible for the operation.

Since the operation includes animal experimentation, we will operate under permits from the Norwegian Animal Research Authority (permit no S-2011/38782) acquired by Petter Kvadsheim. The permits include tagging (DTAG and CTAG) and acoustic exposure of minke whales, bottlenose whales, humpback whales and fin whales according to the protocol described here. Permits also allow biopsy sampling of target species. The exposure experiments are permitted under the condition that maximum exposure level does not exceed 180 dB (re 1 μPa), (50m stand-off range) and that project participants are skilled in handling the animals. In addition to Kvadsheim, Patrick Miller, Lars Kleivane and Lise Sivle will be field operators responsible for permit compliance in the field.

Procedures to mitigate environmental risk will be implemented as described in this document and in the permit documents. Risk to humans should be minimized through the regular safety regime implemented for all relevant working operations on board. The cruise leader is primarily responsible for these risk issues. A separate risk management plan, to mitigate risks to expensive equipment, such as the SOCRATES system and the towed Delphinus array, has also been specified (Appendix A). All personnel involved in handling this equipment, including navigators, must be aware of the content of this plan. Risk involved in the handling and operation of this equipment is the primary responsibility of the TNO chief scientist.

PUBLIC OUTREACH AND MEDIA

During the cruise, all media contact should be referred to the cruise leader (Kvadsheim) who will coordinate with the 3S-board members (Miller, Lam, Tyack) and FFI's information office. An on-shore PR-contact will be appointed by FFI, and will serve as the POC for all inquires from media.

There is some local concern about our operation in Vestfjord, and we might therefore decide to do some public outreach meeting at some point. Where this will be and who will be invited is yet to be decided.

National Geographic documentary on 3S research

We are collaborating with a Dutch film company called Mouissie Corporation who is making a documentary series for National Geographic called "Marine Life" which will be focused on nature conservation issues. One of the planned eight or nine 1 hr long episodes will focus on marine mammals, and they have indicated that half of this will be dedicated to the 3S-research. Their storyline is the issue of anthropogenic noise and impact on marine mammals, and the international research collaboration needed to manage this complex and global issue. They will participate on the trial the first few days 15-18 June, and within this period they will come with us on the Sverdrup to collect illustration footage of sonar operation and tagging operation. There will only be one camera man from their team. He will leave us before we sail to Jan Mayen.

TRAVEL AND ACCOMMODATION

Travel

<u>*Port in/out Tromsø:*</u>

There are frequent direct flights from Oslo to Tromsø with SAS and Norwegian Airlines. Tromsø airport is a 15 min taxi drive from both port terminal and from down town Tromsø.

Hotels

There is a big conference in Tromsø June 14-16 and all hotels in town are fully booked. We can stay on board Sverdrup from June 14$^{th.}$

SHIPPING

For loading and off-loading Sverdrup will be docked at Breivika port terminal in Tromsø. This port has a port crane for lifting of the heavy equipment.

If you are shipping things to Tromsø coordinate with FFI and use this address:

TNO/SMRU/WHOI/FFI (Your own organization's name first)
c/o Holm Shipping
Terminalgaten 58 Breivika havn, Skur 23
NO-9019 Tromsø

It's very important that you ship the equipment to yourself, and not to FFI. Put the following information somewhere else (not in the address field itself, but still clearly readable to the agent):

3S-13
FFI - HU Sverdrup II

CONTACT INFORMATION

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GENERAL ADVICE

The scientific trial you will be involved is a unique experience. Make it enjoyable for yourself and others. Be positive and constructive by finding solutions to problems before complaining.

Weather conditions will be the most limiting factor during the cruise. In June the air temperature will still be relatively cold at sea in these Arctic oceans (0-10 ºC). Make sure you bring high quality clothing for all layers. Floatation suit is mandatory for everybody working on the tag boats. However, it's what you wear under the suit which keeps you warm. A hat, gloves and shoes which keep you dry are your most important tools.

The entire cruise is north of the Arctic circle and it's midsummer, thus we will have midnight sun, and thus 24 hours of daylight and working conditions. There will not even be a dusky period around midnight. This is a big advantage to the operation and our chances of success, because we can work around the clock and don't have to consider retrieving tags before dark. However, make sure you get some sleep! A watch plan will be specified, it is your duty to work when on duty, but also to rest when off duty. We must maximise the time available with good conditions to attempt as many experiments as possible. You should expect long hours of hard work while these good weather windows happen. You will have long hours of rest when weather conditions deteriorate.

Cruise methods and procedures have been fixed in advance, and need to be kept standardized with previous cruises. There is very little that can be changed without affecting the data being collected. If you can think of improvements, discuss them with the cruise leader and principal investigator first before implementing.

This cruise is not a whale watching cruise, so whenever you are on duty keep focused on your tasks. If you are off duty use well your resting period and do not disturb/distract the ones that are on duty. It is probable that you will share a cabin with other people, so keep it tidy and pleasant for everyone. If you have any problems please speak to the cruise leader directly and openly as soon as possible. A delay may make matters worse or cause ill feeling between work colleagues.

The food on the Sverdrup is known to be good. However, on a cruise of this duration without port calls, we will run out off fresh food such as fruit, dairy products and vegetables. It might be a good idea to bring you favourite food goodies (*e.g.* tea, coffee, chocolate, cookies, etc.), and let us know if you have any diet restrictions.

Prepare yourself mentally that we might be at high sea without even sight of land for weeks at the time. At Jan Mayen we are several days away from any port from which you can travel home. Prepare yourself and your family for this. The threshold of going back to a port will be high, unless off course there is a medical need for this.

We will be out of cell phone range most of time. Warn the people at home that you are still alive, even if you don't pick up their calls. You will be allowed to call home, but not unlimited, due to the limited number of satellite based phone lines. The ship has continuous satellite based internet connection and internal wireless network. However the bandwidth is limited so avoid downloading large files and switch off software updates. Limit the use of web based communication such as Skype. There are a few available computer stations on board, but these have to be shared. You are welcome to bring your laptop and connect to the network.

Be prepared! ENJOY! Good luck!
Petter Kvadsheim (cruise leader)

REFERENCES

The following list of other internal documents within the 3S-group also has relevance to the execution of the trial.

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APPENDIX A

Specifications, deployment, operation and recovery of SOCRATES and DELPHINUS system

In this appendix, technical details and sailing restrictions are presented for SOCRATES and Delphinus systems, both to be towed by H.U. Sverdrup II. Sailing restrictions are driven by 3 factors: to avoid hitting the sea floor, to avoid cavitation during (high power) transmission and to avoid entanglement while towing both systems simultaneously (dual tow).

Bottom Avoidance SOCRATES II and Delphinus array

During the trials the SOC2 towed body will be operated with a minimum cable scope of 100 m.
In the Table below the maximum cable scope is indicated for different water depths.

Water depth [m]	110	150	200	250	300	400	500
Max Cable scope SOC2 [m]	100	170	260	400	500	500	500(*)
Max Cable scope Delphinus [m]	170	270	400	500	600	660	660

(*) beyond 500m water depth, the maximum cable scope for SOC2 equals the water depth.

These values are based on the speed-depth diagrams at speed 3 kts with a safety margin of 20 m.
When applied a minimum speed of 4 kts should be enforced.

The cable scope of the Delphinus array should be longer (≥ 20m) than the cable scope of the source in order to get both systems at the same operating depth. The array itself is neutrally buoyant. Therefore it will only sink by the weight of the cable. When H.U. Sverdrup II would need to come to an unplanned stop the array will slowly sink to the bottom. In this case there will be time to recover the array in order to minimize damage to the system.

Turn rate

During dual tow, turns of H.U. Sverdrup II are carried out with the following maximum turn rate:

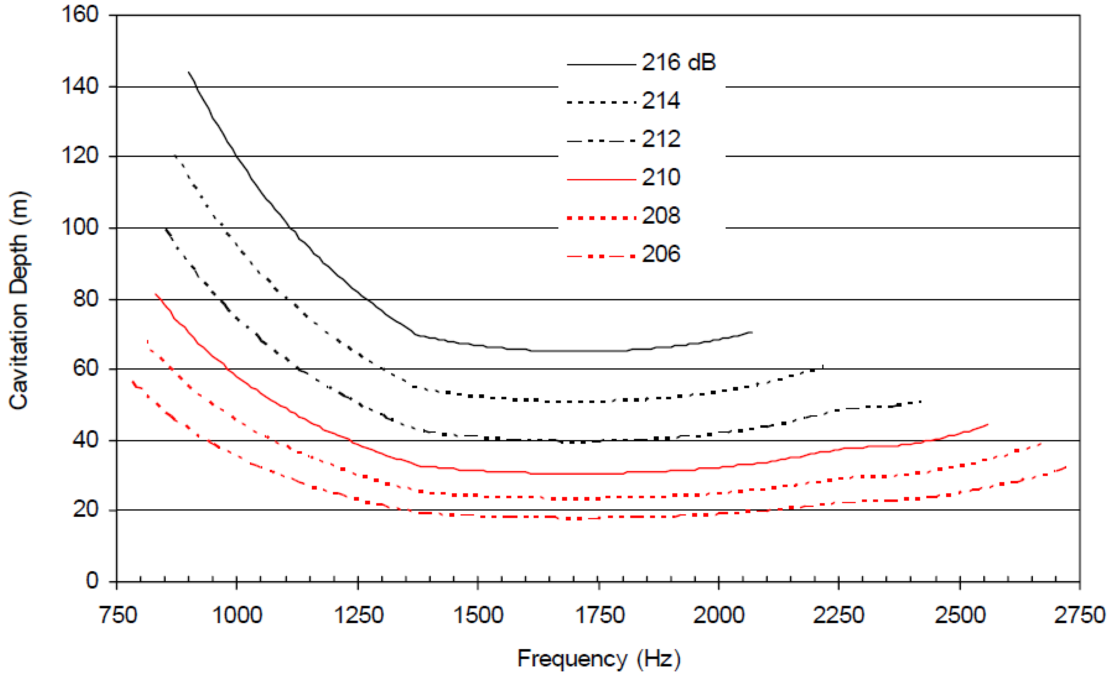
- Starboard turn for 3-12 kts with 20 deg/min.
- Port turn for 3-12 kts with 25 deg/min.
- While turning (and shortly before and after that (2min)) **speed should remain constant**

During single-tow operations the maximum turn rate is 30 degrees/minute.

Cavitation

Because of cavitation the source cannot be operated at full power at small depths. Cavitation depths depend on sonar frequency as shown in the Figure below (curves from Ultra Canada).

The maximum source level of SOC2 is 214 dB. At f = 1000 Hz this results in cavitation depth of 100m. In order to reduce cavitation “shallow tow pulses” are defined that have a minimum frequency of f = 1300 Hz. This reduces the cavitation depth to 60 m.



Full band pulses (1000-2000Hz)

In case other pulses (including frequencies f < 1300 Hz) are used and if the sonar depth is less than 100 m the source level should be adjusted with 1 dB per 10 m as shown in the table below.

Source level [dB]	214	213	212	211	210	208	206	204
SOC2 min depth [m]	100	90	80	70	60	50	40	30
SOC2 min cable scope [m] @ 6 kts	250	220	190	160	140	110	100	100
Min water depth [m] @ 6 kts	190	180	160	145	130	110	110	110
SOC2 min cable scope [m] @ 8 kts	470	410	350	290	230	180	140	100
Min water depth [m] @ 8 kts	280	260	240	210	180	160	130	110

Shallow tow pulses (1300-2000Hz)

In case special *shallow tow pulses* (f > 1300 Hz) are used and if the sonar depth is less than 60 m the source level should be adjusted with about 1 dB per 5 m as shown in the table below.

Source level [dB]	214	213	212	211	210	209	208	206
SOC2 depth [m]	60	55	50	45	40	35	30	25
SOC2 cable scope [m] @ 6 kts	140	120	110	100	100	100	100	100
Min water depth [m] @ 6 kts	130	120	110	110	110	110	110	110
SOC2 cable scope [m] @ 8 kts	230	200	180	160	140	120	100	100
Min water depth [m] @ 8 kts	180	170	160	140	130	120	110	110

Overall depth guidelines
The above information as stated above, can be summarized with the following table for exposure runs at 8 knots (and without turning):

Signal	***Bandwidth (Hz)***	***Modulation***	***Source level dB re 1µPa@1***	***Tow speed Kts***	***Min tow depth m***	***Min water depth m***	***Min cable scope m***	***Target species***
LFAS$_{deep}$	1000-2000	HFM up-sweep	214	8	100	280	470	Bottlenose whales
LFAS$_{shallow}$	1300-2000	HFM up-sweep	214	8	60	180	230	Minke whales Humpback whales

Depth limits for the two earlier defined types of signals, LFAS$_{deep}$ and LFAS$_{shallow}$ during straight exposure runs at 8 knots without turns. Sailing restrictions for BRS-type exposures are discussed below.

BRS-style exposure runs with N.Bottlenose whales and dual tow

As explained in the Cruise Plan, there is a preference for BRS-style exposure runs with northern bottlenose whales, which means starting to close in on the tagged animal or group as soon as they start clicking during their second deep dive. Because we aim to keep tracking acoustically in parallel as much as possible, this implies that this should be done with dual tow (SOC2 and Delphinus). The manoeuvring as explained in the cruise plan is very challenging: it describes dual tow, with constant turning ('boxing') while sailing at low (possibly changing) speed. This manoeuvring needs to be tested in advance in order to verify the safe limits. Until then the following guidelines will be in place as a starting point:

- Minimum speed is expected to be 4 kts (constant speed preferred). This is both for acoustic functionality, as well as for safety of system (to prevent entanglement)
- Turn rate for dual tow is 20 deg/minute (starboard) or 25 deg/minute (port), this results in the following turn durations:

Turn [deg]	Turn duration [mm:ss]	
	Starboard turn [max 20 deg/minute]	Port turn [max 25 deg/minute]
90	04:30	03:36
180	09:00	07:12
360	18:00	14:24

- With numbers as stated above, the minimum box is 1x1nmi at 4 knots.
- It takes about 5-10 minutes for the array to get stable after turning (or changing speed). During this stabilization time the acoustic functionality is ranging from poor to sub-optimal.
- Note that handling, like deploying and recovering SOC (see below), should take place during a straight course. Deploying SOC between two corners of a 1x1nmi box will be (too) tight.
- Note that during dual tow it is more challenging to launch and recover tagboats. Special attention is required at these moments.

We should evaluate how things are working out while testing. If needed, test again!

Deployment and Recovery of systems

Seastate

The SOCRATES source and Delphinus/CAPTAS arrays will be deployed to and including sea state 4. It will be recovered if sea state is forecasted to be higher than 5. The decision to recover will be taken by the chief scientist sonar and the responsible TNO technician, and communicated with the captain of H.U. Sverdrup II and the cruise leader.

Deployment and Recovery Speeds

Deployment and recovery time for the SOCRATES to/from a cable scope of 100 m takes approximately 30 minutes and similar for the towed array. Stabilization time of towed body and towed array is about 5 minutes. During deployment and recovery, the tow ship speed is approximately 4 – 5 kts. When the handling supervisor on the aft deck is comfortable with the actual circumstances (wind, currents and sea state) deployment speed could eventually be increased to max. 8 kts.

Sequence

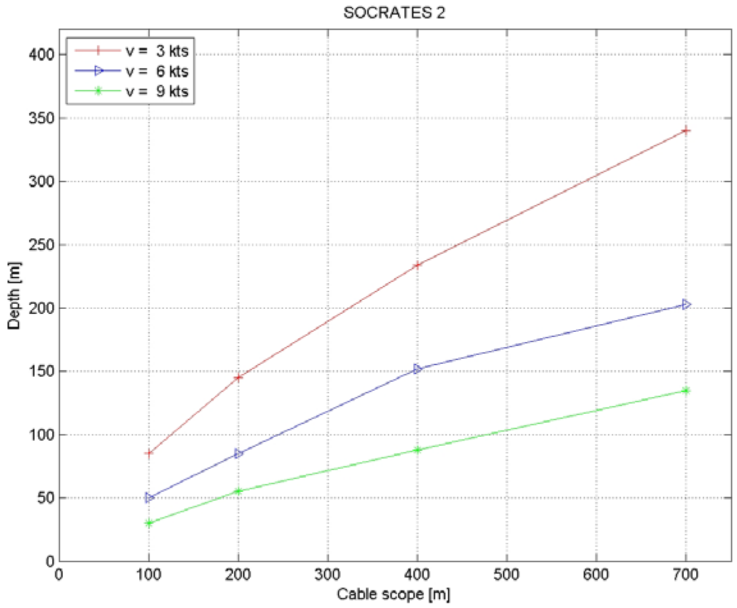
H.U. Sverdrup II can tow both the SOCRATES source and the Delphinus array simultaneously. The deploying sequence will be first the towed array and then the SOCRATES towed source. Consequently the retrieval sequence will be first SOCRATES and then the array.

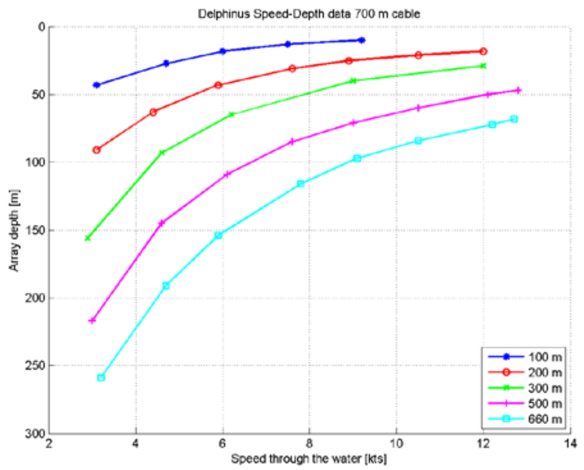
Data Sheet

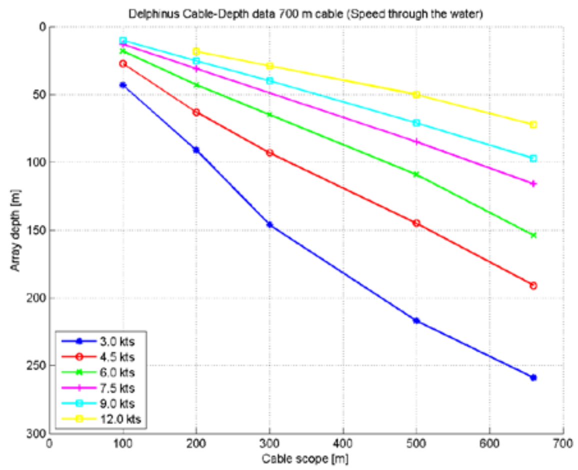
The operational limitations and additional information for H.U. Sverdrup II while towing are presented below:

Item	min	max	Remarks
SOCRATES 2 weight [kg (daN)]	430	750	Weight in water/air
SOCRATES 2 tow length [m]	100	950	
Bottom Vertical Safety Separation [m]	20		
Upper Vertical Safety Separation [m]	15		When not transmitting
Upper Vertical Safety Separation [m]	40		When transmitting
Array depth [m]	10	400	
Array tow length [m]	100	660	
Speed brackets [kts]	4	12	SOCRATES + array

Speed-Depth Graphs







Appendix D Cruise report 3S-13 Baseline I – tag test trial

Resume

Tagging and tags

The tagging and biopsy equipment was operated by Lars Kleivane, using the whale-tag launcher ARTS for tags and the double barreled biopsy gun, the K-gun for biopsy. The experience we have from these tagging events are few, but solid enough to choose the longer barb, the BRA configuration. This is a barb developed by Russ Andrews for LIMPIT tags. The details for the HH-holder to the DTAG housing would need modifications, in order to secure better attachments of all 4 barbs. The setup with event **9Mn1_DTAGv2BRA** was holding a GTR - A1. The A1 would hold for 24h in 2 degree water, while the A2 would hold for 24h in 6 degree water, we would need to make HH-holders for A2. For the CTAG, a safety bag for the instruments will prevent looses of loggers in the future. And extra attention to the valve, and the valve function would be in focus for the ARTS operator.

