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INNER MORAY FIRTH

2D SURVEY

UKCS BLOCKS 17/4B, 17/3, 11/28 & 11/29

AUGUST - SEPTEMBER 2011

MARINE MAMMAL OBSERVATIONS AND PASSIVE ACOUSTIC MONITORING REPORT

Gardline Project Ref.	8885
DECC Ref.	2212
Fieldwork Dates	29th August – 9th September 2011
Report Status	Draft V2
Issue Date	10th October 2011

GARDLINE ENVIRONMENTAL LTD
Endeavour House, Admiralty Road, Great Yarmouth, Norfolk NR30 3NG. England
Telephone +44 (0) 1493 845600 Fax +44 (0) 1493 852106 http://www.gardline.com

REPORT AUTHORISATION AND DISTRIBUTION

Report Status		Draft V2
Issue Date		10th October 2011
Marine Mammal Observers	Marine Wildlife Department	Z. Allen N. Duthie
PAMS Operators	Marine Wildlife Department	K. Preston N. Russell
Compilation	Marine Wildlife Department	Z. Allen K. Preston N. Russell
QC	Marine Wildlife Department	A. Nichol
Authorisation	Marine Wildlife Department	N. Clark

Distribution

One copy to

PA Resources UK Ltd
4th Floor
Waterfront
Winslow Road
Hammersmith
London
W6 9SF
For attention of
Mr Jon Lucas
jlucas@paresources.uk.com

One copy to

JNCC
Inverdee House
Baxter Street
Aberdeen
AB11 9QA

For attention of
seismic@jncc.gov.uk

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Gardline Environmental Ltd
Endeavour House, Admiralty Road, Great Yarmouth, Norfolk NR30 3NG. England
Telephone +44 (0) 1493 845600 Fax +44 (0) 1493 852106 http://www.gardline.com

EXECUTIVE SUMMARY

- A 2D seismic survey was conducted onboard the *M.V. Sea Surveyor* from 29th August to 9th September 2011. The survey was performed in UKCS Blocks 11/28, 11/29, 17/3 and 17/4b in the Inner Moray Firth.

- Weather conditions recorded during the survey were variable. Although constant low swell and predominantly good visibility there were occasional choppy seas.

- The 2D survey utilised airguns on nine days of the survey, to run a total of 75 high resolution seismic survey lines (including reruns) and six gun tests.