Table 1. Tagging events during baseline 3S-1 with Blåstål in the basine of Andfjorden, Norway. A total of 9 launchings using the whale tag launcher ARTS deployed with sensor package DTAG (n=7) and CTAG (n=2), as well as with 3 different barb designs. The DTAGv2BLK is with 4 small barbs (40mm) of stainless steel, the DTAGv2BRA is with 4 medium barbs (65mm) of

Date	**Time**	**Species**	**Tag-ID & Launching no.**	**Lat/Long**	**System**	**Range (m)**	**Pressure (bar)**	**Fisk (angle º)**	**TOW time**	**Skin**	**remark**
Jan 20th 2013	14:53	Humpback	**1Mn1_DTAGv2BLK**	69º 05.01N 16º 04.70E	ARTS	**12**	10	70	0	no	1 HH break
Jan 20th 2013	15:58	Humpback	**2Mn2_DTAGv2BLK**	69º 04.90N 16º 03.61E	ARTS	13	9	80	miss	no	
Jan 25th 2013	11:15	Humpback	**3Mn3_DTAGv2BLK**	69º 03.00N 16º 05.74E	ARTS	15	9	80	0	no	1 HH attached
Jan 25th 2013	13:24	Humpback	**4Mn4_DTAGv2BLK**	69º 01.42N 16º 05.94E	ARTS	16	9,5	90	3,5h	no	
Jan 25th 2013	14:43	Humpback	**5Mn1_CTAG/GPS**	69º 03.88N 16º 11.81E	ARTS	15	9,5	70	miss	no	
Jan 27th 2013	13:27	Humpback	**6Mn2_CTAG/GPS**	69º 03.16N 15º 58.44E	ARTS	16	9,5	85	0	0135	Pressure problem
Jan 27th 2013	13:55	Humpback	**7Mn5_DTAGv2BLK**	69º 03.73N 15º 59.09E	ARTS	12	9	65	0	no	
Jan 29th 2013	12:07	Humpback	**8Mn6_DTAGv2BLK**	69º 12.24N 16º 11.02E	ARTS	15	9	90	>23h	no	
Jan 30th 2013	13:35	Humpback	**9Mn1_DTAGv2BRA**	69º 07.74N 16º 04.69E	ARTS	13	9	75	15h+	0335	

titanium, while the CTAG/GPS is with one single barb (75mm) of stainless steel. Only humpback whales where targeted (TOW= tag on whale).

Photo-identification

ID-photos were taken by Sanna Kuningas and Shingo Minamikawa during total 6 days (20th ,24th, 25th, 27th, 29th and 30th January 2013) in Andfjord. Sanna Kuningas using Canon 30D camera with 70-200mm IS zoom lens (f/2.8 aperture) and Shingo Minamikawa using Canon EOS-1D Mark III. Additionally we collected ID pictures of killer whales and humpback whales from local photographers, especially Kenneth Pettersen, Jan Marius Johnsen and Marten Bril.

Table 2. Total number of photos taken was 12004. Summary of the species (KW = killer whales, HB = humpback whales) photographed and the number of photos taken for each day.

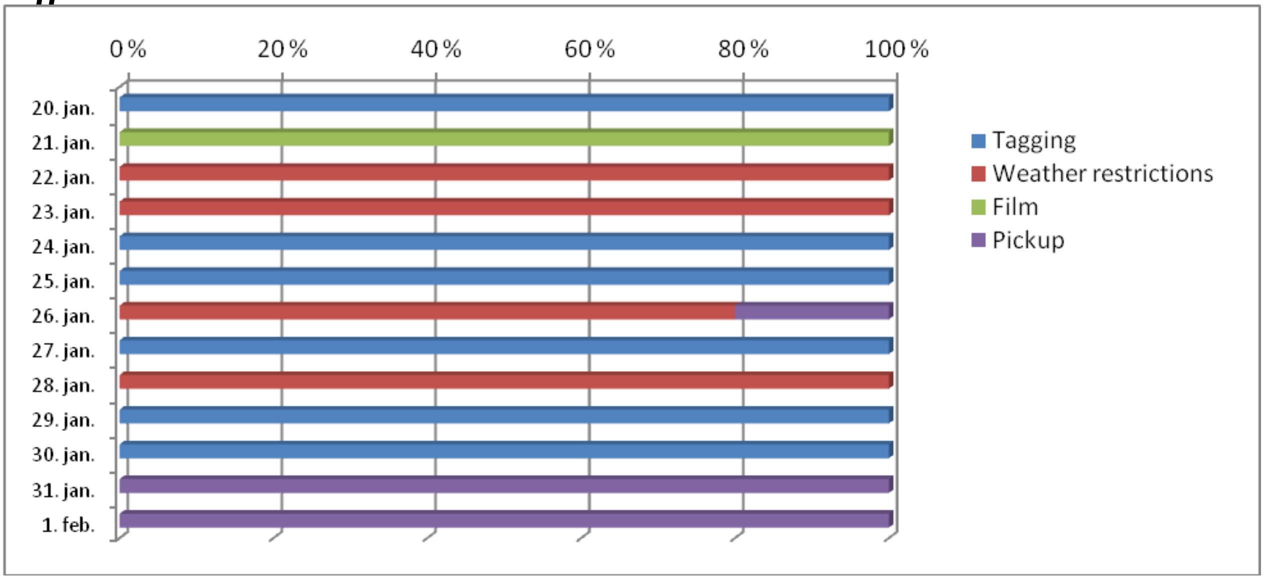
Date	Species	No photos
20.1. Sun	HB, KW	160
24.1. Thu	KW	1127
25.1. Fri	HB, KW	1325
27.1. Sun	HB, KW	2307
29.1. Tue	HB, KW	1570
30.1. Wed	HB, KW	5515
Total number of photos		**12004**

Screening the material we have roughly collected 55 ID pictures of humpback whales and documented at least up to 6 different killer whale pods in the Andfjorden basin during January 2013. Sanna Kuningas will further analyze the killer whale ID pictures for here Ph thesis, while the ID of humpback whales will be handed over to Nils Øien and Kjell Arne Fagerheim at IMR for further studies.

Biopsy samples

A total of 4 biopsy samples were collected of humpback whales during the baseline 3S-1 with Blåstål in the basin of Andfjorden January 2013. The will be handed over to IMR for further genetic analyzes.

Effort table



Project objective

The objective of the trial was to test out and make operational the ARTS system using the DTAGv2 and the Ctag2012, both with barb attachment. Humpback whale was our main target species, non minke whales where observed however numbers of killer whales and on some days also fin whales where accoutered in the research area, as well as 2 pods of pilot whales.

Cruise tasks

Primary tasks:

1. Test new techniques using the whale tag launcher ARTS for the deployment of DTAG2 with barb attachment (DTAGv2B) on minke whales or using humpback whale as a model for minke whales.
2. Test new techniques using the whale tag launcher ARTS for the deployment of Ctag2012 with barb attachment and GPS on minke whale and humpback whale.
3. Test the tagging abilities from the tag boat BlåStål.
4. Test the radio direction finder (DFhorten), and the tracking abilities from the tag boat, BlåStål.

Secondary tasks:

1. Documentary with film and video and underwater footage, whales and nature. A pilot streamer of a research topic: “whales and sonar”.
2. ID picture collection of killer whales in the area Andfjorden.
3. Photo and video documentation of tagging efforts.
4. Biopsy samples of humpback whales.
5. Photo ID of humpback whales.
6. Testing of a Rescue Tag (VHF only) in order to test the tracking ability using this system.

The highest priority was to deploy and test the DTAGv2B, and the second priority was to deploy and test the Ctag2012. A DTAG and a CTAG could be deployed to the same animal, but the DTAG should be the first tag on.

Collaborating organizations

The trial is part of the 3S baseline effort under 3S-2013. It is funded through a joint venture between The Norwegian Defense Research Establishment (FFI), and Sea Mammal Research Unit (SMRU), LKARTS-Norway, and Fenris Film AS. One researcher, Shingo Minamikawa, joined us from the National Research Institute of Far Seas Fisheries, Japan.

Main Logistical Components

The BlåStål is a 27 feet boat, rigged with a setup for tagging and tracking whales, holding a fly bridge and a tagging platform in the front. Basically we returned to base camp every day, however if acquired there is room for sleeping in the front cabin for two persons. Mainly, we will be 4-5 persons during the tagging period and during the tracking periods we will staff according to the situation.
Local contact with fishermen and local photo enthusiasts indicated where to focus our primary effort and visual search for humpback whales, minke whales and killer whales. The BlåStål was outfitted with DFHorten VHF tracking system. Principal effort from BlåStål was ARTS tagging and testing of new tagging equipment (DTAGv2B and Ctag2012, both with barb attachment), documentary effort (photo & video), ID photo collection of humpback whales and killer whales, and VHF-tracking of tagged animals.

ARTS – DTAG system

The ARTS-DTAG system has been extensively tested under controlled conditions and during field testing since 2008. However, no minke whales where tagged during the 3S-2012 cruise, despite substantial effort. We have now modified the sight, and mounted a new manometer. This is in order to improve the performance of the system. We will basically deploy the DTAGV2B at 9-10 bar at medium distances (6-9 meters) and 11-12 bar at longer distances (10-15 meters), while the CTAG2012 will be launched at 9-10bar on distances up to 15 meters. Evaluation of the results and adjustments in the setup will be continuous. The documentation of each launching of the DTAGv2B and the Ctag2012 with the ARTS is a priority issue.

TAGS

The DTAGv2B is not holding DTAG electronics, but only the DTAG housing, with VHF (ATS), TDR (WC; mk9), GTR (A1) and barb attachment. The CTAG2012 is holding VHF (ATS), TDR (Star-Oddi), FastlocGPS (Sirtrack), GTR (A1) and barb attachment. Primarily we tested the ARTS-DTAG system using a setup with VHF and TDR in a DTAG2 housing, with 4 small barb attachments (no DTAG electronics). Two different barb configurations were tested, one produced in Horten of stainless steel, 40mm long with 3 fly (BLK), while another setup developed by Russ Andrews for the LIMPIT tag made of titanium, 65 mm long and with 6 fly (BRA). The test tags had the A1 or the A2 GTR release.

Crew BlåStål-1

Role	Org	16 January – 3 February
Captain / Arts tagger	FFI/LKARTS-N	Lars Kleivane
Documentation / Driver/Diver	Fenris Film AS	Per Børre Kiserud**
Cruise leader/MMO /Arts tagger	FFI	Petter H. Kvadsheim*
MMO /Photo ID	SMRU	Sanna Kuningas
MMO /Tracker	NRIFSF	Shingo Minamikawa
Documentation Film & video/diver	Fenris Film AS	Anders Lycke**
Driver volunteer	Dverberg	Kenneth Pettersen

***   Embarked on the 21 of January and disembark on the 28 of January***
*** * Embarked on the 14 of January and disembark on the 28 of January**

Petter is trial leader when present; Lars is trial leader when Petter is not present.

Sailing line BlåStål-1 January 2013

<u>January 2013</u>

16-18. Lars and Shingo at Ure, Lofoten. Start installation of equipment and preparation of the tag and tracker boat, BlåStål.

19. Transit to Andøya. Sleep over at Sortland.

20. Arrival at Dverberg and Bascamp at 0900. Start installation of equipment in base camp at Kvalnesbrygga. Test of equipment and start survey with focus on primary tasks. Good conditions with a small wind from SW and calm waters in our research area. Encounter multiple killer whale pods, and also a group of 5-6 fin whales. Two launchings at humpback whales with a setup using the ARTS and DTAGv2BLK without any attachments. A total of 5 hours at water.

21. More wind today with frisk bris from NW, and we focus on secondary tasks, taking pictures of killer whales and humpback whales, as well as underwater filming. Petter and Sanna arrives on the evening. The film team with Per Børre and Anders have been at our base camp since the 14 of January. A total of 5 hours at water.

22. Base camp day. The forecast is bad for us with kuling from NW. Close to basecamp we

have a wind-mill that is very useful during the grey-blue morning hours and the assessment of local wind directions. We have the time to plan and look over equipment. During the day we have killer whales and humpback whales close up to Kvalnesbrygga, feeding on herring.

23. Early morning wake, the forecast is not very good, but our analyse from yesterday is that we could possibly work close up to Kvalnesbrygga. Blåstål is in the harbor of Dverberg, about 4 nm south from our campsite at Kvalnesbrygga. We leave harbor in the dark and cruise slowly north towards Kvalnesodden. However, after 2 hours in rough conditions we decide to return to harbor. The wind had picked up further and also turned East of North, so there were no more sheltered waters outside Kvalnesbrygga as yesterday.

24. Semi-good conditions with up to laber bris from N. We are working just East from Dverberg, north of Myrflesa with a single humpback whale. There are few observations this day, and we hope that the behavior of our target will change or lead us into other humpback whales, but neither happens. The filmteam is out with a rib from SeaSafari at Andenes, and is passing us in late day. They had killer whale encounter between us and Andenes, but few humpback whales sighted. We return to Dverberg in dusk light after 5 hours at sea.

25. Workable conditions today, but still some wind from N-NE, up to laber bris. We had a car scouting team out both north and south, without any positive reports. During the dusk hour it is difficult to scan properly with binoculars, and we would not wait too long before going at sea. It is trade with time! However, we encounter humpback whales between Dverberg and Myrflesa. First a group of 3 humpbacks, where one individual has just left the half of the tail on the left side. It looked well nourished and kept up with the other whales. We do not able to close on these whales, and change to a single whale closer to Myrflesa. The whale is taking us south and in to multiple whales, and in mix with killer whales. We observe again the group with the half tail, but we approach another group with 4 whales. First one launching with no attachment. The second launching is Tag On Whale (TOW). We decide to switch to CTAG2012, and then try to double tag the whale. During this operation the ARTS in the gunner platform is damage and brook. The weather was semi-good and boarder line with laber bris from north. We have to change the ARTS before reproaching the animals. One attempt was a water hit in front of the animal, using the new ARTS and CTAG2012. We then return to Dverberg in dim light. The Film team is also today out with Sea Safari from Andenes.

26. No favorable weather conditions with snow and let til laber bris from East. We are optimistic and leave harbor in the morning, however it is soon clear that this will not be efficient with very limiting sight. We decide to return to harbor and mount the antennas for the DFHorten using small handheld antennas in a specially designed rig. When mounted we hear the signals from the tag while in harbor. We then head out and just north of Myrflesa close to the rockeries we pickup the tag, a distance of 2.5nm from the harbor. The tag looks okay and all GTR had released. The Film team is not out today.

27. Still not optimal conditions. We have a car scouting trip south towards Risøyrenna with Petter, Sanna and Shingo. Per Børre is coming with us today for filming, while Anders is returning to Oslo. We are crossing south and encounter killer whales in good light conditions, but no humpback whales. After some time with the killer whales for ID picturing, we have a report of humpback whales more west and south of Myrflesa and head this way. Once we find the whales we have a launching with the ARTS and CTAG2012, where the tag is damage on the impact on the whale. There is a biopsy sample on the CTAG2012 barb. The event is good photo documented. We have then a

launching using the ARTS with a DTAGv2B, hitting water. We return to Dverberg at about 1500 in dusk light. Tiu Simila is coming on visit during the evening.

28. Too rough weather for sea operation with frisk bris from East. Petter is heading back to Oslo in the morning. We have a basecamp day. Per Børre is also returning today to Oslo in the afternoon.

29 Better conditions today, with small winds from north, and we head for Myrflesa where we encounter 2 humpback whales. We have a volunteer, Kenneth Pettersen, with us today driving the boat. We follow these whales north without been able to close on them for tagging. However, finally we have a setting and one DTAGv2B with Horten Barbs is deployed on a humpback whale. We start to track this whale north and encounter also other humpback whales and killer whales. We take a biopsy sample of the companion of the tagged whale. This whale is a black tail. The light is sub-optimal for ID picturing but we are closing up on different killer whale pods, and multiple pictures are saved. The Whale Safari boat is out with tourists, and we encounter them just when we are leaving the area, returning to Dverberg. We had visit of NGO from Andenes the evening. People from Spain and Argentina, that are observing whales from the lighthouse, with a plan of looking at impact on whales from whale tourism. At about 2200 Kenneth and Lars makes a car search for the tagged whale. We have some faint signals from Fiskeneset, but at Andenes we are not able to enter the lighthouse, and we have no reception of signals from the harbor.

30. Similar conditions as today. Kenneth offers to drive to Andenes, and Sanna and Shingo will try to localize the tag we attached yesterday. Lars is waiting for fuel from a lorry. At 11 they have contact with the tag then floating at about 22 degrees real heading from the lighthouse. We are planning a rescue operation. However, we have still one setup to test using the ARTS and a DTAGv2B with Russ Andrews barbs. Blåstål is heading out early afternoon, and Kenneth is driving. Shingo and Sanna are taking pictures as usual and Lars is preparing the tag. We find multiple whales close to Myrflesa, and one tag is attached on a humpback whale, but it looks like only 2 barbs are attached, while 2 other barbs are implant close to the tag. We take a biopsy of the tagged whale. And also a biopsy of another animal in the area. Dusk light is falling and we loss a biopsy dart with a sample, and decide to return to Dverberg. We can hear the tag from the marina, and also from base camp when we return to Kvalnesodden. Sanna is returning to St Andrews in the evening.

Lars is going out at 2330, and starts to track the whale. It has a special behavior with long time logging at the surface. The tracking path is going south towards Grytvær, and at 0500 Lars takes into Grytvær and sleeps for 3 hours.

31. The sky is overclouded and the wind is from NW en let til laber bris. Out in the area at 0900, about 4 hours since the last signals where received, there was no more contact with the tag. Blåstål calls up the coatsgard KV Barentshav, and they are willing to assist the search later in the day. Blåstål and Lars returns to Dverberg and campus at Kvalnesbrygga. We have again a scouting signal trip north to Fiskenesodden, but this time with no detection of signals. Blåstål is heading out to the coastgard at about 1400, and Shingo and Lars is picked up by the MOB of the KV Barentshav. We make a short brief on the bridge and starts to search southward to the last tag deployed. Signals are picked up East to the position where we had the last reception this morning. The MOB of KV Barentshave is launched with 3 sailors, Shingo and Lars, and we start to close into the signals, and have a pickup in sheltered waters between rockeries just West of Krøttøya in position 69091N-16302E, about 5nm from our last received signal position, 8 hours earlier, and about 4nm from where we received signals at the upper bridge at KV Barentshav.

The coastgard vessel then brings us north to Andenes for a search for the tag deployed on the 29 of January at 1205. It was then about 55 houres since the tag was deployed and 21 hours since we had contact with the tag from the Lighthouse at Andenes. At the upper bridge we start to hear the tag at a distance of about 8-9nm from Andenes about in 22 degrees from the lighthouse. But the signals are confusing, and best reseption is when pointing the Yagi into the boat towards some other instruments. There are no signals when then trying to search on the wings or forward from the upper deck or one deck down. We have now been 8 hours in a search modus with KV Barnetshav, they will have other duties, and we return to Andenes and harbor at about 2200. Kenneth is picking us up in the marina. We have a meeting at the basecamp of SeaSafari at Andenes, with one of the drivers, Marten Bril. He is free to go for a search tomorrow and we make arrangements with him in early afternoon.

February 2013

1. Unfortunately there are more bookings at Sea Safari, and we will not be able to use their rib for a search of the lost tag. We decide to go with Blåstål from Dverberg, and arrive in the area about 5nm north of Andenes at 1300. We have a long pool rigged with a Yagi antenna, but no signals detected. The swell and the wind is not favorable so we decide to abandon the search, and return to Andenes for fuel. At about 1800 we start on our return towards Lofoten and Svolvær. We make a break in Sortland at 2100 and sleep on land at Sortland Hotel.
2. We are heading south at about 0830, overclouded but just a flaug wind from north, and good transit conditions. A break in Trollfjorden, with breakfast and some ARTS launchings using the biopsy system ARTS-LKDart.
   Arrival in Svolvær is at 1400, now rigging down antennas and preparing the equipment for transportation.
3. Blåstål is left at Kabelvåg Mekaniske verft, for check of different details. Shingo and Lars returns to Horten.

Cruise achievements

Primary tasks:

1. In total during 7 launchings using the ARTS-ARTSCarrier on humpback whales, 3 DTAGv2 tags where attached on target, 3 DTAGv2 hit the animal without attachment whereof two with barb break, while one was a water hit. Two barb configuration where tested, one type of stainless steel with 3 fly and 40mm long (BLK), and one type of titanium with 6 fly and 65mm long (BRA). Only one launching was made with the BRA configuration, two of the barbs detached from the DTAG housing upon impact forces, however the tag was attached more than 15 hours on the animal.
2. The Ctag holding a GPS logger was launched only two times, and no good value was found for these tests. First launching on the 26 of January was a water hit. While on the 27 of January the launching led to a break of the tag upon hit. The gunner Lars Kleivane clearly analyze this event as a misfire where too much air had entered the pressure chamber. Upon loading the chamber the pressure valve have either not been in the right position or have been stroked during the chase of the target, resulting in elevated pressure. Both the GPS logger and the TDR logger was lost, as well as the ARTSCarrier holder
3. The boat Blåstål was operating well during the tagging approches, and the platform in front was stable and well suited for tagging. However, performance will further increase making it easier for the driver when the instruments on the fly bridge are tuned right and Blåstål can be operated from the top.
4. The functionality of radio direction finder (DFhorten), and the tracking abilities from BlåStål was excellent, using handheld Yagi antennas.

Secondary tasks:

1. We had multiple discussions of different research topics suitable for public interest, however no further plans were foreseen. Underwater footage of killer whales and humpback whales will result in TV petitions.
2. ID picture collection of killer whales resulted in a total of >10000 pictures, and Sanna Kuningas primarily screening give ID pictures from at least 6 different killer whale pods from the Andfjorden basin from this cruise in January 2013.
3. We have well documented both with film and photo the different tagging events, so that it is possible to analyze details from different settings.
4. We collected 4 biopsy samples of humpback whales.
5. A total of about 55 ID pictures of humpback whales were collected during the cruise, also from local photographers.
6. There were no options to test any rescue tag during this cruise.

Appendix A Details of tagging events

Deployment: 1Mn1_DTAGv2BLK
Sensors: VHF and TDR (mk9)
Barb: Stainless steel barbs (BLK): 40mm/4fly x4

Date: 20-Jan-2013
Position: 69º 05.01N - 16º 04.70E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Sea state 2
Launching time: 14:53
Pickup time: same
Biopsy: no
VHF frequency: 148.5419 Mhz – 60rmp
System: ARTS
Operator: Lars Kleivane
Range: 12m
Power: 10bar
Photo: Shingo Minamikawa
Film: Per Børre Kiserud & Lars Kleivane
Plattform: Blåstål - front
Driver: Anders Lycke
Tagging team members: Lars Kleivane, Shingo Minamikawa, Per Børre Kiserud og Anders Lycke
Comments: Tag detached, one HH-holder break and 2 barb attached

Deployment: 2Mn2_DTAGv2BLK
Sensors: VHF and TDR (mk9)
Barb: Stainless steel barbs (BLK): 40mm/4fly x4

Date: 20-Jan-2013
Position: 69º 04.90N - 16º 03.61E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Sea state 2
Launching time: 15:58
Pickup time: same
Biopsy: no
VHF frequency: 148.5419 Mhz – 60rmp
System: ARTS
Operator: Lars Kleivane
Range: 14m
Power: 9 bar
Photo: no
Film: no
Platform: Blåstål - front
Driver: Anders Lycke
Tagging team members: Lars Kleivane, Shingo Minamikawa, Per Børre Kiserud og Anders Lycke
Comments: Miss, hit water in front of the animal

Deployment: 3Mn3_DTAGv2BLK
Sensors: VHF and TDR (mk9)
Barb: Stainless steel barbs (BLK): 40mm/4fly x4

Date: 25-Jan-2013
Position: 69º 03.00N - 16º 05.74E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Sea state 3
Launching time: 11:15
Pickup time: same
Biopsy: no
VHF frequency: 148.5419 Mhz – 60rmp
System: ARTS
Operator: Lars Kleivane
Range: 15m
Power: 9 bar
Photo: Shingo Minamikawa & Sanna Kuningas
Film: Lars kleivane
Platform: Blåstål - front
Driver: Petter Kvadsheim
Tagging team members: Petter Kvadsheim, Lars Kleivane, Shingo Minamikawa and Sanna Kuningas
Comments: Tag detached, 1 barb attached. Might have been a water effect just upon impact.

Deployment: 4Mn4_DTAGv2BLK
Sensors: VHF and TDR (mk9)
Barb: Stainless steel barbs (BLK): 40mm/4fly x4

Date: 25-Jan-2013
Position: 69º 01.42N - 16º 05.94E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Sea state 3
Launching time: 13:24
Pickup time: After 22h in position: 69º 05.67N - 16º 04.71E
Biopsy: no
VHF frequency: 148.5419 Mhz – 60rmp
System: ARTS
Operator: Lars Kleivane
Range: 16m
Power: 9,5 bar
Photo: Shingo Minamikawa
Film: Lars Kleivane
Platform: Blåstål - front
Driver: Petter Kvadsheim
Tagging team members: Petter Kvadsheim, Lars Kleivane, Shingo Minamikawa and Sanna Kuningas
Comments: Low placement, but impact looked good. However, only 3,5h on the animal. The tag looked normal upon pickup with all GTR released 22 hours after attachment. The tagged whale was accompanied of 3 other whales, and we can neither conclude if the detachment was due to the barbs or due to social/animal stroke. During the tracking face we heard 1-2 bips from the VHF beacon associated with arching dives.

Deployment: 5Mn1_CTAG/GPS
Sensors: VHF and TDR (mk9)
Barb: one stainless steel barb (75mm/2fly)

Date: 25-Jan-2013
Position: 69º 04.90N - 16º 03.61E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Sea state 3
Launching time: 14:43
Pickup time: same
Biopsy: no
VHF frequency: 148.652 Mhz – 240rmp
System: ARTS
Operator: Lars Kleivane
Range: 15m
Power: 9,5 bar
Photo: Shingo Minamikawa and Sanna Kuningas
Film: Lars Kleivane
Platform: Blåstål - front
Driver: Petter Kvadsheim
Tagging team members: Petter Kvadsheim, Lars Kleivane, Shingo Minamikawa and Sanna Kuningas
Comments: Miss, hit water in front of the animal.

Deployment: 6Mn2_CTAG/GPS
Sensors: VHF and TDR (mk9)
Barb: one stainless steel barb (75mm/2fly)

Date: 27-Jan-2013
Position: 69º 04.90N - 16º 03.61E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Calm sea state 2
Launching time: 15:58
Pickup time: same
Biopsy: Yes – 0135 Position: 69º 04.90N - 16º 03.61E
VHF frequency: 148.652 Mhz – 240rmp
System: ARTS
Operator: Lars Kleivane
Range: 16m
Power: 9,5 bar
Photo: Shingo Minamikawa and Sanna Kuningas
Film: Lars Kleivane
Platform: Blåstål - front
Driver: Petter Kvadsheim
Tagging team members: Petter Kvadsheim, Lars Kleivane, Shingo Minamikawa and Sanna Kuningas
Comments: The tag cracked upon hit, and the launching felt much too hard. The pressure was set to 9,5 bar, however the pressure-valve have probably just been in a small open gate position, and in this added more pressure to the pressure chamber.

Deployment: 7Mn5_DTAGv2BLK
Sensors: VHF and TDR (mk9)
Barb: Stainless steel barbs (BLK): 40mm/4fly x4

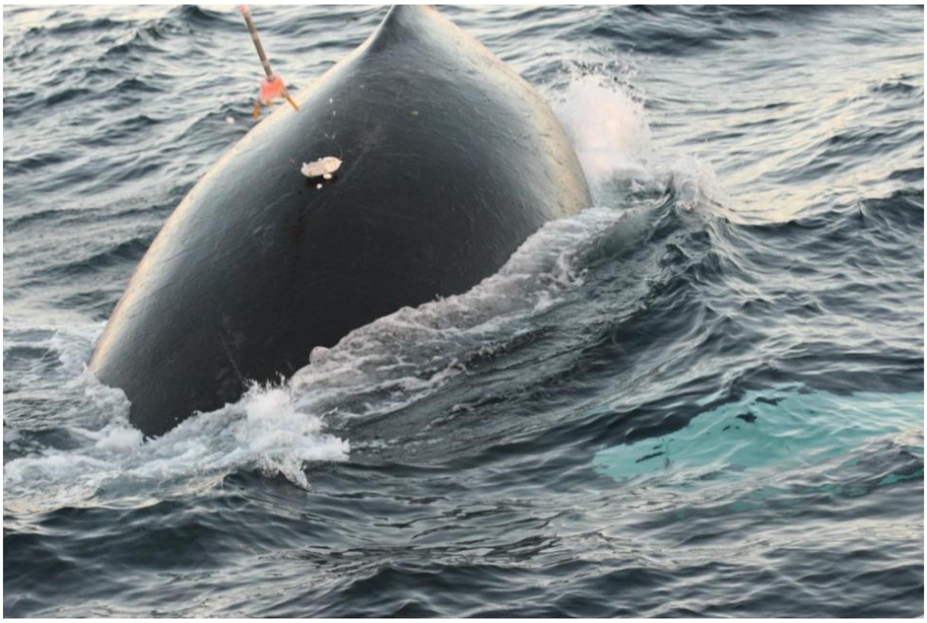
Date: 27-Jan-2013
Position: 69º 03.73N - 15º 59.09E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Sea state 3
Launching time: 13:55
Pickup time: same
Biopsy: no
VHF frequency: 148.5419 Mhz – 60rmp
System: ARTS
Operator: Lars Kleivane
Range: 12m
Power: 9 bar
Photo: Shingo Minamikawa
Film: Lars Kleivane
Platform: Blåstål - front
Driver: Petter Kvadsheim
Tagging team members: Petter Kvadsheim, Lars Kleivane, Shingo Minamikawa and Sanna Kuningas
Comments: The tag touch the whale however only with the "giraffe feet". The target was coming towards Blåstål and the launching was some late and not enough ahead of the whale.

Deployment: 8Mn6_DTAGv2BLK
Sensors: VHF and TDR (mk9)
Barb: Stainless steel barbs (BLK): 40mm/4fly x4

Date: 29-Jan-2013
Position: 69º 12.24N - 16º 11.02E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Sea state 3&4 mist
Launching time: 12:07
Pickup time: Tag missing
Biopsy: no
VHF frequency: 148.5419 Mhz – 60rmp
System: ARTS
Operator: Lars Kleivane
Range: 15m
Power: 9 bar
Photo: Shingo Minamikawa and Sanna Kuningas
Film: Lars Kleivane
Platform: Blåstål - front
Driver: Kenneth Pettersen
Tagging team members: Lars Kleivane, Shingo Minamikawa, Sanna Kuningas and Kenneth Pettersen.
Comments: The deployment was ok and high on the left side of the animal, and felt good upon hit. We tracked the tagged whale for roughly 3,5 hours taking ID pictures of killer whales in the area, and also a biopsy of the tagged animal. We had 3-4 bips from the radio beacon during each surfacing. We leave the animal in pos. 69º 17.82N - 16º 21.74E at 15:30. The Tagged whale and it companion have been heading due East for 2 hours and are still heading East. The night at 2230 we have weak signals from Fiskeneset, and the following day we have signals from the lighthouse at Andenes (Hight:40m) in a 22 degree line heading from the lighthouse. Operator Sanna Kuningas had 10 minutes track and describe this as tag off. The following day from the coast gard ship KV Barentshav, Lars Kleivane have contact with the tag about 10 nm N-NE of ANdenes at 20:00 hour, however with strange interference not on the signal but of directionality from the ships instruments. A theory is that the tag is much further way and that the signals have been picked up on antennas on the ship. We have to abandon the search and enter Andenes harbor at 22:00. Tag missing

Deployment: 9Mn1_DTAGv2BRA
Sensors: VHF and TDR (mk9)
Barb: medium titanium RAbarbs (65mm/6fly) x4

Date: 30-Jan-2013
Position: 69º 04.90N - 16º 03.61E
Species: Humpback whale (*Megaptera Novaeangliae*)
Weather: Sea state 2&3 partly overcasted
Launching time: 13:35
Pickup time: After 27 hours from MOB of KV Barentshav in pos 69º 03.17N - 16º 25.32E
Biopsy: Yes - 0335
VHF frequency: 148.324 Mhz - 240 rmp
System: ARTS
Operator: Lars Kleivane
Range: 13m
Power: 9 bar
Photo: Shingo Minamikawa and Sanna Kuningas
Film: Lars Kleivane
Platform: Blåstål - front
Driver: Kenneth Pettersen
Tagging team members: Lars Kleivane, Shingo Minamikawa, Sanna Kuningas and Kenneth Pettersen.
Comments: The animal was heading Blåstål, and upon hit 2 of the barbs detached from the DTAG housing, while 2 barbs was attached with the tag. We leave the tag at about 16:00 and take some ID picture of killer whales returning to Dverberg marina. We can hear the tag from the harbor, and also later upon return to basecamp at Kvalnesodden. Blåstål is going out again at 23:00 houre and start to search for the tag. The tag is still on the animal and has mouved south to the rockeries outside Grytavær. We track the wahle until 05:00 houre and take 4 hours break at Grytavær marina. However upon searching again from 09:00 there are no signals from the tag. The coast gard ship KV Barentshav is in the area and offers assistance upon request. Shingo and Lars enters the vessel from Blåstål at 14:00, and Blåstål is braught back to harbor by Kenneth Pettersen.



Appendix B - Logistics

Operation area

Our operation area was in the Andfjorden

Management and chain of command

Operational issues

Operational decisions and priorities was made by the cruise leader according to the situation from day to day.

Safety issues

The captain makes final decisions on safety issues.

Permit issues

The permit holder is Petter Kvadsheim. He makes final decisions on permit issues. However, Lars Kleivane have responsibility for permit compliance during tagging (when Petter is not present)

Responsibilities:

LKARTS-Norway

Personel: Captain, Trial leadership, part time driver and tagger

Equipment: Research vessels (BlåStål), two whale tag launcher ARTS, Rescue Tag, photo camera and digital video cameras, 1 Laser-Range Finders, angle board, acoustic recorder Sonabouy setup, biopsy equipment; 2 LKDarts, one double barreled biopsy gun (K-gun) using FL biopsy darts.

FFI

Personnel: Trial leadership, permits, VHF-tracking, marine mammal observers, documentation (photo&video), local knowledge, tag-boat driver, ARTS tagging.

Equipment: gas for boat, 1 tracking system with antenna, radio direction finder (DFhorten), DTAGv2B, CTAG2012, DTAG-ARTS carrier and robots, VHF-communication equipment, hand-held GPS, PC with Logger software.

SMRU

Personnel: MMO/photo id and documentation

Equipment: 2 units Sirtrack Fastlock GPS, camera

Fenris Fim AS

Personnel: Film and video documentation, boat driver and diver

Equipment: Professional film camera, also for underwater footage. Digital video cameras, Diving equipment, car.

Contact information

Name	e-mail:	cell phone	Next kind	cell phone
Lars Kleivane	lkl@ffi.no	+47 98009066	Tora Haabet	97020641
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Per Børre Kiserud	per-bk@online.no			
Sanna Kuningas	sk297@st-andrews.ac.uk			
Shingo Minamikawa	sminami@affrc.go.jp			
Anders Lycke	anders.lyche@tv2.no			
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Local contacts:				
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Appendix E Cruise report 3S-13 Baseline II – minke whale effort

Cruise report

3S-2013 Baseline II - Minke whale effort

Lise Doksæter Sivle[1], Petter H. Kvadsheim[2], Lars Kleivane[2], Marije Siemensma[3] and Paul Wensveen[4]

[1] Institute of Marine Research (IMR), Norway, [2] Norwegian Defence Research Establishment (FFI), Norway, [3] Netherlands Organisation for Applied Scientific Research (TNO), The Netherlands, [4] Sea Mammal Research Unit (SMRU), University of St.Andrews, Scotland.

The 3S-2013 baseline II trial is conducted as part of the $3S^2$-project and is split into two separate but coordinated efforts; a minke whale team and a pilot whale team.

1

Cruise report

3S-2013 Baseline II - Minke whale effort

Lise Doksæter Sivle[1], Petter H. Kvadsheim[2], Lars Kleivane[2], Marije Siemensma[3] and Paul Wensveen[4]

[1] Institute of Marine Research (IMR), Norway, [2] Norwegian Defence Research Establishment (FFI), Norway, [3] Netherlands Organisation for Applied Scientific Research (TNO), The Netherlands, [4] Sea Mammal Research Unit (SMRU), University of St.Andrews, Scotland.

The 3S-2013 baseline II trial is conducted as part of the 3S²-project and is split into two separate but coordinated efforts; a minke whale team and a pilot whale team.

English summary

Marine mammals are sensitive to sound in their environment and there is a continuing need to quantify the sensitivity of the animals to behavioural disturbance, in order to regulate the use of powerful anthropogenic sound sources and recommend procedures to mitigate impacts. The $3S^2$-project will produce quantitative information on how cetaceans react to sonar. However, in order to assess if any behavioral change is a response to sonar and the biological relevance of responses, we have to collect baseline behavioral data and conduct control experiments, in addition to conducting controlled sonar exposures. This report summarizes the achievements, activities and data collection of an international research trial ($3S^2$-2013-Baseline) conducted in Vestfjorden, Norway. The overall objectives of the trial were to collect baseline behavioural data of minke whales as well as exposing them to playback of killer whale sounds, humpback whale sounds and sonar signals. Additionally, the trial should be used to test the invasive D-tag on minke whales and evaluate Vestfjorden as a potential site for the full scale sonar exposure trial later in summer of 2013.

In contrast to earlier years where minke whales had been highly abundant in Vestfjorden this time of year, very few whales were observed during the trial. This trend was confirmed by local whalers reporting an unusual low number of catches and observations. Despite good weather conditions, we were therefore not successful in placing any tags on minke whales, resulting in no collected data on baseline behavior. As for evaluation of the field site for further work with minke whales later in the summer, Vestfjorden should be considered as an area not worth spending much effort in.

Norsk sammendrag (Norwegian summary)

Sjøpattedyr er følsomme for lyd i deres miljø, og for å kunne regulere bruken av intense akustiske kilder er det et behov for å kvantifisere hvordan menneskeskapt lyd påvirker deres atferd og hvilken biologisk relevans en slik påvirkning har. $3S^2$-prosjektet har som målsetning å generere kvantitativ informasjon om hvordan hval reagerer på militære sonarpulser. Får å kunne identifisere en endring i atferd som en respons og å forstå den biologiske betydningen til slike atferdsendringer må vi forstå dyrenes normalatferd og gjennomføre kontrollforsøk, i tillegg til forsøk med kontrollerte sonareksponeringer. Denne rapporten oppsummerer aktivitetene, data innsamlingen og utfallet fra et internasjonalt forskningstokt som ble gjennomført som en del av dette prosjektet. Hovedmålsetningen med $3S^2$-2013-baseline toktet har vært å samle inn data for naturlig adferd hos vågehval, samt å eksponere dem for tilbakespilling av vokalisering fra spekkhogger og vågehval, samt sonar. I tillegg ønsket en å undersøke hvorvidt Vestfjorden egnet seg som for å arbeide med vågehval, og å teste ut ”barb D-tag”.

I motsetning til tidligere år hvor vågehval har vært svært tallrike i Vestfjorden, ble det under dette toktet gjort svært få observasjoner. Denne trenden ble bekreftet av lokale hvalfangere, som også rapporterte usedvanlig lave fangstall og få observasjoner. Til tross for godt vær i nesten hele toktperioden, var vi derfor ikke i stand til å få merket noen dyr, noe som resulterte i at ingen data ble innsamlet på naturlig adferd. Som resultat av dette ble Vestfjorden vurdert som lite egnet for videre arbeid med vågehval senere i sesongen, og ikke verd å bruke mye ressurser på å lete etter hval her med mindre situasjonen endrer seg.

Preface

The $3S^2$-2013-baseline trial was conducted as part of the $3S^2$-project by the $3S^2$-group. We are an international research consortium with the aim to investigate behavioral responses of cetaceans to naval sonar signals, in order to establish safety limits for sonar operations. During three main field trials, sonar exposure experiments are conducted where target whales (minke whales, humpback whales and bottlenose whales) are tagged and their behavior observed before during and after exposure to naval sonar signals and control sounds. To obtain more baseline data on minke whales, this trial was conducted to collect more data at a lower cost compared to the full-scale trial with a large offshore going vesssel.

This report summarizes the outcome of this baseline trial, wich was conducted by a team of totally 7 scientists from Norway and The Netherlands. The field work was conducted from the vessel "Blåstål" with the team living in a land based station in Ure in Lofoten, Northern Norway.