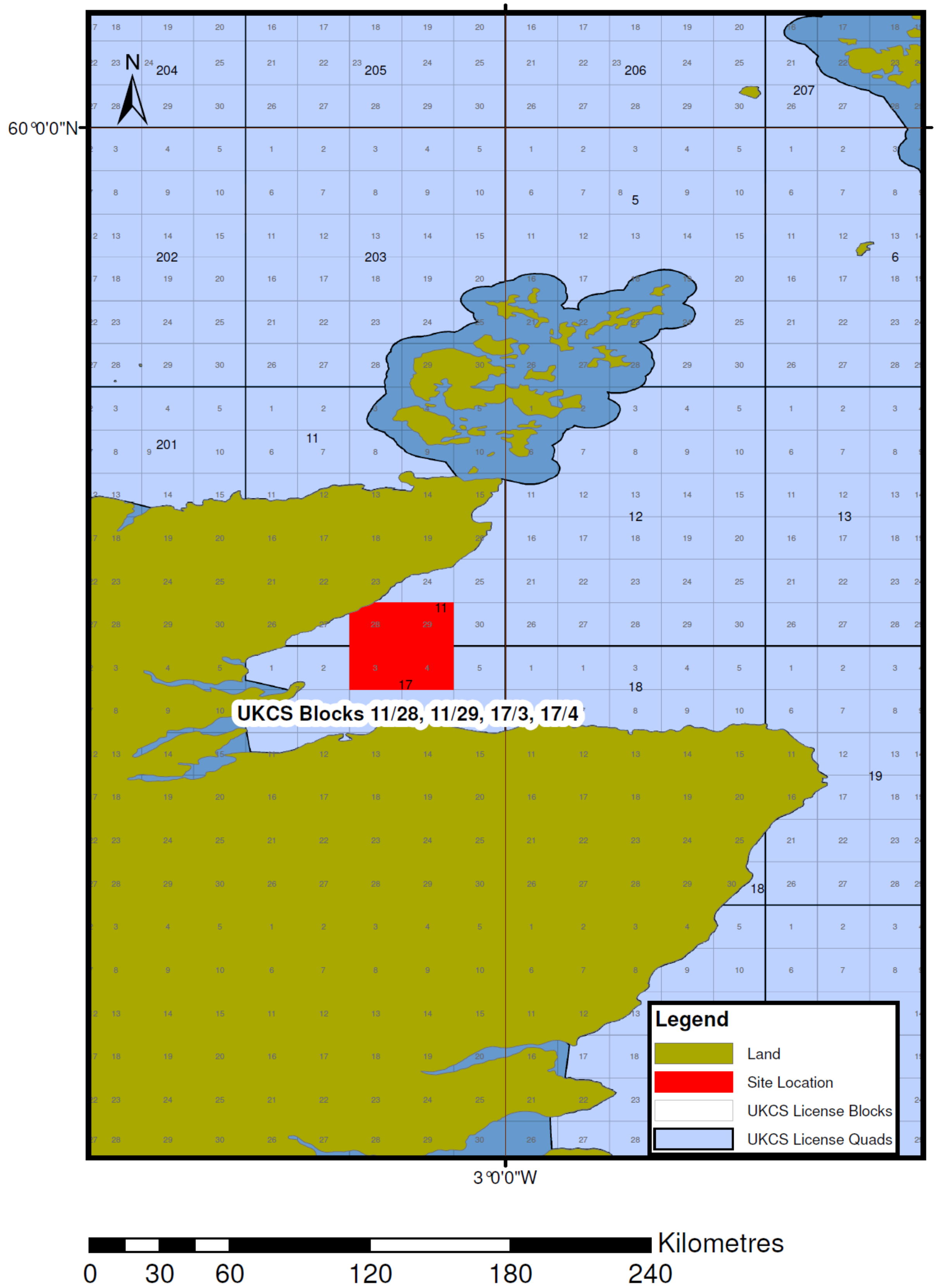
- There were a total of 77 soft starts conducted during the survey. Of these, 47 were during daylight hours and low light hours and were covered by full pre-shoot watches. All soft starts were preceded by a pre-shoot monitoring period on the PAMS.

- Visual monitoring for marine animals occurred over 10 days, totalling 128 hours and 11 minutes of effort, while PAMS was used on 9 days, totalling 196 hours and 10 minutes of effort.

- During the survey there were 14 sightings but no acoustic detections of marine mammals.

- During the survey there were no incidences where 2D seismic acquisition was delayed due to the close proximity of marine mammals, turtles, sharks or Atlantic sturgeon.

LOCATION MAP



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1. INTRODUCTION

1.1 Background

Sound is conducted through water approximately 4.5 times faster than through air, thus it is the most important sense for many marine organisms. This is especially true for marine mammals which use sound to communicate, navigate, forage and for predator avoidance. The frequency range used by marine mammals varies between 10 Hz - >200 kHz, with the large baleen whales using the lower frequencies while smaller toothed whales use higher frequencies (Gotz *et al*, 2009) (Figure 1.1).

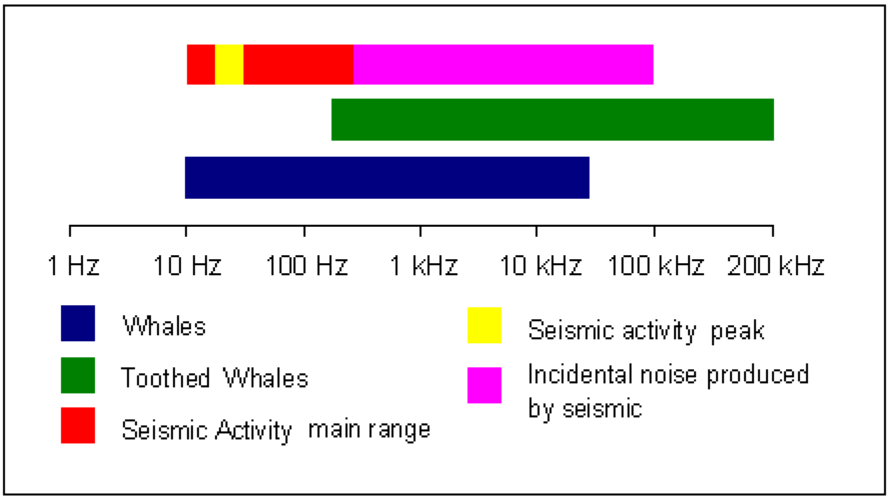

Figure 1.1 Frequencies used by marine mammals and main frequency range of seismic activity

Seismic surveys are performed to establish and investigate geological structures associated with hydrocarbon deposits in the seabed. Airgun arrays are the most common energy sources used in marine seismic surveys. Air, under high pressure, is released into the water from airguns towed behind the vessel and is reflected by rock and other sedimentary layers and subsequently detected by hydrophones that are located in towed cables. Seismic airguns generate low frequency sound pulses below 250 Hz (DeRuiter, 2006) with the strongest energy between 30-50 Hz. Incidental noise up to 100 kHz is also produced from airguns (DeRuiter, 2006), this frequency range is not directed downwards as with the main frequency range but dissipates horizontally. The power of the airguns can reach a maximum power of approximately 260 dB re. 1 µPa @1m (Gotz *et al*, 2009). It has been shown that in suitable oceanic environments seismic activity can be detected above background noise at 3000 km (Nieukirk *et al,* 2004).

Sound can impact marine mammals in varying degrees of severity from behavioural responses to physiological damage, generally limited to the auditory system (Gotz *et al*, 2009). The most commonly observed effects are behavioural changes. It was shown that acoustic disturbance within a lagoon caused a grey whale (*Eschrichtius robustus*) population to avoid the area until several years after the disturbance had ceased (National Research Council, 2005). Several species of baleen whale have displayed avoidance behaviour to seismic surveys, although in some species, this does seem to be sex specific. For instance male humpback whales (*Megaptera novaeangliae*) have reportedly been either attracted to or tolerant of seismic activity, while females display avoidance behaviour (Gotz *et al*, 2009). One study by Clark and Gagnon (2006) showed that a group of fin whales (*Balaenoptera physalus*) ceased all vocalisation until after completion of the survey. It is hard to predict what such behavioural responses to seismic activity will do to a population but these may include long-term behavioural responses, migratory disruption, shifts in feeding distributions and residential displacement (Evans & Nice, 1996; Morton & Symonds, 2002; Gordon *et al*, 2003), however varying views within the scientific community make such predictions cautionary. There have been some links between seismic activity and mass strandings but none of these have been confirmed and there is no conclusive evidence that seismic activity causes these strandings (Gotz *et al*, 2009).

There has been some research into the impact of seismic activity on the auditory systems of marine mammals, most of which has been focused around toothed whales. Research points towards the fact that seismic activity can cause Temporary Threshold Shifts (TTS) in marine mammal hearing (Finneran *et al*, 2002; Lucke *et al*, 2009). This occurs when high levels of noise cause the hair cells in the cochlea to begin to fatigue, making the animals hearing less effective. When these hairs eventually return to their normal shape normal hearing is resumed, however, if the hair cells are broken, or do not return to normal, the damage is permanent and this is called Permanent Threshold Shift (PTS) (National Research Council, 2005). Research on toothed whales has shown that the frequencies emitted by seismic surveys could cause TTS, but the animals would have to be close to the source and there was no evidence to conclude that airguns could cause PTS (Finneran *et al,* 2002).