Group photos: Left - Crew part 1: Petter Kvadsheim (FFI), Lise Doksæter Sivle (IMR), Marije Siemensma (TNO), Frans-Peter Lam (TNO), Lars Kleivane (FFI). Right - Crew part 2: Lars Kleivane (FFI), Jasper van Vliet (independent), Dan Bogorff (WHOI), Marije Siemensma (TNO), Paul Wensveen (SMRU/TNO), Eirik Grønningsæter (FFI)

The main partners of the $3S^2$-project conducting the $3S^2$-2013 baseline trial are:

- The Norwegian Defense Research Establishment (FFI)
- The Netherlands Organization for Applied Scientific Research (TNO)
- Sea Mammal Research Unit (SMRU), Scotland
- Woods Hole Oceanographic Institution (WHOI), USA

In addition the following organizations are contributing to the project through their association with one or several of the 3S-partners:

- Institute of Marine Research (IMR), Norway
- LK-ARTS, Norway
- Kelp Marine Research (KelpMR), The Netherlands
- Marine Science & Communication, The Netherlands

The 3S2 research project is funded by;
- The Norwegian Ministry of Defense
- The Netherlands Ministry of Defense
- Office of Naval Research, USA
- DGA, French Ministry of Defense

1 Introduction – cruise objectives and tasks

Marine mammals are sensitive to sound in their environment. There is a continuing need to quantify the sensitivity of these animals to behavioural disturbance, and determine how potential behavioural changes may affect biologically significant activities, in order to regulate the use of powerful anthropogenic sound sources and design procedures to mitigate impact. The $3S^2$ project aim at producing quantitative information on how cetaceans react to sonar and relevant control sounds. However, to enable evaluation of a potential behavioural change in response to sonar, good baseline data on normal behavior and exposure to control sounds are highly necessary. This trial has therefore been conducted to collect such baseline data.
The baseline data on natural behavior together with data on behavior during exposure to sonar and control sounds will provide a good basis for quantify the risk of sonar exposure to minke whales. This will be used to establish safe operating procedures for the navy.

This report summarizes the achievements, activities and data collection of a small scale trial on minke whales to collect data on baseline behavior to support the exposure data from the full scale sonar exposure trials. The cruise was conducted in Vestfjorden, Northern Norway in May – June 2013.

1.1 Cruise objective

Collect baseline data on minke whales as well conducting playbacks of killer whale, humpback whale and naval sonar sounds.

1.2 Cruise tasks

The objective of the trial will be met through the execution of the following specific primary and secondary tasks:

Primary task

1. Tag minke whales with Dtag or Ctag and record baseline information of horizontal and vertical movement and surface behavior, and thereafter carry out playback of sounds from mammal eating killer whales and humpback whales.

Secondary tasks

1. Evaluate, test and assess different tags and tagging techniques for minke whales in support of the sonar exposure trial in June-July.
2. Assess Vestfjorden as a suitable/non-suitable operation area for working with minke whales during the sonar trial in June-July.
3. Conduct playback of sonar signals.
4. Collect biopsy samples of the tagged animals.
5. Support pilot whale team with sighting information and during killer whale playbacks.

2 Method –equipment and experimental procedure

2.1 Operation area and equipment

We were operating from our campsite at Ure in Vestfjord between Skrova and Reine, with the primary operation area within one hour (10 nmi) from Ure. To try to target the animals further east in Vestfjorden, the team moved to Risvær. The accommodation here was an old fish factory, providing easy access to the Northern part of Vestfjorden.

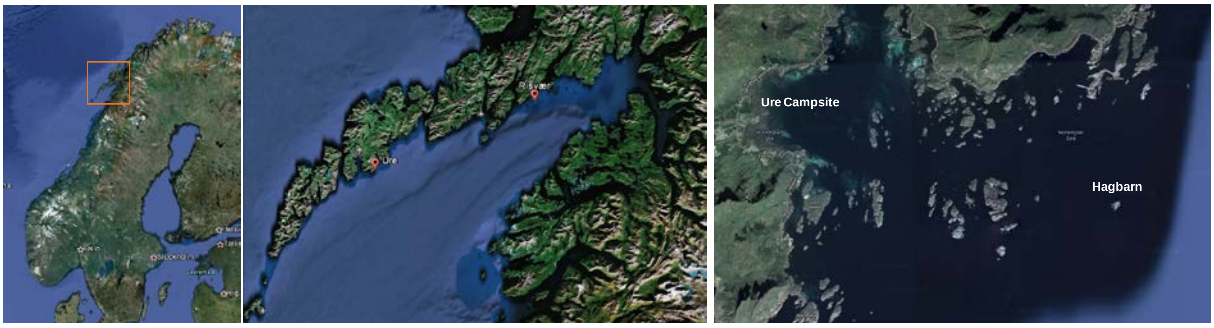


Figure 2.1.1 Operation area. *Left: the larger perspective, Vestfjorden marked by square.Middle: More detailed map of Vestfjorden, showing the locations of Ure and Risvær. Rigth: Zoomed in on the campsite in Ure, also showing the small island Hagbarn from which we often started our search for minke whales.*

Detailed description of ship, tagging equipment, tags, and playback source can be found in the cruise plan (Appendix C).

2.2 Experimental procedure

The operation was planned to cycle through different phases; a search phase, a tagging phase, a pre-exposure phase, an exposure phase, a post-exposure phase, and then after a data checking and resting phase we return to search phase. The default timing of the different experimental phases varies from species to species and is summarized in Figure 2.2.1. The details of our experimental procedures are given in the cruise plan (Appendix C), but are summarized below.

Daily work plan

The daily working schedule depended on the current and expected weather situation. Sea state 0-1 were considered good working conditions, whereas sea state 2 boarderline conditions. Above sea state 3, we did not go out.
On a regular day, we started by having breakfast at Ure Rorbucamp at 07:00 and attempted to depart at 08:00.

Working procedure
During searching and tagging visual observations are done by a minimum of two MMOs. When an animal is sighted, it is tracked, and all information is put into Logger.

The duration of the phases after a tag is on is shown below.

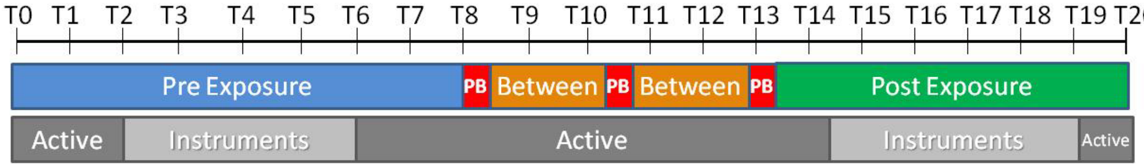


Figure 2.2.1. *The default timing of the different operational phases.*

The plan was to divide between active and instrument based tracking during the period the animal was tagged, to allow some rest of the crew (Figure 2.2). Details of active and instrument tracking protocols are given in Appendix C.

During tracking, we aimed at staying 100-200 m from the animal.

Tagged animals were planned to be exposed to three different playback stimuli:
1) KW stimulus: Natural vocalizations of unfamiliar transient mammal-feeding killer whales, previously recorded in British Columbia using DTAG in a behavioral context of foraging on marine mammals. The playback of these sounds will simulate the presence of a potential predator.
2) Control stimulus: Humpback whale songs (biological sounds that does not represent a threat) previously recorded in Australia using DTAG.
3) Sonar playback: A 15 min playback of the same sonar signal that is used during the full scale sonar trial; LFAS-shallow, 1.3-2.0 kHz, with 1 sec pulses and 20 sec interpulse intervals.

The playback should be done from Blåstål, positioning itself 800 m in front of the animal based on the likely movements of the whale.

3 Results –overview of operation and achievements

3.1 Achievements

During the a total cruise period of 23 days (18.May – 09.June) we had 18 days of operation, with the remaining 4 days being arrival and installation (2), crew change and training (1), bad weather (1) and de-installation and departure (1). We had total effort of 165.5 hours at sea, and only one day where weather was a limiting factor to go out. The daily effort is summarized in table 3.1.1. Details of daily effort and achievements are given in Appendix A.

Table 3.1.1 *Day-by-day effort summarized.*

Date	Total effort (hh:mm)	Searching effort (hh:mm)	Tracking effort (hh:mm)	Sigthings	Tagging attempts
20.05.2013	03:00	03:00	00:00	0	0
21.05.2013	07:30	07:30	00:00	0	0
22.05.2013	08:00	08:00	00:00	0	0
23.05.2013	09:30	09:30	00:40	1 humpback whale	0
24.05.2013	07:00	07:00	00:00	1 porpose, 2 minke whales (by Tango)	0
25.05.2013	11:00	11:00	00:00	1 minke whale (by Tango)	0
26.05.2013	09:00	09:00	00:00	1 minke whale	0
27.05.2013	11:00	09:33	01:27	2 minke whales (1 by Tango)	0
28.05.2013	12:00	12:00	00:00	2 porpoises	0
29.05.2013	10:00	07:16	02:44	2 minke whales	3
30.05.2013	03:30	03:30	00:00	group of killer whales	0
31.05.2013	14:30	13:32	00:58	4 minke whales	1
01.06.2013	10:00	10:00	00:00	0	0
02.06.2013	00:00	00:00	00:00	0	0
03.06.2013	05:30 (transit)	00:00	00:00	0	0
04.06.2013	16:30	16:30	00:00	1 minke whale, 2 porpoises	0
05.06.2013	07:00	07:00	00:00	2 porpoises	0
06.06.2013	17:30:00	16:32	00:58	1 minke whale, 7 porpoises	0
07.06.2013	03:00	03:00	00:00		0

Overall, weather was very good, with good visibility and low sea state. Detailed weather conditions day by day are given in Appendix B. Despite good weather conditions, we were not successful in getting any tags on minke whales, and therefore failed in meeting the primary objective of collecting baseline data from tagged animals. Our main searching area were around Hagbaren, searching east and west, which have previously been found as a good area. In the last week of the trial, we moved further east in Vestfjorden going out from Risvær. The track of Blåstål from the entire trial is shown in figure 3.1.1.

Very few minke whales were found in Vestfjord during the survey period. This was an unusual situation, and the absence of whales was also confirmed by local whalers, also reporting very few catches and observations. Totally, 14 minke whales were observed during the entire survey period (Table 3.1.2, Figure 3.1.2.). Other marine mammals observed during the survey included 1 humpback whale (*Megaptera novaeangliae*), 14 harbour porpoises (*Phocoena phocoena*) and 2 killer whales (*Orcinus orca*) (Table 3.1.2, Figure 3.1.2.).

Table 3.1.2. *Overview of sightings during the cruise. Latitude and longitude given indicate the position of Blåstål at the time of the sigthing.*

Date	Time	Latitude	Longitude	Species	Latin name	# of animals
23.5.2013	14:29:15	68.10929	13.84464	Humpback whale	*Megaptera novaeangliae*	1
24.5.2013	08:30:26	68.09355	13.82918	Harbour porpoise	*Phocoena phocoena*	1
26.5.2013	16:29:28	68.10123	13.87932	Minke whale	*Balaenopetera acutorostrata*	1
27.5.2013	10:04:42	68.08069	13.79188	Harbour porpoise	*Phocoena phocoena*	1
27.5.2013	12:51:23	68.01705	14.18347	Minke whale	*Balaenopetera acutorostrata*	1
28.5.2013	16:49:26	67.98064	14.56535	Harbour porpoise	*Phocoena phocoena*	1
28.5.2013	17:05:38	68.0078	14.47363	Harbour porpoise	*Phocoena phocoena*	1
29.5.2013	08:22:38	68.10119	13.97521	Minke whale	*Balaenopetera acutorostrata*	1
29.5.2013	08:55:49	68.09375	13.88703	Minke whale	*Balaenopetera acutorostrata*	1
30.5.2013	15:50:41	68.09608	13.80789	Killer whale	*Ocinus orca*	2
31.5.2013	08:12:15	68.10442	13.94929	Minke whale	*Balaenopetera acutorostrata*	1
31.5.2013	09:28:42	68.09963	13.82487	Minke whale	*Balaenopetera acutorostrata*	1
31.5.2013	10:36:32	68.06232	13.65685	Minke whale	*Balaenopetera acutorostrata*	1
31.5.2013	13:42:11	68.1039	14.20055	Minke whale	*Balaenopetera acutorostrata*	1
31.5.2013	00:00:00	68.15572	14.20976	Minke whale	*Balaenopetera acutorostrata*	1
3.6.2013	20:32:19	68.17847	14.72259	Harbour porpoise	*Balaenopetera acutorostrata*	1
4.6.2013	03:03:02	68.20387	15.47759	Minke whale	*Balaenopetera acutorostrata*	1
4.6.2013	11:42:09	68.26841	15.11785	Harbour porpoise	*Phocoena phocoena*	2
5.6.2013	19:39:12	68.18538	14.82872	Harbour porpoise	*Phocoena phocoena*	1
5.6.2013	20:36:50	68.21287	15.05846	Harbour porpoise	*Phocoena phocoena*	1
6.6.2013	11:54:31	68.20216	15.45824	Harbour porpoise	*Phocoena phocoena*	1
6.6.2013	13:54:55	68.15788	14.9043	Harbour porpoise	*Phocoena phocoena*	1
6.6.2013	14:02:52	68.1551	14.91905	Harbour porpoise	*Phocoena phocoena*	1
6.6.2013	14:18:17	68.1395	14.8795	Harbour porpoise	*Phocoena phocoena*	1
6.6.2013	14:21:56	68.13535	14.86666	Harbour porpoise	*Phocoena phocoena*	1
6.6.2013	15:40:01	68.10546	14.55142	Minke whale	*Balaenopetera acutorostrata*	1
6.6.2013	17:08:46	68.10231	14.60673	Harbour porpoise	*Phocoena phocoena*	1
6.6.2013	17:13:33	68.10331	14.58297	Harbour porpoise	*Phocoena phocoena*	1

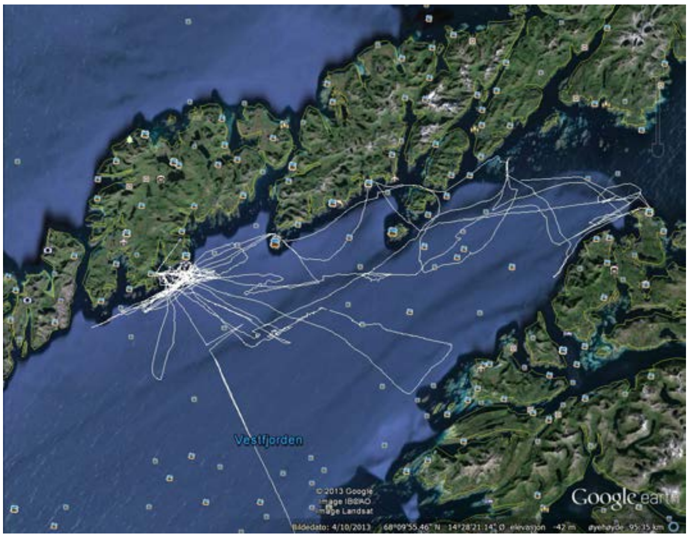


Fig. 3.1.1 *Track of Blåstål from the entire field operation.*

However, the baseline provided us with useful information about the general movement pattern of the minke whales, with the northern shore apparently being used as a migration corridor for whales moving west out of the Vestfjorden basin. We were able to track 4 minke whales for extended periods of time. These all showed a westwards migration pattern (Fig. 3.1.3).

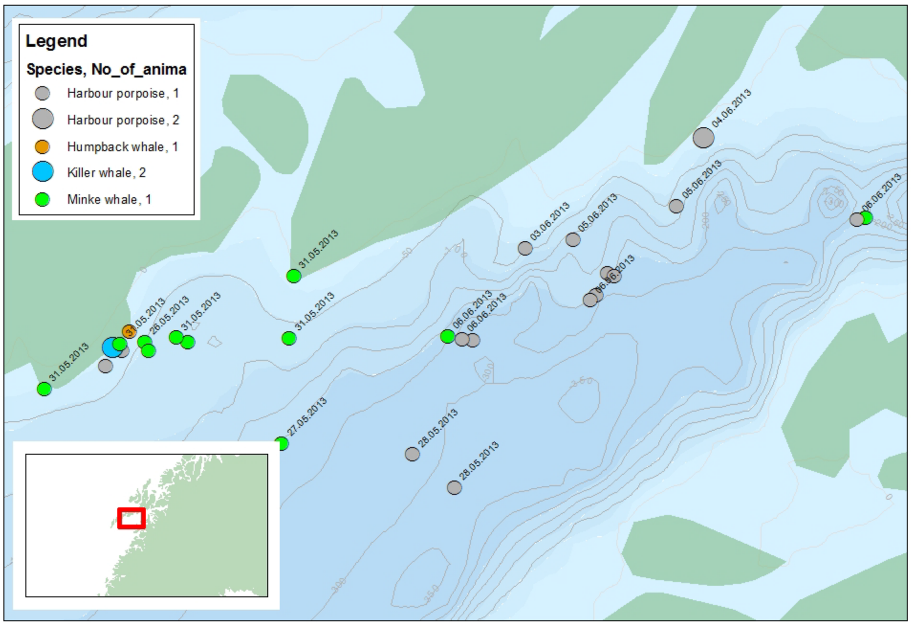


Fig. 3.1.2. *Visual observations of marine mammals in Vestfjorden in the cruise period; 20.May-6.June 2013.*

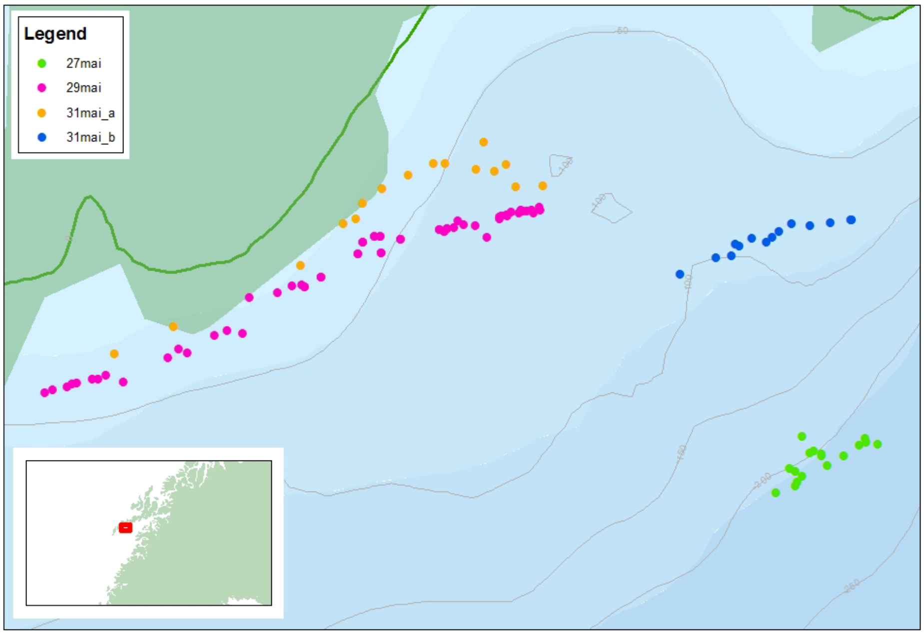


Fig. 3.1.3 *Track of minke whales followed for extended periods for 27. Mai, 29.Mai and 31.Mai. All animals were generally moving westwards out of the fjord basin along the northern shore.*

4 Discussion - achievements of objectives and tasks

We did not achieve the primary cruise objective of collecting baseline data from tagged minke whales. The main reason for this was likely a combination of few animals in the area and few possibilities for tagging attempts.

Our main searching area were around Hagbaren, searching east and west, based on knowledge from previous years that this was a highly suitable area. Our searches further east in Vestfjorden neither gave any results. Our search very supplied with information from local whalers, fishermen and ferry personnel as well as other inhabitant in the Vesfjorden area. Such contacts were called every day, however most often without them reporting any observations. The apparent lack of minke whales in Vestforden in this time of the year was an unusual situation, and the absence of whales was also confirmed by local whalers, reporting very few catches and observations. Why there was such a low number of minke whales this year compared to other years, may be caused by several factors, such as low prey density. Minke whales feed on fish such as herring and mackerel, of wich the fishery were reported low for in Vestfjorden during our cruise period. A low prey density may have caused the minke whales to rather migrate further North e.g. to the Barents Sea, where there was reports of good catches in this period, both for fish and minke whales. This are however only speculations.

Those whales that were observed in during our trial, were all apparently travelling, with a westward migration at relatively high speed (Fig. 3.1.1). Such animals are difficult to track and difficult to tag. Feeding animals are usually the most taggable, as these spend more time close to the surface, and are generally more ignorant for close follows, but no feeding animals were observed. None of the animals were typically "seekers"; animals swimming towards the boat.

One of the secondary objectives of this cruise was to evaluate Vestfjorden as a field site for the 3S sonar trial in June – July 2013. Based on the experience from this cruise, Vesfjorden seems this year not to have a dense concentration of minke whales. This can of course change e.g. with a change in prey density making it more attractive. However, based on the experience from the baseline cruise, we recommend to not use much effort in Vestfjorden to search for minke whales unless we have good reports of a change in the situation.

The secondary objectives about evaluating the different tags (barb Dtag ang Ctag), collecting biopsy of tagged animals and conducting playback of sonar signals, were not met since we did not have a tag on an animal. The two taggers (Lars and Petter) did however regularly practice on shooting with the arts for training, which is valuable for a higher success in the sonar trial, and the three tagging attempts gave good practice on a real target. This also gave valuable practice in driving and tagging from Blåstål as a platform for future trials.

The last secondary objective was to assist the pilot whale team with sighting information. This was conducted at a regular basis. Lars had contact with whalers, ferry personnel as well as people living spread out in the Vestfjorden area. These contacts gave valuable information about pilot whale sightings, and one of the two experiments conducted on pilot whales were conducted on a group of whales found and tracked by information from several of these contacts.

Acknowledgement

Thanks to Patrick Miller (SMRU) and Frans-Peter Lam (TNO) for their contribution, both financially and logistically. The advice of Tommy and Thomas Sivertsen during planning and execution of the trial is also highly appreciated. Thanks also for hosting us in Lofoten. Nina Nordlund (FFI) is acknowledged for making some of the geographical plots.

Appendix A: Detailed day - by – day reports

For weather reports see app.

Saturday 18.May
Lars and Lise arrive. Lars ARTS training with Kylie. Lise shop grocery and get installed in house.

Sunday 19.May
Installation and set of in “Blåstål”. Arrival of Frans-Peter, Petter and Marije. Dinner together with pilot whale team. Planning meeting with minke team. Planning meeting with both teams.

Monday 20. May
Continued installation of “Blåstål”. Starts operation at noon. Return to Ure after 3 h due to oil leakage at “Blåstål”.

Sightings: 0
Total effort at sea: 3 hours
Team: Lars, Petter, Lise, Marije, Frans-Peter

Tuesday 21. May
Conduct range test to test the vhf range. Tracking range found to be 2.5 nmi.
Searching for minke whales between Brandstadholmen and Henningsvær in variable conditions.

Sightings: 0
Total effort at sea: 7.5 hours
Team: Lars, Petter, Lise, Marije, Frans-Peter

Wednesday 22. May
Searching around Hargbaren in perfect conditions in the first part of the day. Around 16:00 local time conditions get worse, windy and conditions not suitable for sighting minke whales. Conduct some training with the Lubell with Lise, Lars and Marije. Tested sounds of both humpback whales and killer whales, no sonar. Test was conducted at position 68°05'60,00"N, 13°46'12,00"E.

Sightings: 0
Total effort at sea: ~8 hours
Team: Lars, Petter, Lise, Marije, Frans-Peter

Thursday 23. May
Weather conditions not good in the morning, but expected to improve. Therefore await departure until after lunch, go to Leknes for grocery shopping.

Depart Ure 14:30 local time in borderline conditions, but weather improve during the afternoon. Search for minke whales around Hargbaren.
One humpback whale sigthed. Tracked it for about 1 hour for training. Return around midnight.

Sightings: 1 humpback whale, tracked for ~1 h for tracking training
Total effort at sea: 9.5 hours
Team: Lars, Petter, Lise, Marije, Frans-Peter

Friday 24. May
Weather conditions good in the morning when departing Ure. “Tango” sighted two minke whales 8 nmi south of position of “Blåstål”. Transit over to that position, but “Tango” team lost track of the whales as “Blåstål” reached that position. Stay at this position for approximately 1 h. Wind pick up, conditions not suitable to see minke whales. Transit back to Ure at 15:00 local time due to weater.

Sightings: 1 harbour porpoise, 2 minke whales sighted by “Tango”
Total effort at sea: 7 hours.
Team: Lars, Petter, Lise, Marije, Frans-Peter

Saturday 25. May
Conditions not very good when departing Ure in the morning. Search south off the shelf break, where two minke whales were sighted the day before. Sighting of minke whale by “Tango” at position 68°01'12,00"N, 14°07'48,00"E. “Blåstål” transit to this position, but whale is gone when reaching position.
Searching eastwards along the shelf break as far as Skrova. Gradually improving conditions.
Got fuel in Svolvær and turned back westwards. Still no sightings, neither any birds around.
Port call in Henningsvær to eat dinner at 20:00 local time.
22:00 Transit back to Ure

Sightings: 1 minke whale sighted by “Tango”
Total effort at sea: 11.5 h
Team: Lars, Petter, Lise, Marije, Frans-Peter

Sunday 26.May
Go out in the morning but return to Ure after approximately 2 h due to unworkable weather conditions. Lunch in Ure, and go back after lunch as weather has improved. Frans-Peter leaves Ure. Searching for minkes from Hagbaren to Brandsholmbøen
Sighting of 1 minke whale. Tracked for three surfacings. Activate C-tag and Dtag, search in area, but lost animal.

Sightings: 1 minke whale
Total effort at sea: 9 hours
Team: Lars, Petter, Lise, Marije

Monday 27.May
Searching around Hagbaren in the morning before conducting a loop to the shelf edge. Observation of one minke whale by “Tango”. “Blåstål” transit to position of “Tango”, but whale lost when “Blåstål” arrives”. Another sighting of a minke whale by “Tango” on their way back to Ure. “Blåstål” takes over tracking, and track the whale around 2 hours. The whale however was small, and did not come close, no tagging opportunity. Left the whale and went back to Ure after training with Lise and Marije with Lubell at sea.

Sightings: 2 minke whales (1 only by “Tango”)
Total effort at sea: ~11 h
Team: Lars, Petter, Lise, Marije, Dan

Tuesday 28. May
Searched along the 200 m shelf line eastwards in good weather conditions. After reports of pilot whales south in Vestfjorden, crossed over to localize them for the pilot whale team.

Sightings: 2 harbour porpoises
Total effort at sea: 12 hours
Team: Lars, Petter, Lise, Dan, Marije

Wednesday 29. May
Sigthing of 1 minke whale in morning just outside Hagbaren. Tracked for approximately 3 h, 3 tagging attempts with C-tag. The animal was very small, “semi-seeker” and travelled westwards at constant pace of about 4 knots. Decided to do a tagless playback, but lost track of the animal at this point. One other minke whale was sigthed during tracking of this whale, but decided to follow this one. Lise left Ure at 20:00 local time, Lars and Petter brought her with “Blåstål” to Stamsund for Hurtigrutten. Paul arrived Ure at 18:00 local time. Nice, calm conditions all day.

Sightings: 2 minke whales
Total effort at sea: 10 hours
Team: Petter, Lars, Lise, Marije, Dan

Thursday 30. May
Day of preparations in Ure and crew change. Shopping, cleaning the house. Lunch together with new team members, Lars, Marije, Petter, Paul Eirik and Dan. Training close to the harbor with Eirik and Paul by Lars, Marije and Petter in the afternoon. Observation of killer whales, tracked them for a while for training purposes. Petter left Ure at 17:00 local time.

Total effort at sea: 1.5 hour training in harbor, 3.5 h searching and tracking training
Sightings: group of killer whales
Team: Petter, Lars, Paul, Marije, Eirik [so here without

Friday 31. May
Observed 1 minke whale close to Ure, tracked it for ~4 h migrating westwards before the whale was lost. Two tagging attempts. Searching back eastwards, and another minke whale

was observed and tracked for 45min, also this animal migrating westwards. This whale was more difficult to follow, not a seeker. Excellent weather conditions all day. Two more minke whales were observed close to Ure on the way back. Both very small and considered not to be taggable.

Total effort at sea: 14.5 h
Sighting s: 4 minke whales
Team: Dan, Paul, Eirik, Marije and Lars.

Saturday 01.June
Left Ure in the morning, but weather too rough for searching. Sailed in for shelter behind a small island, stayed there for 2.5 h before weather improved and moved out again.

Total effort at sea: 10 h (including 2.5 h break for shelter)
Sightings: 0
Team: Paul, Eirik, Lars and Marije

Sunday 02.June
Bad weather conditions, wind. Stayed in Ure to prepare for some days of expedition in the eastpart of the Fjord. Marije went shopping to Leknes. Paul had a training with Dan for the tag preparation. Lars and Eirik went briefly out with Blåstål to do some training (shooting and driving).

Team left Ure at 22:30 local time for new basecamp at Risvær more east in Vestfjorden. Jasper van Vliet, partner of Marije joined to be a fifth person onboard.

Sightings: 0
Total effort at sea: 0 h
Team: Lars, Paul, Eirik, Marije, Jasper

Monday 03.June
Arrival at the island of Risvær at 04:00 local time. Basecamp established in a fish factory with two small rooms. Team went to sleep, and rested during the day, as the weather was too rough for searching. Searched towards Svolvær in late evening. Continued searching throughout the night.

Sightings: 0
Total effort at sea: 5.5 h (transiting)
Team: Lars, Paul, Eirik, Marije, Jasper

Tuesday 4.June
Continued searching during the night. Two porpoises observed. One Minke whale observed in the morning, only resighted once. Variable weather conditions.

Sightings: 1 minke whale, 2 porpoises

Total effort at sea: Monday and Tuesday; 16.5 h
Team: Lars, Paul, Eirik, Marije, Jasper

Wednesday 5.June

Weather conditions in morning and most of the afternoon too rough to go out. Team rested. Slight weather improvement in evening, and team went out at 16:30 local time. Two porpoises observed.

Sightings: 2 porpoises
Total effort at sea: 7h
Team: Lars, Paul, Eirik, Marije, Jasper

Thursday 6.June

Left Risvær early morning. Went to the other side of the fjord, on transit, because of bad weather conditions. On the other side team started observation again. Weather conditions improved to excellent during the day. Several porpoises seen, one logging on the surface.
Team met Heike Vester and her team around 15.30, she was out with students, reported airgun recordings from her hydrophone. One minke whale observed in the afternoon, tracked for and ~1.5 h, but the whale did not approach the boat close enough for tagging.

Sightings: 1 minke whale, 7 porpoises
Total effort at sea: 17.5 h
Team: Lars, Paul, Eirik, Marije, Jasper

Friday 7.June

Weather conditions not good to go out in morning and afternoon. Slightly improving in late afternoon, and went out around 16:30 local time. Searched around Hagbaren in high swell.

Sightings: 0
Total effort at sea: 3 h
Team: Lars, Paul, Eirik, Marije, Jasper, Dan

Saturday 8.June

Due to weather conditions team did not go out. After an early lunch team started rigging down "Blåstål" and preparing equipment of FFI, SMRU and TNO for transport to Tromsø.

Total effort at sea: 0h
Team: Lars, Paul, Eiric, Marije, Jasper

Sunday 9.June

Lars left home. Eirik left early in the morning. Rest cleaned (basic) [??] the house and transferred what was left (food). Jasper and Marije left at noon. Paul left in the afternoon. End of trial!

Appendix B: Detailed weather updates when at sea

Weather information about sea state, swell and visibility were entered in Logger every hour. Here, these data are summarized for each day when we were out at sea. Only entries when weather changed from the last entry are shown. Time hence refer to the time of the change in weather. The seastate codes are based on the following descriptions in Logger:

0: glassy mirror-like
0.5: glassy & ripple patches
1: scale ripples
2: small wavelets
2.5: rare whitecaps
3: whitecaps, 1 - 5/sector
4: frequent whitecaps
5: many whitecaps/spray

Date	Time (UTC)	Beaufort sea state	Swell	Visibility
20-mai-13	07:31:23	0.5	Low <1m, short waves	Good > 10 km
21-mai-13	10:29:09	2	Moderate <2m, short waves	Good > 10 km
22-mai-13	06:40:31	0.5	no swell	Good > 10 km
22-mai-13	08:48:07	0.5	Low <1m, short waves	Good > 10 km
22-mai-13	10:14:15	2	Low <1m, short waves	Good > 10 km
22-mai-13	10:35:16	2	Low <1m, short waves	Moderate; 6-9 km
23-mai-13	13:24:54	2	Moderate <2m, short waves	Good > 10 km
23-mai-13	16:43:02	1	Low <1m, short waves	Good > 10 km
23-mai-13	17:30:11	1	Low <1m, long waves	Good > 10 km
23-mai-13	21:02:02	0.5	no swell	Good > 10 km
23-mai-13	21:51:47	0	no swell	Good > 10 km
24-mai-13	07:18:48	0.5	Low <1m, long waves	Good > 10 km
24-mai-13	08:21:57	0.5	Low <1m, short waves	Good > 10 km
24-mai-13	09:23:05	1	Low <1m, short waves	Good > 10 km
24-mai-13	10:51:29	2.5	Low <1m, long waves	Good > 10 km
24-mai-13	11:31:23	2.5	Low <1m, short waves	Moderate; 6-9 km
24-mai-13	11:46:49	4	Low <1m, short waves	Good > 10 km
25-mai-13	07:12:32	2	Low <1m, short waves	Good > 10 km
25-mai-13	08:07:28	2	Low <1m, long waves	Moderate; 6-9 km
25-mai-13	09:14:19	2.5	Low <1m, short waves	Good > 10 km
25-mai-13	10:16:40	2	Low <1m, short waves	Good > 10 km
25-mai-13	11:04:20	2	Low <1m, long waves	Moderate; 6-9 km
25-mai-13	12:08:44	2.5	Low <1m, long waves	Moderate; 6-9 km
25-mai-13	13:04:18	2	Low <1m, short waves	Good > 10 km
25-mai-13	13:42:42	1	Low <1m, long waves	Good > 10 km
25-mai-13	16:38:23	1	no swell	Good > 10 km
25-mai-13	17:24:41	1	Low <1m, long waves	Good > 10 km
26-mai-13	13:07:42	0.5	Low <1m, long waves	Good > 10 km
26-mai-13	16:12:12	1	Low <1m, long waves	Good > 10 km
26-mai-13	18:33:42	2	Low <1m, short waves	Good > 10 km
26-mai-13	19:04:30	0.5	no swell	Good > 10 km
27-mai-13	08:01:19	1	Low <1m, short waves	Good > 10 km
27-mai-13	09:01:04	1	no swell	Good > 10 km
27-mai-13	14:39:30	1	Low <1m, long waves	Good > 10 km
27-mai-13	16:44:05	1	no swell	Good > 10 km
27-mai-13	17:44:02	0.5	no swell	Good > 10 km
28-mai-13	07:55:38	0	Low <1m, long waves	Good > 10 km
28-mai-13	09:01:13	0.5	no swell	Good > 10 km
28-mai-13	10:49:41	0.5	Low <1m, long waves	Good > 10 km
28-mai-13	11:52:59	0	Low <1m, long waves	Good > 10 km
28-mai-13	12:56:24	0	no swell	Good > 10 km
28-mai-13	15:04:44	0	no swell	Good > 10 km
28-mai-13	17:34:31	1	Low <1m, short waves	Good > 10 km
28-mai-13	18:44:16	0.5	no swell	Good > 10 km
29-mai-13	09:12:12	0	no swell	Good > 10 km
29-mai-13	12:18:11	0.5	no swell	Good > 10 km
29-mai-13	14:18:21	2	no swell	Good > 10 km
29-mai-13	15:05:44	1	Low <1m, short waves	Good > 10 km
29-mai-13	15:58:38	1	no swell	Good > 10 km
29-mai-13	17:02:27	0	no swell	Good > 10 km
30-mai-13	14:01:43	0	no swell	Good > 10 km
30-mai-13	15:49:19	1	Low <1m, short waves	Moderate; 6-9 km
30-mai-13	18:14:26	0	no swell	Good > 10 km
31-mai-13	06:17:58	0	no swell	Good > 10 km
31-mai-13	10:15:23	0.5	no swell	Moderate; 6-9 km
31-mai-13	11:07:49	0	no swell	Good > 10 km
31-mai-13	16:59:18	0.5	no swell	Good > 10 km
01-jun-13	06:53:49	1	Low <1m, short waves	Good > 10 km
01-jun-13	08:19:49	2	Moderate <2m, short waves	Moderate; 6-9 km
01-jun-13	11:41:39	2	Low <1m, short waves	Good > 10 km
01-jun-13	13:13:49	0	Low <1m, short waves	Good > 10 km
01-jun-13	14:52:55	1	Low <1m, short waves	Good > 10 km
01-jun-13	16:27:46	0.5	Low <1m, short waves	Good > 10 km
02-jun-13	21:13:04	2.5	Moderate <2m short, waves	Moderate; 6-9 km
03-jun-13	19:53:56	1	Low <1m, long waves	Moderate; 6-9 km
03-jun-13	21:05:58	2	Low <1m, long waves	Moderate; 6-9 km
03-jun-13	21:53:05	2	Low <1m, long waves	Good > 10 km
04-jun-13	00:24:57	2	Low <1m, long waves	Good > 10 km
04-jun-13	03:49:25	2	Low <1m, short waves	Good > 10 km
04-jun-13	04:49:35	1	no swell	Good > 10 km
04-jun-13	05:13:20	2	Low <1m, long waves	Good > 10 km
04-jun-13	05:42:04	2	Low <1m, short waves	Moderate; 6-9 km
04-jun-13	08:20:33	2.5	Low <1m, short waves	Good > 10 km
04-jun-13	11:42:09	1	no swell	Good > 10 km
04-jun-13	11:42:09	0.5	Low <1m, short waves	Good > 10 km
05-jun-13	15:05:25	0.5	Low <1m, short waves	Good > 10 km
05-jun-13	15:21:19	1	Low <1m, short waves	Good > 10 km
05-jun-13	17:31:26	2	Low <1m, long waves	Good > 10 km
05-jun-13	18:17:03	1	Low <1m, short waves	Good > 10 km
05-jun-13	19:46:36	1	Low <1m, short waves	Good > 10 km
05-jun-13	20:54:25	0.5	Low <1m, short waves	Good > 10 km
06-jun-13	03:35:37	2	Low <1m, long waves	Moderate; 6-9 km
06-jun-13	05:06:52	2	Low <1m, short waves	Good > 10 km
06-jun-13	11:13:26	1	no swell	Good > 10 km
06-jun-13	12:33:37	0	no swell	Moderate; 6-9 km
06-jun-13	13:39:19	0.5	no swell	Good > 10 km
06-jun-13	19:27:47	2	Low <1m, short waves	Good > 10 km
06-jun-13	19:57:43	2.5	Low <1m, short waves	Good > 10 km
07-jun-13	15:43:01	1	Low <1m, long waves	Moderate; 6-9 km

Appendix C. Cruise plan

Cruiseplan

3S-2013 Baseline II -Minke whale effort

The 3S-2013 baseline II trial is conducted as part of the $3S^2$-project and is split into two separate but coordinated efforts; a minke whale team and a pilot whale team.

CRUISE TASKS AND OBJECTIVES

Primary objective

1) Tag minke whales with Dtag or Ctag and record baseline information of horizontal and vertical movement and surface behavior , and thereafter carry out playback of mammal eating killer whales and humpback whales.

Secondary tasks

1) Evaluate, test and assess different tags and tagging techniques for minke whales before the sonar exposure trial in June-July
2) Assess Vestfjorden as a suitable/non-suitable operation area for working with minke whales during the sonar trial in June-July.
3) Conduct playback of sonar signals.
4) Collect biopsy samples of the tagged animals
5) Support pilot whale team with sighting information and during killer whale playbacks.

Secondary tasks should be prioritized to not interfere with our ability to accomplish our primary objective.

SAILING SCHEDULE

Sat 18. May: Arrival of Lars to train other team in use of ARTS and Lise to organize with groceries before the weekend.

Sun 19. May: Arrival of the rest of the team to Ure Rorbucamping, installation of equipment at Blåstål. Minke whale team meeting at 19:00, and joint meeting with pilot whale team at 20:30

Mon 20. May: Continued preparation and installation. Operational at noon

21. May-08. June: Regular operation

09. June: De-installation and departure. Shipment of equipment that should be used in the main trial to Tromsø.

OPERATION AREA

We will work in the Vestfjord between Skrova and Reine , but the primary operation area will be within one hour from the campsite at Ure. When the weather is good, we will go out of Ure in the morning, and start searching for whales based on sighting information if available.

Operation area. Left: the larger perspective, Vestfjorden marked by square. Middle:Vestfjorden in more detail. Ure is marked by red placemarker. Rigth: More detailed map of the area around Ure, where we will be based.