There has been little research into the effects of seismic activity on basking sharks (*Cetorhinus maximus*); however, their surface feeding has the potential to bring them in close contact with the airguns and avoidance behaviour could lead to changes to migration routes (Bloomfield & Solandt, 2007). Long-term effects of noise disturbance could lead to weight loss and reduced reproductive success (Bloomfield & Solandt, 2007) which in turn could impact population recruitment. Some shark species have excellent hearing with sensitivity peaking around 20 Hz (Casper & Mann, 2006). These species are predatory and use sound as a means of locating prey, however it is unlikely that basking sharks have such a well developed sense of hearing due to their planktivorous diet.

Marine turtles are another species potentially impacted by seismic surveys (their maximum hearing sensitivity falls in the low frequency range < 1kHz, (Bartol *et al,* 1999) however it is unlikely that any would be found in the Inner Moray Firth.

The UK Department of the Environment issued the Guidelines for minimising acoustic disturbance to small cetaceans in February 1995, as part of the government's response to the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS). The Guidelines aimed to reduce the disturbance to cetaceans from seismic surveys in UK waters. The Guidelines were last revised August 2010. Previous revisions were in 1998, 2004 and 2009. Seismic operators were and still are subsequently required to contact the Joint Nature Conservation Committee (JNCC) when planning surveys in UK waters to discuss methods of minimising acoustic disturbance to marine mammals. The present Guidelines (Appendix A) state that "In relation to oil and gas seismic surveys in the UKCS, it is a requirement of the consent issued under Regulation 4 of the Petroleum Activities (Conservation of Habitats) Regulations 2001 (& 2007 Amendments) by the Department for Energy Climate Change (DECC), that the JNCC

Seismic Guidelines must be followed, and the elements of the Guidelines that are relevant to a particular survey are incorporated into the legally-binding condition of consent". It should be noted that it is the responsibility of the company issued consent by the DECC that the JNCC Seismic Guidelines must be followed. It is recommended that a copy of the JNCC guidelines are available onboard all vessels undertaking seismic activities in UK waters. Where relevant, when the survey is completed a MMO report must be submitted to the JNCC.

The 2010 version of the JNCC seismic guidelines reflects amendments (2007 and 2009 amendments) to the Conservation (Natural Habitats &c.) Regulations 1994 (Habitat Regulations, HR) for England and Wales and the Offshore Marine Conservation (Natural Habitats, &c) Regulations 2007 (Offshore Marine Regulations, OMR, as amended in 2009 and 2010). Both regulations have revised the definition of deliberate disturbance of 'European Protected Species' (EPS), which now excludes trivial disturbance from the offence. Both regulations now also include the offence of deliberate injury. European Protected Species include cetaceans and turtles.

The JNCC recommends that the soft start procedures for marine mammals would also be appropriate for marine turtles, basking sharks and, most recently, Atlantic sturgeon. To record procedures and to detect and identify marine animals during the survey, operators are required to employ trained Marine Mammal Observers (MMOs). However, due to the incorporation of turtles, basking sharks and sturgeon, all watches carried out were for 'marine animals' and will be referred to as such throughout the report.

1.2 Objective

This report presents the findings of dedicated marine animal watches during a 2D survey in UKCS Blocks 11/28, 11/29, 17/3 and 17/4b in the Inner Moray Firth (see Location Map). This survey was conducted for PA Resources on board the *M.V. Sea Surveyor* from 29th August to 9th September 2011.

2. THE MARINE ENVIRONMENT

2.1 Physical Environment and Oceanographic Features

The ocean is a highly heterogeneous environment, with both large- and small-scale spatial patterns in oceanography (Hunt & Schneider, 1987). Fluctuations in physical and biological factors within the ocean environment will have an effect on the abundance and distribution of marine fish and zooplankton, which in turn will be reflected in specific marine populations (Thompson & Ollason, 2001). Physical processes such as circulatory patterns may have large-scale implications on the dispersion of all marine life. Equally important small-scale features, or localised episodes, will also have an overall effect. Oceanographic features vary on a temporal scale, with seasonal formation of fronts and annual fluctuations in temperature, salinity and primary production (le Fèvre, 1986; Ellett & Blindheim, 1992).