MAIN LOGISTICAL COMPONENTS

R/V Blåstål

Length: 27 feet
Max speed 24 knots

Blåstål will be the operation boat for all the minke whale effort, and has a MMO platform at the roof, and a tagging platform at the bow. Tagging will be conducted both from the bow and from the MMO platform. Blåstål will be outfitted with a VHF directional tracking system, Visual search for minke whales, VHF- and visual tracking of tagged animals, operation of playback source and tagging will be done from Blåstål. Blåstål also has basic kitchen, lavatory and sleeping facilities that can be used in the case of long duration operations.

R/V Blåstål

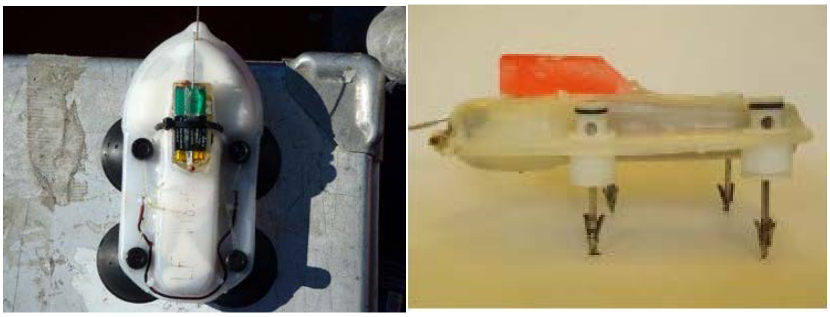
Ure Rorbu camp

We will be based in Ure Rorbucamp, located at Vestvågøy in Lofoten We will share accommodation with the pilot whale team.
The rented facility contains four rooms with a total of 14 bunks. The nearest towns are Leknes (10 km by car) or Stamsund (15 km by car but only 3 km by boat).
The houses have well equipped kitchen and fridge/freezer, and the two teams will organize with shopping and cooking separate, because we might be on different daily rhythms.
Grocery shopping could be done at Leknes or Stamsund. Leknes is most easy, only 10 min by car, and will we used as the primary option if SMRU car is available. Otherwise shopping could be done by boat to Stamsund.

Ure Rorbu camp, seen from above (left), from sea (middle) and inside (rigth).

Whale tag – barb DTAG

The DTAG, is a miniature sound and orientation recording tag developed at WHOI. The tag is attached to the whale using a pneumatic remote deployment system (ARTS). Traditionally, Dtags are attached to whales with suction cups, but our experience from 3S-11 was that Dtag suction cups do not stick to skin of minke whales in these waters. Therefore, for DTAG deployments on minke whales the suction cups are replaced by four small 55 mm long invasive barbs.. After 20 hrs a galvanic time release detaches the tag from the attachment and the tag floats to the surface.
The tag contains a VHF transmitter used to track the tagged whale with the DFHorten unit during deployment and to retrieve the tag after release. All sensor data are stored on board the tag and the tag therefore has to be retrieved in order to obtain the data. DTAGs record sound at the whale as well as depth, 3-dimensional acceleration, and 3-dimensional magnetometer information. DTAG audio will be sampled at 96 kHz and other sensors at 50 Hz, allowing a fine reconstruction of whale behavior before, during, and after sonar transmissions.



DTAG2 with suction cups (left) and with small 55 mm invasive barbs (right). Both tags will also have a GPS logger piggybacked to them.

Whale tag - CTAG

Previous attempts to tag minke whales with suction cups tags has shown that this might be very difficult. It's difficult to get whales within DTAG tagging range, and suction cups do not seem to attach to their skin. We will try to use small invasive attachments of the DTAG, but this has not been fully tested. We have therefore developed a small and light invasive tag, to be used as back up if "DTAGing" turns out to be too difficult. The CTAG is developed to be deployed using the ARTS system at distances up to 15m. Compared to the DTAG the CTAG contains a simpler set of sensors; a VHF-transmitter, and a Star Oddi DST Centi time depth recorder. In addition the CTAG will also contain a GPS-logger. It is attached to the whale by a single 75mm barb. The tag is released from the animal using a galvanic time release. The tag does not contain acoustic sensors. We will opportunistically use both CTAG and DTAG in parallel to optimize our chances of getting tags on minke whales during this trial.

CTAG with barb (left) and the ARTS system (right).

Whale tag - GPS tags

During 3S-11 we successfully tested SirTrak Fastloc GPS loggers by attaching them to the back of the DTAG. This tag is a valuable back up, which keeps collecting data of surfacing positions of the tagged animal, even if the tracking boat looses track of it for a while. All tag deployments (DTAGs and CTAGs) will therefore include a GPS tag piggybacked to the main tag. Accurate positioning of the tag high on the back of the animal is crucial for the GPS tag to work properly.

Playback source – Lubell speaker

Tagged whales will be exposed to playbacks of killer whales and humpback whales. The sounds will be generated using a M-Audio Microtrack II recorder and amplified by a Cadence Z8000 amplifier connected to a Lubell LL9642T underwater loudspeaker (frequency response: 0.2–20 kHz) submerged at a depth of 8 m.

Biopsy sampling

In the end of the tag deployment, before the tag detaches, a biopsy sample will be taken from the tagged animal. The LKDart with a standard Finn Larsen biopsy tip will be used for this.The biopsy tip is a hollow and sharp needle, which samples a small piece of skin and blubber tissue from the back of the animal. The biopsy tip is 8mm in diameter and penetrates 40-60mm into the blubber. The tissue is used to sex and i.d. the animals, to assure that they have not been exposed before. Tissue samples will be made available for other projects to look at e.g. biochemical composition, presence of environmental pollutions or for genetic analysis. Since the biopsy sample is taken before the tag detaches, we will use the stored data to also look at possible behavioral changes related to the biopsy sampling.

LKDart with 40 and 60 med mer tip.

Tag deployment systems

The tags will be deployed using the ARTS-system; a pneumatic tag launcher that launches the tags through the air on to the animals. It was developed to be used with the DTAG during the 3S-project to enable longer tagging ranges, rapid changes of directions and to ease approach of animals which avoid the pole.

The ARTS system (left) used to deploy a DTAG (middle) and a CTAG (right) on minke whales.

Tracking and data collection

To visually search for animals in the search phase, and to observe the behavior of the animals during tagging and tracking, a marine mammal observer platform is installed on the roof of the Blåstål. This platform will be equipped with binoculars, laser range finder, an angle board, a ruggedized computer running Logger and a DFHorten direction finder system with 4 yagi antennas (5 element) mounted at 5 meters height . The DFHorten unit can be turned to angle to be operated from the MMO platform or from the cabin, depending on the weather condition.

RESPONIBILITIES

FFI

Personnel: Tagger, boat driver, marine mammal observer, cruise leader
Equipment: VHF-tracking systems with antennas and cables (VHF receivers R1000/2000 (1) and R-1000 (1), and DFHorten VHF direction finder system (2)), CTAGs (2), ARTS-DTAG carriers (3) and robots (3), VHF-communication equipment (3), lifevest (5), Ruggedized computer (1) Work suits (4)

SMRU

Personnel: marine mammal observer
Equipment: Research vessel, GPS tags (2), killer whale playback equipment (1), Logger software platforms.

WHOI

Personnel: DTAG-technician (shared with pilot whale team)
Equipment: LF DTAG2s (), DTAG accessories

TNO

Personnel: Marine mammal observers.
Equipment: Ruggedized computer (1), hydrophone for KW PB sound measurements

IMR

Personnel: Marine mammal observer
Equipment: pen and paper

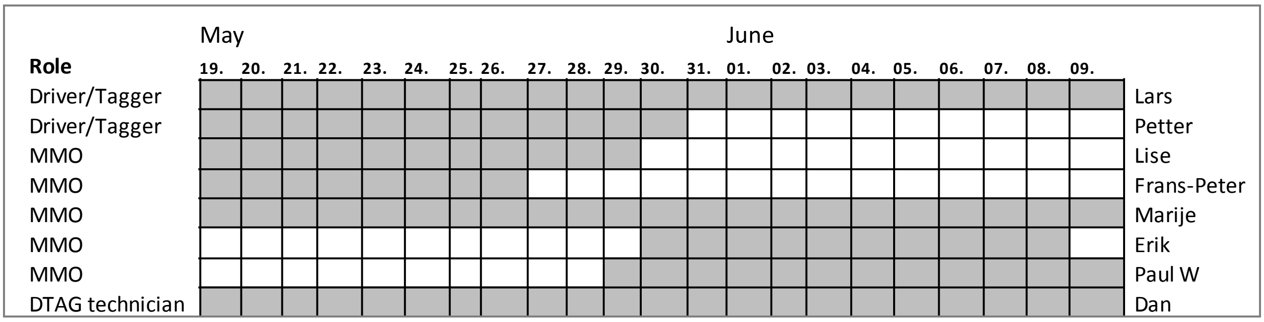
LK-ARTS

Equipment: ARTS (2) with pressured air bottles (5), photo equipment (Canon D1 MK3, and lens 70-200mm),digital camera (Sony1000, and GoPro cameras (2)), Angleboard (1), Handheld GPS (2), GPS dogfinder with one waterproof unit (1), tagging and biopsy equipment (2 LKDarts and Finn Larsen tips), VHF receiver (R-1000 (1)), and 4 Yagi antennas (5 elements), vials for biopsy samples (50) and DFHorten VHF direction finder system (1).

CREW PLAN

Name	Main role	Secondary role	Affilation	Nationality
Petter Kvadsheim	Driver	tagger	FFI	NOR
Lars Kleivane	tagger	driver	FFI/LK ARTS	NOR
Lise D. Sivle	MMO	KW playback	IMR	NOR
Frans Peter Lam	MMO	MMO	TNO	NED
Erik Grønningsæter	MMO	MMO	FFI	NOR
Marije Siemensma	MMO	MMO	TNO	NED
Paul Wensveen	MMO	KW playback/tag technician	SMRU	NED
Dan Bogorff	DTAG technician	MMO	WHOI	US

Lars and Marije will be participating throughout the entire cruise period, while the rest will participate in parts of it, given in the detailed crew plan below.



Crew plan for the baseline trial. You are planned to arrive the date of the first grey marked day, and depart the date of the last grey day. As the number of beds are limited, we cannot have days with a double number of people. Therefore it is important that people book flights to arrive the day of their first grey marked day.

Room plan:

We have available two houses (1 & 2), house 1 is large with 2 floors, three bedrooms and a total of 11 beds as well as kitchen and living room. House 2 is far smaller, with one bedroom, three beds, and a small kitchen/livingroom. As the two teams will work independently, and sometimes at different schedules (minke team might sometimes work at night and sleep during day), it is desirable to stay in separate houses, to avoid disrupting eachother. The pilot whale team is hence set to stay in the large house (1) while the minke team will stay in the small house (2). However, the minke team might need some work space in house 2, as will need to use the living room also as bedroom. The minke team will also need one bed in one of the pilot whale rooms.

Room 1.1 (3 beds, 1st floor): pilot whale team
Room 1.2 (4 beds, 1st floor): pilot whale team
Room 1.3 (4 beds, 2nd floor): pilot whale team
Room 2.1 (3 beds, separate house): minke whale team

DAILY WORK PLAN

The daily working schedule will depend very much on the current and expected weather situation. Whale tagging and small boat operations in this area is a good weather activity, and we have to consider that even if we could tag an animal under difficult condition we need to reliably also be able to track it for 20 hours after tag on. Low temperature and precipitation are not limiting factors, but the sea condition and to some extent visibility is. Sea state 0-1 are good working conditions, whereas sea state 2 are boarderline conditions. Above sea sate 3, we will not go out.

During good weather days, working hours will be very long, sometimes >24 hrs at sea. This is tiring, but during bad weather days we can all rest. Even though we have to be very flexible with our work schedule, we also need some daily routine whenever possible:

On a regular day, we will start by having breakfast at Ure Rorbucamp at 07:00. After breakfast a joint meeting with the pilot whale team will be held at 08:00. Here we will discuss the weather situation/forecast for the day, availability of animals (sightings from fishermen, locals, own sightings the day before). Based on this information, we will decide on a plan for the day; where to start searching, what is the likely operation area based on wind directions etc. If weather does not allow for a full operation, alternative activities will be decided.

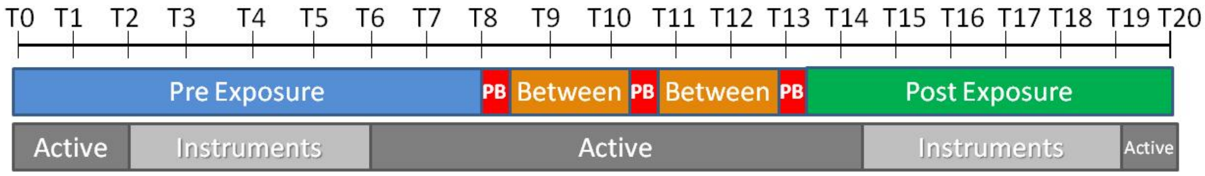
We will generally follow a schedule where we work during day, and sleep at night. However, once a tag is on an animal, we will need to follow this animal to the tag is off and recovered, which will take 20 h + from tag on. Those days will therefore require that we work also at night. However, it will be possible for some rest during the deployment, as large parts of the pre-exposure and post-exposure phase we will be tracking the animals by instruments only, which requires only 2-3 people.

The work plan is divided into two; search/tagging and experimental phase.

Search/tagging phase
A minimum of two MMOs will conduct visual observations of marine mammals and a tagger need to be in stand-by mode for tagging. Before a whale is detected we will decide if we should try DTAG, CTAG or parallel tagging effort. Once a minke whale is detected, we need all hands on deck. We will try to approach the animal as soon as the taggers are ready, and see if it is a "seeker" (a whale coming to the boat). If the animal in not a seeker, we will have to assess for how long it makes sense to continue to try to tag it and with which type of tag, before we continue to search for other animals.

During this phase, the MMOs will track the animal and put all information into Logger.

Experimental phase
Once a tag is on, we enter the experimental phase. The time of tag on is termed T0, and the duration of the different phases of the deployment is shown below.



Pre exposure will be 8 h, at least for the first deployment. If the tag attachment and release mechanism seem to be working reliably, we may decide to extend the pre-exposure period to 12 hours during subsequent deployments.

The playback session may require 6 h to complete. Each individual will be tested with 2 experimental playback sounds, separated by a silence period of 2h:

1) KW stimulus: Natural vocalizations of unfamiliar transient mammal-feeding killer whales, previously recorded in British Columbia using DTAG in a behavioral context of foraging on marine mammals. The playback of these sounds will simulate the presence of a potential predator.
2) Control stimulus: Humpback whale songs (biological sounds that does not represent a threat) previously recorded in Australia using DTAG.
3) Sonar playback: A 15 min playback of the same sonar signal that is used during the full scale sonar trial; LFAS-shallow, 1.3-2.0 kHz, with 1 sec pulses and 20 sec interpulse intervals.

All acoustic signals have a similar average RMS power and duration of 15min.
The order of the first two playbacks are randomized according to the table below. The sonar playback will always be played last, due to the primary task of this cruise to conduct killer whale playback and control.

Exp #	1st PB	2nd PB	3rd PB
#1	HW	KW	-
#2	KW	HW	Sonar
#3	HW	KW	Sonar
#4	HW	KW	Sonar
#5	KW	HW	Sonar
#6	KW	HW	Sonar
#7	HW	KW	Sonar
#8	KW	HW	Sonar
#9	KW	HW	Sonar
#10	KW	HW	Sonar

The remaining time after playback has ended is the post exposure phase, which may be up to 6 h if the playback sessions are conducted with no delays and the tag does not come off early. However, based on experience from earlier, both of the mentioned are likely to occur, causing the need for such a long potential post exposure period. In addition the time between playbacks will have to be extended beyond the regular 2hrs if the animal have not returned to what is judged to be normal behavior within that time. In the end of the post exposure period, but before the tag comes off, a biopsy will be taken (T+18)

In the experimental phase, we will switch between active tracking and instrument tracking, as is indicated in the figure above.

Active tracking: In the first two hours after tag on, and 1 hour before, during and 1 hour after the playback we will actively track the animal. Active tracking will also be conducted during the last hour of post exposure when attempting to take biopsy. During active tracking we need everyone on watch, and sightings should be entered into Logger at every 2 min or at the next surfacing. Position fixes (range and bearing), number of surfacings since the last fix, experimental phase, other animals in the area, other boats in the area and conspicuous behavioral features should be recorded in Logger.

Instrument tracking: Due to the low number of people onboard (4 or 5) and the potential long working load (20 h deployment + searching and tagging) the tracking of the animal is conducted partly based on the VHF-instruments, to allow people to rest a bit. During instrument tracking, there will be 2-3 people on watch; a driver and 1-2 MMOs to operate the VHF-tracking systems and look for whales. Sightings should be entered into Logger every 30 min.

During tracking (both instruments and active) we should aim as staying at a fixed distance of 100-200 m from the animal, to try to keep both the boat noise as well as the physical presence of a boat as constant as possible the entire time of data recording. An exception is when we move to get in front of the animal to do the playback.

The playbacks will be conducted as following:

Before starting the playback, we will make a prediction of the most likely track of the whale, based on its latest movement pattern. Approximately 5 min before the planned playback starts, we will move Blåstål ahead of the whale, and start the playback at the pre-determined time, in a target position 800 m ahead of the animal and slightly to the side of the predicted trajectory of the animal. We will drift passively but with the engine running in neutral for the 15 min long playback time. During the playback, we will try to keep track of the animal as long as possible, usual VHF-tracking and binoculars, and at least be able to have an idea of the direction it has moved in if heading fast away from the ship. After playback have ended, we will try to localize the tagged whale again and keep tracking it actively until the next playback session. The second session starts 2 h after finishing the first, or; if the animal react strongly, when the animal seem to have calmed down again, and a good track has been established.

MANAGEMENT AND CHAIN OF COMMAND

Operational issues
Operational decisions such as decisions on sailing plan, crew dispositions etc are ultimately made by the cruise leader. Kvadsheim is cruise leader in the period from May 19-30, and Kleivane from May 30 to June 09.

Safety issues
The captain of the ship (Kleivane) makes final decisions on safety issues.

Permit issues
The permit holder is Petter Kvadsheim. He makes final decisions on permit issues. However, Lise Sivle and Lars Kleivane also have responsibility for permit compliance during tagging and playback.

COMMUNICATION PLAN

Communication with the pilot whale team will be done using maritime VHF channel 73. There will be cell phone coverage in the operation area and this could be used as back up.

RISK MANAGEMENT AND PERMITS

FFI has obtained necessary permits from appropriate authorities for the operation described in this document. The operation area is entirely within Norwegian territorial waters thus under Norwegian jurisdiction.
Since the operation includes animal experimentation, we will operate under permits from the Norwegian Animal Research Authority (permit no S2011/38782) acquired by Petter Kvadsheim. The permits include tagging (DTAG and CTAG) and acoustic exposure to playback to minke whales, according to the protocol described here. Permits also allow biopsy sampling. In addition to Kvadsheim, Lars Kleivane and Lise Sivle will be field operators responsible for permit compliance in the field.
Procedures to mitigate environmental risk will be implemented as described in this document and in the permit documents. Risk to humans should be minimized through the regular safety regime implemented for all relevant working operations on board. The cruise leader and captain is primarily responsible for these risk issues.

NATIONAL GEOGRAPHIC DOCUMENTARY ON 3S RESEARCH

A Dutch film company called Mouissie Corporation is making a documentary series for National Geographic called “Marine Life”. They will participate on the 3S-13 main trial in the start-up period, roughly from 15 to 18 June. Participation in the Minke whale trial has been cancelled for now. At present several options are being explored to collect footage from the baseline trial, possibly also collected by ourselves.

TRAVEL AND ACCOMMODATION

Travel

The nearest airport to Ure is Leknes, with daily flights from Oslo via Bodø with SAS. From Leknes airport to Ure it’s about 15 km by car. It is also possible to fly to Bodø and take the coastal ferry (Hurtigruten) from Bodø to Stamsund (which is also 15 km from Ure by car). Hurtigruten leaves Bodø at 15:00 every day, arriving 19:30 in Stamsund.

SHIPPING

The shipping address to Ure is
Ure Rorbucamping
NAME, v/Tommy Sivertsen
Ureveien 146
8352 Sennesvik
Norway

At the end of the trial (June 9th) all equipment will be sent to Tromsø for the 3S-13 sonar trial. FFI (Kleivane) will be in charge of coordinating this, with support of SMRU (Wensveen) and TNO (Siemensma).

CONTACT INFORMATION

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ATTACHEMENT

GTR table for tag releases.

ACCURACY - GTR's release time varies over the temperature range stated in the chart below. One day releases have a variability of 6 hours between hash marks. All other time durations have a variability of 12 hours between hash marks. The hash mark on the left represents the actual release time at the temperature above the hash mark. For instance, an A4 will release at 24 hours at 53F. At the right hash mark, 59F, it will release at 18 hr. For a 2 day B4, the GTR will release at 48 hr. at 46F and at 36 hr. for the temp above the right hash mark, 57F. For temperatures between the hash marks, release times can be approximated.

<table>
<tr><th>WATER TEMP</th><th>2C 30F   +2C 35F   4C 40F   7C 45F   10C 50F   13C 55F   16C 60F   18C 65F   21 C 70F   24C 75F   27C 80F</th><th>Time Variation Between Hash Marks</th></tr>
<tr><td>1 DAY</td><td>| A1 | A2 | A3 | A4 | A5 | A6</td><td>6 hrs</td></tr>
<tr><td>2 DAY</td><td>| B1 | B2 | B3 | B4 | B5 | B6</td><td>12 hrs</td></tr>
<tr><td>3 DAY</td><td>| C1 | C2 | C3 | C3A | C4 | C5 | C6</td><td>12 hrs</td></tr>
<tr><td>4 DAY</td><td>| D1 | D2 | D2A | D3 | D4 | D5 | D6 | D7 | D8</td><td>12 hrs</td></tr>
<tr><td>5 DAY</td><td>| E1 | E1A | E2 | E3 | E4 | E5 | E6 | E7 | E8 |</td><td>12 hrs</td></tr>
<tr><td>6 DAY</td><td>| F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8</td><td>12 hrs</td></tr>
<tr><td>7 DAY</td><td>| G1 | G2 | G3 | G4 | G5 | G6 | G7 | G8 | G9</td><td>12 hrs</td></tr>
<tr><td>10 DAY</td><td>| J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 | J9 |</td><td>12 hrs</td></tr>
<tr><td>14 DAY</td><td>| N1 | N2 | N3 | N4 | N5 | N6 | N7 | N8 | N9 |</td><td>12 hrs</td></tr>
<tr><td>30 DAY</td><td>| AK30 |</td><td>12 hrs</td></tr>
</table>

Table of GTR’s actually planned to be used and expected release time for CTAG and DTAG in Vestfjorden and Jan Mayen. This is based on the table above, expected sea temperature and previous experience during 3S-2011 and 3S-2013 Baseline I.

GTR-table	Jan Mayen	Vestfjord	Release time
CTAG	A1	A2	18-20 hr
DTAG	A1	A2	16-22 hr
Sea temp	3-5°C	5-10°C	

Appendix F Cruise report 3S-13 Baseline III – pilot whale effort

University of St Andrews

Scottish Oceans Institute

Baseline cruise report 3S-2013
Pilot whale effort

Charlotte Curé[1]*, Machiel Oudejans[2], Fleur Visser[2, 3], Patrick Miller[1]

[1]*Sea Mammal Research Unit, Scottish Oceans Institute, School of Biology, University of St Andrews, St Andrews, Fife KY169QQ UK.*
[2] *KMR: Kelp Marine Research, The Netherlands.*
[3]*TNO: Netherlands Organization for Scientific Applied Research, The Hague.*

*** contact:** cc201@st-andrews.ac.uk

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Baseline cruise report 3S-2013
Pilot whale effort

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Content

1. EXECUTIVE SUMMARY

The pilot whale effort of the 3S-2013 baseline cruise was successful in achieving its tasks. A total of five DTAGs were attached to long-finned pilot whales using hand help pole system with a total of 28h and 10min of recorded tag data. One tag deployment was followed by baseline observations during tracking with no experiment, while three other experiments were fully accomplished including a pre-exposure baseline period followed by playback sound exposures. In one of these three experiments, two DTAGs were simultaneously deployed providing data of two animals. For one over the three experiments, a biopsy sample was taken before the Dtag released, and for four of the five DTAGs deployed, a GPS logger was piggyback attached to the DTAG. High quality visual tracking and monitoring recordings were made throughout the trial as well as observations of group-level behavior including observations before, during and after the sound playbacks.

In total, we conducted 3 playbacks of killer whale sounds, 2 playbacks of sonar (1-2kHz), 1 playback of humpback whale sounds and 1 playback of broadband noise to long-finned pilot whales, with clearly observable reactions to the stimuli playbacks.

As secondary objectives, Minke whales sightings were communicated to the Minke whale team but no tagging attempts were made. Coordination with the Minke whale team was highly effective with mutual sightings support. These data will support analyses of the 3S experiments that were previously conducted on long-finned pilot whales in the same locations in 2008, 2009 and 2010.

2. INTRODUCTION

CRUISE TASKS

Primary tasks:

1. Tag long-finned pilot whales with DTAGv2 equipped with a GPS logger, and record baseline vocal-, movement- and surface behavior, followed by playback experiments where tagged animals are exposed to mammal-feeding killer whale sounds and control sounds.

Secondary tasks:

1. Biopsy sampling of tagged animals.

2. Support Minke whale effort: sharing sightings information, opportunistically tag Minke whale seekers using a barb DTAG.

3. Collect baseline behavior records of long-finned pilot whales.

BACKGROUND

Within the 3S research project, we performed sonar signal exposures to different cetacean species including the long-finned pilot whale (3S cruises 2008 and 2009). To be able to assess whether the behavioral responses of cetaceans to sonar signals correspond to a disturbance effect, we need to compare these responses to the behavioral responses when facing a natural threat such as the presence of a predator. In this aim, we also conducted experiments where pilot whales were exposed to the playback of killer whale vocalizations simulating the presence of a potential predator (3S cruises 2008, 2009 and 3S baseline cruise in 2010). The hypothesis we wanted to test is that behavioral responses to sonar sounds are similar to reactions to killer whale sounds.

Killer whales can be divided into population elements, which have distinctive acoustic dialects, and which specialize in eating fish or in eating other mammals. Therefore, they could be potentially perceived by the other cetacean species as either a competitor for food or a potential predator. During the 2008-2010 trials, playback experiments were conducted using fish-eating killer whale sounds previously recorded with D-tags in the Norwegian Sea from killer whales that were feeding upon herring. The results of these experiments were very consistent, with pilot whales reacting strongly to the killer whale sounds by joining other subgroups to form larger groups and by approaching the killer whale sound source (Curé et al., 2012). However, these results did not allow us to distinguish between two possible explanations for this reaction. One explanation could have been an attraction of pilot whales to a location of food being predated upon by a competitor. Alternatively, the response may have been a defense strategy whereby individuals group together and move towards their predator. To distinguish between these different interpretations, in the aim to make valuable comparisons to reactions to sonar, during the Baseline cruise II – 2013 we conducted playback experiments using mammal-eating killer whale sounds that represent potentially higher predation risk than fish-eating killer whale sounds. In addition we presented a higher diversity of control sounds in addition to broadband noise previously used (Curé et al., 2012).

3. METHOD – LOGISTICS, EQUIPMENT AND EXPERIMENTAL PROCEDURE

LOGISTICAL COMPONENTS

Operation area and study animals

Target species were the long-finned pilot whale (*Globicephala melas*). We worked in areas in Vestfjord (Norway) where pilot whales are regularly sighted. The long-finned pilot whales were chosen opportunistically from animals found in the study site.

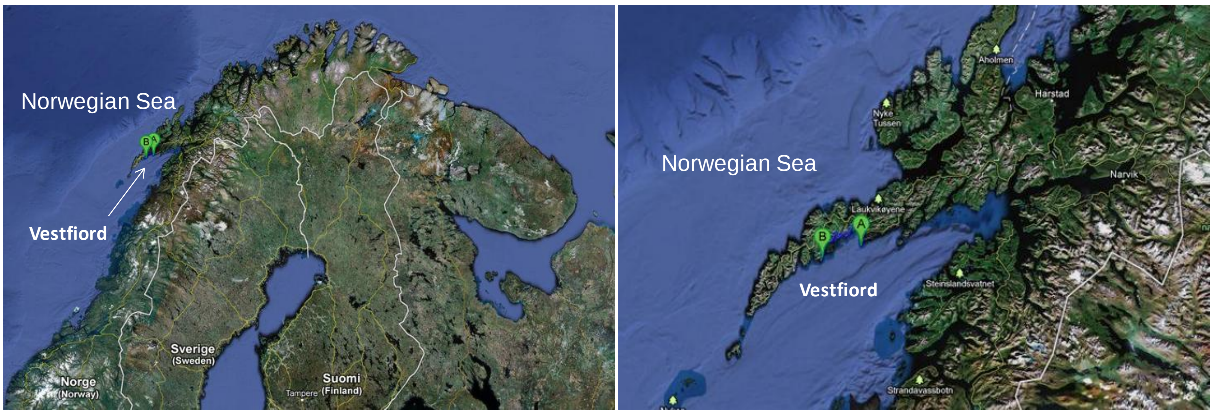


Figure 1: *Pilot whale effort was conducted in Vestfiord (see maps at the top. A: Henningsvaer, B: Ure).* The team and equipment were based on land at Henningsvaer for few days and then at Ure Robucamp (at the bottom: picture of Ure basement).

Teams

The 3S 2013 baseline trial was composed of two teams dedicated respectively for Minke whale and Pilot whale research. Both teams worked independently but with continuous communication and mutual support between them.

The pilot whale team collaborated with a local researcher, Heike Vester, principal of 'Ocean Sounds' based in Henningsvaer, who helped us with searching and with conducting the sound playbacks.

Operation vessels

Figure 2: SMRU motor boat – 'TANGO'

Length: 5.9 m
Max crew: 5 people
Max speed: 22 knots

The SMRU boat called 'Tango' (Fig. 2) was the main operation boat for the pilot whale effort. It was used for searching, tagging and tracking.

Fig. 3: Heike Vester's boat – 'OCEAN SOUNDS'

Length: 7.3 m
Max crew: 12 people
Max speed: 40 knots

The ‘Ocean Sounds’ boat (Fig. 3) was used as additional searching vessel and as playback vessel.

For the experiment that was conducted at the beginning of the main $3S^2$ trial (18 June 2013), we used different boats: MOBHUS 1 as observation platform for tracking and MOBHUS 2 as playback vessel.

TAGGING WITH DTAG + GPS LOGGER

The tags were deployed using the hand held pole technique. Animals were tagged with a non-invasive suction cup attached to acoustic and motion sensor DTAG (Fig. 4). The tag has a built in release mechanism and was set to release from the animal after 6-7 hours of deployment.

DTAG includes a pressure sensor and 3-axis accelerometers and magnetometers which records animal depth and orientation. It also includes hydrophones to record the vocalizations produced and received by the tested animals. Using the radio beacon on the tag, we were able to track the tagged whale during experiments and to collect visual observations such as whale positions and surface social behaviour.

In four of five DTAG deployments, a small SirTrak Fastloc GPS logger was piggyback-attached to the DTAG (Fig. 4). This GPS logger records the surfacing positions of the tagged animal, giving a back up for the whale positions and enabling us to obtain the track of the animal even when observers lose tracking of the tagged animal for a while.

Figure 4*: Long-finned pilot whale tagged with a Dtag version 2 (left); DTAG2 with Sirtrac GPS logger attached (right).*

SEARCHING, TRACKING AND DATA COLLECTION

We visually searched for animals and observed the behavior of tagged animals during tracking from ‘Tango’ boat. In this aim, Tango was outfitted with an ADF system for tracking tagged whales, Logger software for recording whale sightings and behavior (based on the input of the MMOs) and all necessary equipment (see protocol details in Kvadsheim and al. 2009, 2011 and 2012 and Miller et al. 2010).

PLAYBACK PROCEDURE AND ACOUSTIC STIMULI

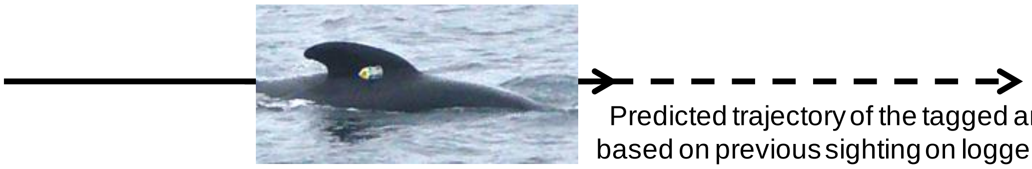
The playback experiments were performed from a separate boat.
Playback sounds were generated with a Lubell speaker at a depth of 8m. The stimuli were broadcast from the playback vessel at a sound pressure level of 145-155 dBrms re 1µPa. The playback sounds were monitored by a calibrated hydrophone placed at 1m from the underwater speaker to measure the source level and to assure that sounds were not distorted and faithfully played back by the system (for details on the playback procedure see Curé et al. 2012, 2013 and Miller et al. 2010).

The location of playback source is crucial when assessing potential changes of direction of horizontal movements (attraction/avoidance relative to the playback vessel). Position of the playback vessel was decided according to the travel path of the tagged animal. Communication and coordination between the observation boat and the playback boat was crucial to adjust the playback vessel position. For all stimuli, the playback started at an estimated distance of 800m from the focal animal, slightly ahead and on the side of its path (Fig. 5). The actual position of the playback vessel relative to the focal animal can be checked afterwards using tracking data.

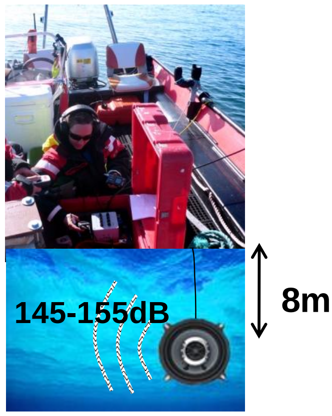
The four playback stimulus types prepared beforehand by Charlotte Curé were:
1) Natural vocalizations of unfamiliar transient mammal-feeding killer whales (*simulating predator presence*).
2) a broad band noise (*non biological sound used* as negative control).
3) Humpback whale songs (*biological sounds that does not represent a threat, used as negative control*).
4) Sonar sounds LFAS-shallow (frequency range: 1-2 kHz, with 1 sec pulses and 20 sec interpulse intervals).

All acoustic signals had a similar Average RMS Power and duration of 15min. For each stimulus type (except sonar) we used three different stimuli (obtained from three different recordings) to avoid pseudoreplication.

Figure 5: Configuration of the playback vessel position during playback experiments.
Each focal group was tested with two or three different playback stimuli depending on the time left for conducting the playback experiments. For each session of playback experiments, the order of presentation of the different stimuli was randomized.



Correct configuration of playback vessel position at start of playback:
800m form the focal whale, slightly ahead and to the side of the animal predicted path.



Playback vessel correctly positioned at start of playback.

Potential behavioral changes of the animal in response to a given stimulus will be assessed by comparison to the 15 min of natural behavior preceding the start of stimulus playback. A minimum of 45 min of silence in between the different sound exposures was important for 1) avoiding a possible bias due to cumulative stimulation of the animals and 2) having the animal back to a normal behavioral pattern before broadcasting the next sound stimulus and collecting pre exposure baseline behavioral data before each stimulus.

SOCIAL BEHAVIORAL DATA COLLECTION

Using the radio beacon on the DTAG, we were able to track the tagged whale during experiments and to collect surface social behavioural data of the tagged whale group (e.g. group size) using a standardized sampling protocol (for details see Visser et al. in review, Curé et al. 2012).
Moreover, additional behavioral parameters were taken for any animals (not necessarily the tagged animal) within 1km of the playback vessel (for details, see protocol of Curé 2013 in Baseline cruise plan). This data supplement was collected from a couple of minutes before the start of exposure up to a couple of minutes after the end of exposure (so a total duration of data collection of about 20 min for each stimulus playback). Data was collected by two observers positioned back to back (the playback operator + another person that could be either the boat driver or an additional person who joined the playback vessel in that purpose), each of these two behavioral samplers taking a visual observation angle of 180° if we consider a full 360° of observation. We used as a backup for the visual observation of the responses two GO PRO cameras mounted back to back on the top of a pole fixed on the playback boat (Fig. 6).

Figure 6 : playback vessel during playback experiments on the 18^{th} of June 2013.

Biopsy sampling

In one over the three experiments where playbacks were conducted, a full blubber profile biopsy was taken from the focal animal at the end of the experiment, before the tag detached. We used a standard LKDart with a Finn-Larsen Biopsy tip for this launched from a pneumatic gun (ARTS). It is a hollow and sharp needle, which samples a small piece of skin and blubber tissue from the back of the animal. The biopsy tip is 8mm in diameter and penetrates 60mm into the blubber. The sample was stored for future analysis from skin and blubber components.

DAILY AND EXPERIMENT SCHEDULES

We followed a schedule where we worked during the day and slept at night. The daily working schedule depended on weather conditions essentially. We did not work in weather above sea sate 3. Every night, we joined together with Minke whale team for a brief meeting to discuss about predicted forecast of the following day and information about animals' locations (sightings from fishermen, locals, own sightings of the day). Based on this information, we decided on a plan for the coming day and where to start searching.

We tried as much as possible to follow the experimental phases given in the experiment time-line table (Fig. 7) which consisted of: searching, tagging, pre-exposure (including post-tagging and baseline data collection), playback experiments, post-exposure, biopsy, tag recovery.

Figure 7*: experiment time-line table from tag on to tag off.*

TIME	T0 = second tag on (or 1h after 1^{st} tag on)	T1	T2		T3		T4		T5	T6 = 2^{nd} tag off
PHASES	Searching + Tagging (1h of 2^{sd} tagging attempt)	Post-tagging (1h) + Baseline (1h)	PB stim 1 (15min)	Silence (45min)	PB stim 2 (15min)	Silence (45min)	PB stim 3 (15min)	Silence (45min)		Biopsy (1h)
			1h		1h		1h			

Total duration of the 2^{nd} tag on: 6h
(7h for the 1^{st} tag)

The steps in the experimental procedure were the following:
1) Searching for animals, 1st tag on, and 2nd tagging attempt (max 1h) + photo ID collection.
2) Collection of baseline behavioural data (visual tracking and surface social behaviour) for 2h (from T0 to T2). T0 is set when the second tag is on (or when we decide to stop the second tagging attempt).
3) Collection of behavioural data during and between sound exposures (2 or 3 stimuli - depending on the time left for experiments - of 15min each, separated by a 45min silence period. After the last stimulus, a 45min of post exposure is collected.
4) Biopsy sampling for the last hour, end of visual tracking.
5) Tag recovery and return to base.

At T0, the three MMOs conducted the data collection protocol, with doing a fix (whale positions and social behaviour data) at regular 2min intervals. Their tasks were divided as follows: a data recorder, a tracker and a surface social behaviour observer. During tracking, we tried as much as possible to stay at a distance of about 200m from the focal group. The data recorder and tracker may have made rotations but the social behaviour observer was always the same.

4. RESULTS - OVERVIEW OF OPERATION AND ACHIEVEMENTS

CHRONOLOGICAL SUMMARY

14 May: Arrival of the team at Henningsvaer at night.
15-16 May: Installation, testing of equipment, meeting with Heike Vester.
17 May: Pilot whales found after 1h of searching from 'Ocean Sounds' boat. Tango boat launched and joint in the afternoon. DTAG successfully attached. Tracking went OK, 2h45 of recorded baseline, KW and HW playbacks successfully conducted, with observation of animals' attraction towards sound source. No biopsy attempts were conducted and no sample was collected.
18 May : Packing and transit to Ure.
19-21 May: Reinstallation at Ure. Waiting for a good weather window to go out.
22 May : The team went at sea for training. Found whales, took photo ID.
23 May : Weather not good enough to go into the fiord but we went onboard and did some training close by the camp.
24 May: We went out (south west) but no pilot whales found. We sighted 2 Minkes and called the other team to give position of our sightings. Bad weather came through.
25 May : We got information that pilot whales were sighted in Folla. all day on water. Transit to Folla. No whales found.
26-27 May: Transit to south east again, found animals, after a second attempt a tag was successfully attached at 17h20 GMT time but did not stay on the animal (off at 18h46). Good tracking for 1h26 of baseline. The tag was re-deployed at 19h36 GMT time but went off prematurely again (19h43). We slept in Kjaringoy and went back at sea early morning on the 28th. Animals were acoustically detected form 'Ocean Sounds' but were too far (>20miles from shore) to be able to get there (safety limits

of the Tango). On the transit back to Ure, sightings of Minke whales, we kept tracking animals until the Minke whale team comes over.
28 May: off water. Bad weather. Team resting and downloading data.
29 May: a large group of pilot whales found in the middle of Vestfjord just north of the entrance of Oksfjord. 'Ocean Sounds' joined Tango after we located the pod. Photos ID confirmed the whales were the same as the ones observed in Folla a few days earlier. DTAG was successfully attached on a large adult animal. Good tracking for 2h of baseline. Sonar and Killer whale sounds playbacks successfully conducted. A successful biopsy sample was collected 15min before the tag came off.
30 May : Off water. Team resting and working on data.
31 May: went out. No pilot whales found but killer whales found. Photo ID and acoustic recordings of killer whales.
1 June: on water, no animals found.
2-5 June: Off water.
6 June: Search for animals, not successful. Heike Vester recorded what she believes to be seismic activity at 14:17 local time behind Skrova, just outside Inglesøy.
7-11 June: Off water.
12 June: Searching for animals, not successful.
13 June: Packing. Boat off water
14 June: Transit shipment to Tromso for 3S[2] main cruise.
18 June: Experiment in Vestjiord during main 3S trial. 2 DTAGs deployed. 2h of tracking baseline followed by 3 successful playback exposures.