The distribution of marine animals is extremely irregular and is generally related to the distribution of their food source. Marine animals feed on a variety of foodstuffs and thus their distribution is related to the movement or abundance of such food sources (e.g. Evans, 1990; Macleod *et al,* 2004; Friedlaender *et al*, 2006). As the distribution and abundance of marine animals is influenced by oceanographic characteristics it is important to describe the topography and marine processes in the study area.

The study area is situated in the Inner Moray Firth (see Location Map), which forms an integral part of the wider North Sea basin and Atlantic, sharing large scale environmental factors including water circulation and climate patterns (Eleftheriou *et al*, 2004). Two oceanographic features, identified as the Dooley current, dominate the region; a cold water current moving in from the north and a plume of warmer water emerging from the Inner Firth (Tetley *et al*, 2008). There are 10 major rivers which flow into the Inner Firth area substantially reducing salinity and creating an estuarine-like environment (Adams & Martin, 1986). Contained within the Inner Moray Firth are three smaller firths, the narrow mouths of which are composed of steep sided basins of over 50 m within 1 km offshore (Whaley, 2004). At this finer scale, tidal flows, bathymetry and the brackish nature of water create tidal intrusion fronts (Mendes *et al*, 2002). The seabed in the rest of the Inner Moray Firth slopes to a depth of 50 m approximately 15 km offshore (Holmes *et al*, 2004).

2.2 Marine Communities

Similar to the North Sea, *Ceratium* species dominate the phytoplankton, with the diatoms *Hyalochaete* spp. and *Thaossiosira* spp. also abundant within the area (Johns, 2004). In the zooplankton community, copepods, particularly *Calanus* species, have the highest abundance. Small copepods such as *Acartia* spp., *Para-pseudocalanus* spp. and juvenile *Calanus* are also particularly abundant. Larval stages of many benthic organisms also form an important part of this community, particularly echinoderm, decapod and coelenterate larvae (Johns, 2004).

The Inner Moray Firth is considered to support a significant area of subtidal sandbank features: defined as being slightly covered by seawater at all times, these consist mainly of soft sandy sediments but larger grain sizes including boulders and cobbles, or smaller sizes including mud may also be present (Moray Firth SAC Management Group, 2009). Initial surveys show a high diversity of fauna dominated by polychaetes, bivalves *Tellimya ferruginosa* and *Mysella bidentata* and brittle star *Ophiothrix fragilis* (Eleftheriou *et al*, 2004). The Inner Moray Firth also has extensive rocky platforms that are a mixture of bedrock, boulders, cobbles and mixed sediments. The biota of these hard areas are characterised by *Alcyonium digitatum* and brittle stars *Ophithrix fragilis* and *Ophiocomina nigra* (Foster-Smith *et al*, 2009). Between these rocky outcrops, sandy muds are present in deeper waters and medium, fine, sometimes shelly sands in shallow waters. Benthic fauna is characterised by brittle stars (*Amphiura* sp.) and the mollusc *Turritella communis*. The shallowest sediments are characterised by the brittle star *Ophiura ophiura*, razor shells (*Ensis* sp.), small heart urchins *Echinocardium cordatum* and bivalves (Foster-Smith *et al*, 2009).

The fish assemblage of the Inner Moray Firth is dominated by three pelagic species, sandeel (*Ammodytes marinus*), sprat (*Sprattus sprattus*) and herring (*Clupea harengus*). Whiting (*Merlangius merlangus*), haddock (*Melanogrammus aeglefinus*), common dab (*Limanda limanda*), lemon sole (*Microstomus kitt*) and plaice (*Pleuronectes platessa*) are also particularly abundant (Greenstreet *et al*, 1998).