SUMMARY OF EFFORT

We had a total of 33 days of baseline field work (including the 18th of June during main 3S cruise that was dedicated to pilot whale effort). The table I below shows that we spent 12 days operational on water including 67h of intense searching (visual and acoustic survey). We were mostly limited by the small size of Tango boat that required very good weather conditions to go out safely.

Table I: Summary of effort during the whole field work period.

Unpacking/ packing	Set up/training	On water (workable)	Off water (weather issues)
4 days	5 days	12 days	12 days

Total searching
67h

# days with PW sighted	
5 over 12 workable days	4 days : experiment
	1 day: additional training

The table II shows our achievements with 5 Dtag deployments and 3 animals exposed to sound playbacks (7 playback trials in total).

Table II: Summary of achievements during the whole field work period.

Date	Effort	Tagging event	GPS logger (YES/NO)	Tracking (hh:mm)	Achievements
17/05	ON	1 tag on	No	07:00	photo ID, baseline, PB exposures (HW, KW)
22/05	training	training	_	_	photo ID
26/05	ON	1 tag on + 2h of attempts	Yes	01:00	photo ID, baseline
29/05	ON	1 tag on	Yes	05:00	photo ID, baseline, PB exposures (Sonar, KW), biopsy
18/06	ON	2 tags on (2 ≠ animals)	Yes	08:00	photo ID, baseline, PB exposures (KW, Sonar, Noise), skin sample
Total :		**5 tags ON**			**3 animals exposed to PB**

BASELINE FOLLOW DATA COLLECTION

A primary objective we accomplished during the trial was the collection of a suite of observations on long-finned pilot whales that match the observations made during the previous 3S sonar exposure experiments. These observations include attachment of a DTAG on a subject whale, followed by tracking of the whales' surfacing locations and observations of group-level behaviour from the observation boat, i.e. Tango or MOBHUS I.

A total of 12h20min of baseline tracking follow data was collected (from N=4 different focal animals). Visual tracking during the baseline follows was highly effective using the same methods used in the 3S experiments (see Kvadsheim et al. 2009, 2011, 2012 and Miller et al. 2010).

PLAYBACK EXPERIMENTS

Playback experiments were conducted from 'Ocean sounds' boat (or Mobhus II) while observation and tracking was conducted from 'Tango' or Mobhus I). The team on Tango communicated to 'Ocean Sounds' the waypoint of where to go to start playback. The position of the playback vessel was correctly positioned before the start of each playback, i.e. at a distance around 800m from the focal group and on the side of the group's path.

Three playback experiments were successfully conducted on long-finned pilot whales. In total, we conducted three playbacks of killer whale sounds, two playbacks of sonar (1-2kHz), one playback of humpback whale sound and one playback of background noise to pilot whales, with clearly observable reactions to the stimuli playbacks. The results of the playback experiments are summarized in Table III.

Table III. Summary of the three playback sessions performed during the Cruise

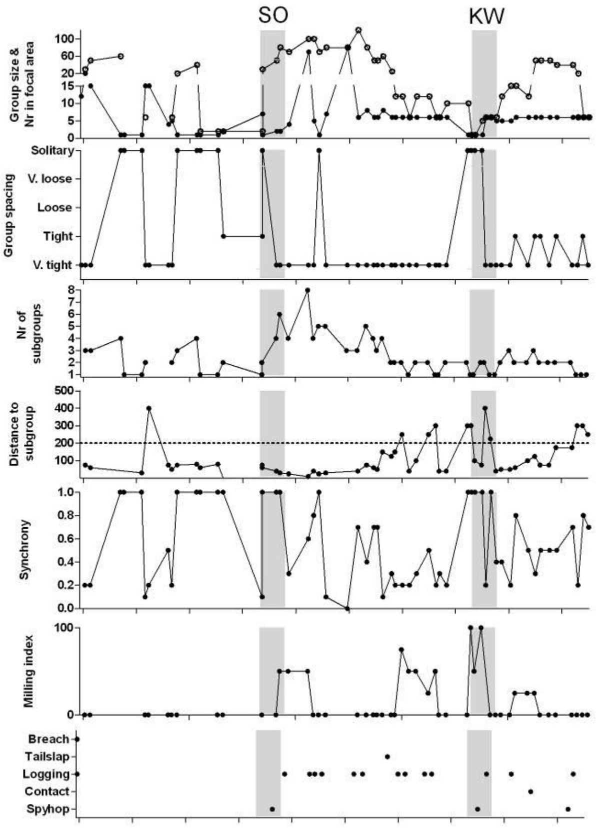
	Date and time of playback			Acoustic signals & comments on responses	
	Date	*Time (GMT) and location of Start*	*Time (GMT) and location of End*	*Acoustic signals*	*Comments*
Gm13_137a	17May	17:09:55 19:04:00	17:09:55 19:19:00	1- Humpback songs (HW1) 2- Killer whale sounds (KW1)	Strong response to both stimuli: clear attraction of the animals towards the sound source. Recording monitoring of PB: Yes for the second playback only.
Gm13_149a	29 May	11:40:40 13:39:26	11:54:00 13:52:25	1- Sonar (1-2kHz) 2- Killer whale sounds (KW2)	Strong response to both stimuli: clear attraction towards the sound source. Long reaction to sonar even after end of playback. Recording monitoring of PB: Yes for both playbacks.
Gm13_169a (focal) Gm13_169b (non-focal)	18 June	11:23:40 12:26:25 14:25:17	11:39:00 12:41:25 14:40:16	1- Killer whale sounds (KW3) 2- Sonar (1-2kHz) 3- Broadband Noise (Noise3)	Strong response to Sonar and KW: clear attraction towards the sound source. No response to Noise: kept original course. Recording monitoring of PB: Yes for the three playbacks.

SOCIAL BEHAVIOR DATA COLLECTION

A focal follow sampling protocol for the visual sampling of cetacean group behaviour, developed specifically for sampling the social behavior of cetaceans, was used to collect data on group size, group spacing and several other social behavior parameters during the entire focal follow period (Visser et al. in review). The protocol ensures quantitative, systematic and generic collection of cetacean group behaviour. During all tag deployments, a dedicated, experienced behavioural observer collected data on the social behavior of the tagged animal (Fig. 8).

Figure 8: Social behaviour of the focal group associated with tagged whale gm13_149a, May 29th 2013. The different panels of the graph show group size, number of individuals and groups in the focal area, group spacing, distance to the nearest other group, surfacing synchrony and the occurrence of surface display events in the focal group during phases with no playback (white area), playback of

sonar sounds (grey area, marked ‘SO’) and playback of killer whale sounds (grey area, marked ‘KW’).



DTAG DATA COLLECTION

The tag deployments are summarized on Table IV. Tag data were collected for five animals and visual tracking was collected for four of these five subjects. A total of 28h10mins of DTAG data was recorded. Four of the five DTAGs deployed had a GPS logger piggy attached on it.

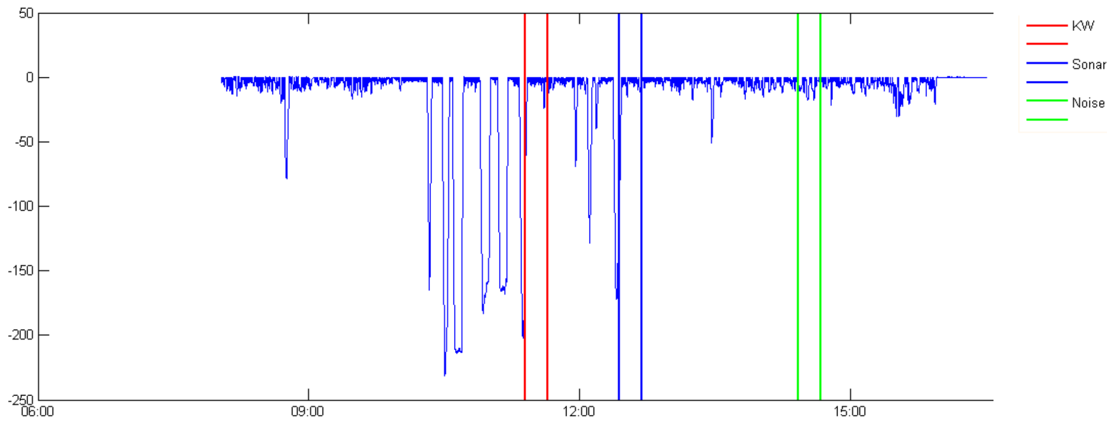
Table IV: Summary table of the tag deployments

Whale ID	Tag on (UTC)	Tag off (UTC)	Re-sighting number	Start of PB session (UTC)	End of PB session (UTC)	Duration of baseline visual tracking (pre exposure)	GPS logger on Dtag (Yes/No)	Biopsy taken (Yes/No)	Photo ID (Yes/No)
gm13_137a	14:20:05	21:00:21	315	17:09:55	19:19:19	2h46min	No	No	Yes
gm13_146a	17:19:42	18:45:51	319	_	_	1h12min	Yes	No	Yes
gm13_149a	09:38:55	14:46:49	321	11:40:40	13:52:25	1h57min	Yes	Yes	Yes
gm13_169a (focal)	08:01:42	16:02:38	30	11:23:40	14:40:16	6h25min	Yes	No biopsy but skin sample yes	Yes
gm13_169b (Non focal)	09:04:36	_	_			_	Yes	No	Yes

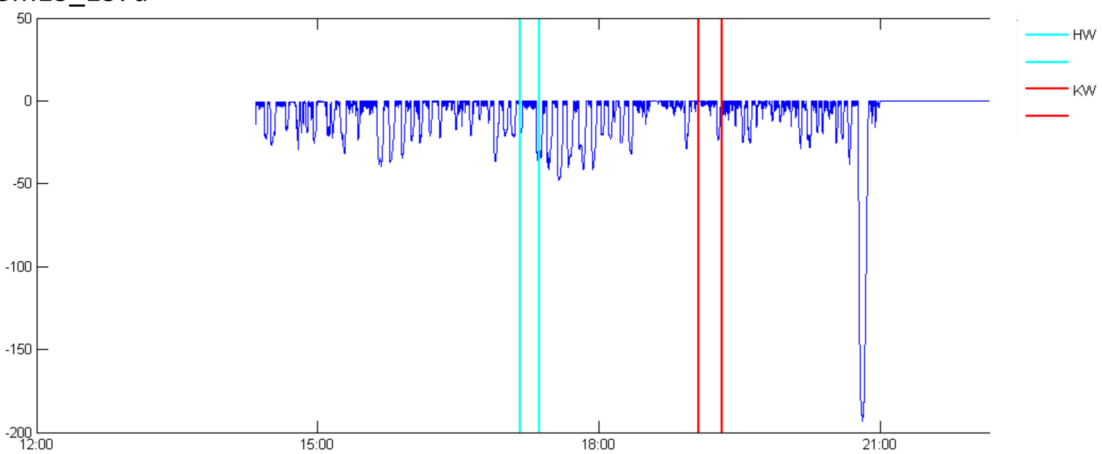
The DTAG recorded the depth, providing the dive profile of the tagged animals. Figure 9 illustrates the dive profiles of two tagged whales.

Figure 9: Time-depth profiles for two DTAG deployments accomplished during the 3S-2013 baseline trial.

Gm13_169a



Gm13_137a



Visual tracking data

Visual tracks of the tagged animal give information about potential changes of horizontal movements. Figures 10-12 give examples of the tracks of tagged whales.

Figure 10: Logger trackline of deployment gm13_137a

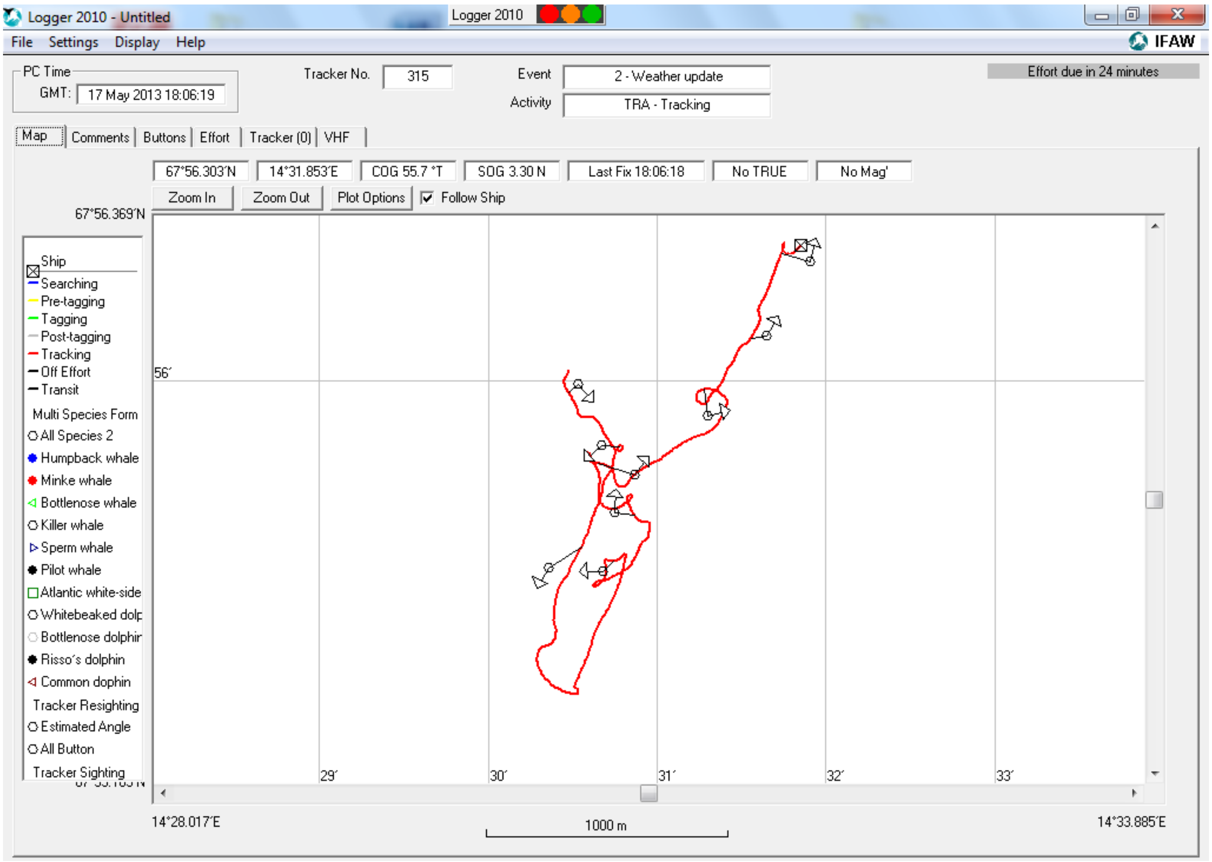
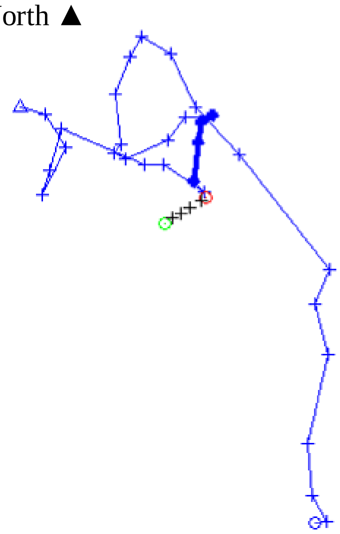


Figure 11 : zoom of the track of gm13_169a during killer whale sound playbacks:

North ▲

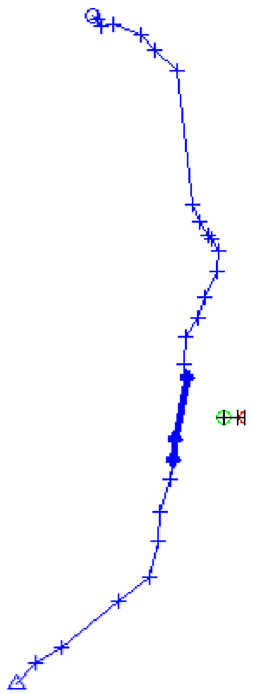


Legend:
Blue circle: start of tracking.
Blue triangle: end of tracking.
Each blue cross is a re-sighting position of the tagged whale.
In bold: track during KW playback.
Green circle: position of playback vessel at start of KW playback.
Red circle: position of playback vessel at end of KW playback.
Back crosses: projection of the playback vessel drifting between start and end of KW playback.

In this example above (Fig. 11), the playback of KW sounds elicited a change in the direction of horizontal movement of the tagged whale towards the playback vessel.

Figure 12 : zoom of the track of gm13_169a during the broadband noise playback:

North ▲



In blue bold: track during Noise playback

Green circle: position of playback vessel at start of Noise playback.
Red circle: position of playback vessel at end of Noise playback.
Back crosses: projection of the playback vessel drifting between start and end of Noise playback.

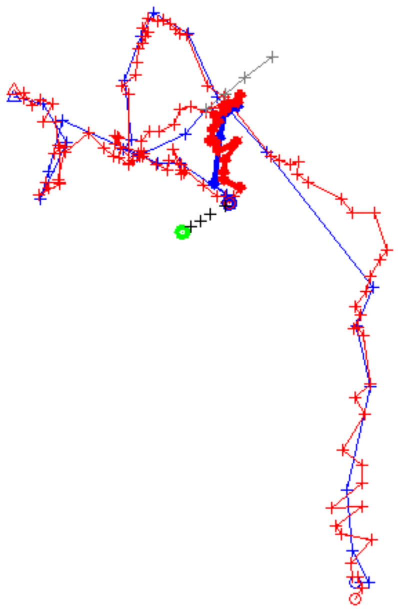
In contrast to the response to the KW playback, the tagged whale kept its original course when the broadband noise stimulus was played back.

GPS LOGGER DATA

For four over the five DTAG deployments, the DTAG was coupled with a GPS logger. The GPS tracks matched with the visual tracking, showing the accuracy of the visual tracking method (see Fig. 12).

Figure 13: Comparison of the visual track (blue) and GPS track (red) for gm13_169a before, during and after KW playback.

North ▲



Legend:
In blue: visual tracking
In Red: GPS tracks
Green circle: position of playback vessel at start of KW playback.
Red circle: position of playback vessel at end of KW playback.
Back crosses: projection of the playback vessel drifting between start and end of KW playback.
Grey line: direction of the whale's horizontal movement if the animal had kept its original course (based on the projection of the last 15min pre exposure sightings, see Curé et al. 2012 for details of the method).

PHOTO ID DATA COLLECTION

Photo-identification equipment included Canon 30D camera and Canon 50D camera, both equipped with Canon Image Stabilizer zoom lenses (70-200mm, 1:2.8).

Photo-identification pictures of pilot whales were taken during the tagging phase. Photographs taken of pilot whales (Fig. 14) will be compared to photos taken on previous cruises 2008, 2009 and 2010 for potential re-sightings. There are photos available for all deployed tags.

Fig. 14: photo ID of tagged animal gm13_137a

TISSUE SAMPLE COLLECTION

Two tissue samples were collected during the trial. One biopsy sample was collected during DTAG deployment, using the LKARTS system and Finn---Larsen tips. This sample had a skin and blubber sample. A second sample consisted of a skin and blood sample, which was left in one of the suction cups of the DTAG, after the tag had come of the animal.

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