Three species of cetacean are known to regularly occur in the Moray Firth, the harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*) and minke whale (*Balaenoptera acutorostrata*) (Eisfield *et al*, 2009). The Inner Moray Firth is one of the first areas in Europe to be identified as a marine candidate Special Area of Conservation (cSAC) for bottlenose dolphins. Although bottlenose dolphins are present year round in the coastal margins (Hastie *et al*, 2003), they undergo distinct seasonal movements within the area, with the deep, narrow entrances to coastal inlets at the head of the Firth used most intensively particularly during the summer months (Wilson *et al*, 1997; Hastie *et al*, 2003).

In contrast harbour porpoise are more widely distributed throughout the Inner Moray Firth area (Hastie *et al*, 2003). Minke whales regularly occur in the southern Outer Moray Firth during the summer months (Robinson *et al*, 2009). Individuals are also recorded in the offshore areas of the Inner Moray Firth (Bailey & Thompson, 2009).

Both grey seals (*Halichoerus grypus*) and common seals (*Phoca vitulina*) are encountered in the open waters of the Inner Moray Firth. Sheltered estuaries are used as haul-out and breeding sites by common seals, while grey seal pups are found on rocky beaches and caves (Thompson *et al*., 1996). The Dornoch Firth is considered particularly important for common seals, supporting 2% of the UK population and has been designated a cSAC (Butler, 2004). Common seals tend to forage within 60 km of haul-out sites, while grey seals which forage in the Moray Firth travel up to 145 km from sites (Thompson *et al*., 1996).

3. METHODOLOGY

3.1 Study Area

The 2D survey was carried out for PA Resources. The site was located in the Inner Moray Firth (see Location Map) in an area of water approximately 50 m deep. The position of the site can be found in Table 3.1.

Table 3.1 Seismic survey location

Site	Latitude	Longitude	Blocks	DECC Ref.
Inner Moray Firth	57° 58" 27' N	3° 22"20' W	11/28, 11/29, 17/3 & 17/4b	2212

3.2 Survey Vessel

The 2D seismic survey was carried out on board the *M.V. Sea Surveyor* from 29th August to 9th September 2011. The vessel details are as displayed in Table 3.2.

Table 3.2 Vessel particulars

Vessel	*M.V. Sea Surveyor*
Class	Lloyds – 100 A1 LMC
Flag	Bahamas
Length OA	64.4 m
Breadth OA	11.4 m
Draft	3.50 m
Built	1979
Rebuilt	1988
Endurance	28 DAYS
Main Engine	2 x Mirrlees Blackstone ESL6, each BHP @ 900 r/m. Driving 2.5:1 reversible reduction gearboxes, twin propellers
Propellers	Twin Ajax Bamford Fixed Pitch. 4 blades Ø 1650
Thrusters	Bow & Stern, 175 HP
Accommodation	38 berths
Owners	Gardline Shipping Ltd.
Cruising speed:	10 kts
Average trials speed:	3-4 kts

3.3 Survey Parameters

The survey comprised of 2D seismic work and took place between 29th August and 9th September 2011. Survey speed was approximately four knots throughout. The objective was to undertake a 2D seismic investigation of a potential prospect in the inner Moray Firth.

3.3.1 2D Seismic Survey

Details of the 2D seismic equipment used to acquire data during the survey can be found in Table 3.3 and the completed line plan is shown in Figure 3.1. The area surveyed was 7 x 15 km and was centred on the proposed location.

Table 3.3 2D survey equipment

Source:	**470 cu in**
Guns	3 x 60 cu in, 1 x 90 cu in, 2 x 100 cu in
Tow depth	6 m $\pm$ 1 m
Shot point interval	6.25 m
Operating pressure	2000 psi
Frequency	175000 Hz
Intensity	18.3 bar m
Streamer	**2000 m**
Channels:	168
Group interval:	12.5 m
Nominal streamer depth:	6 m $\pm$ 1 m
Recording	
Sample rate	2 ms
Record length	6 s

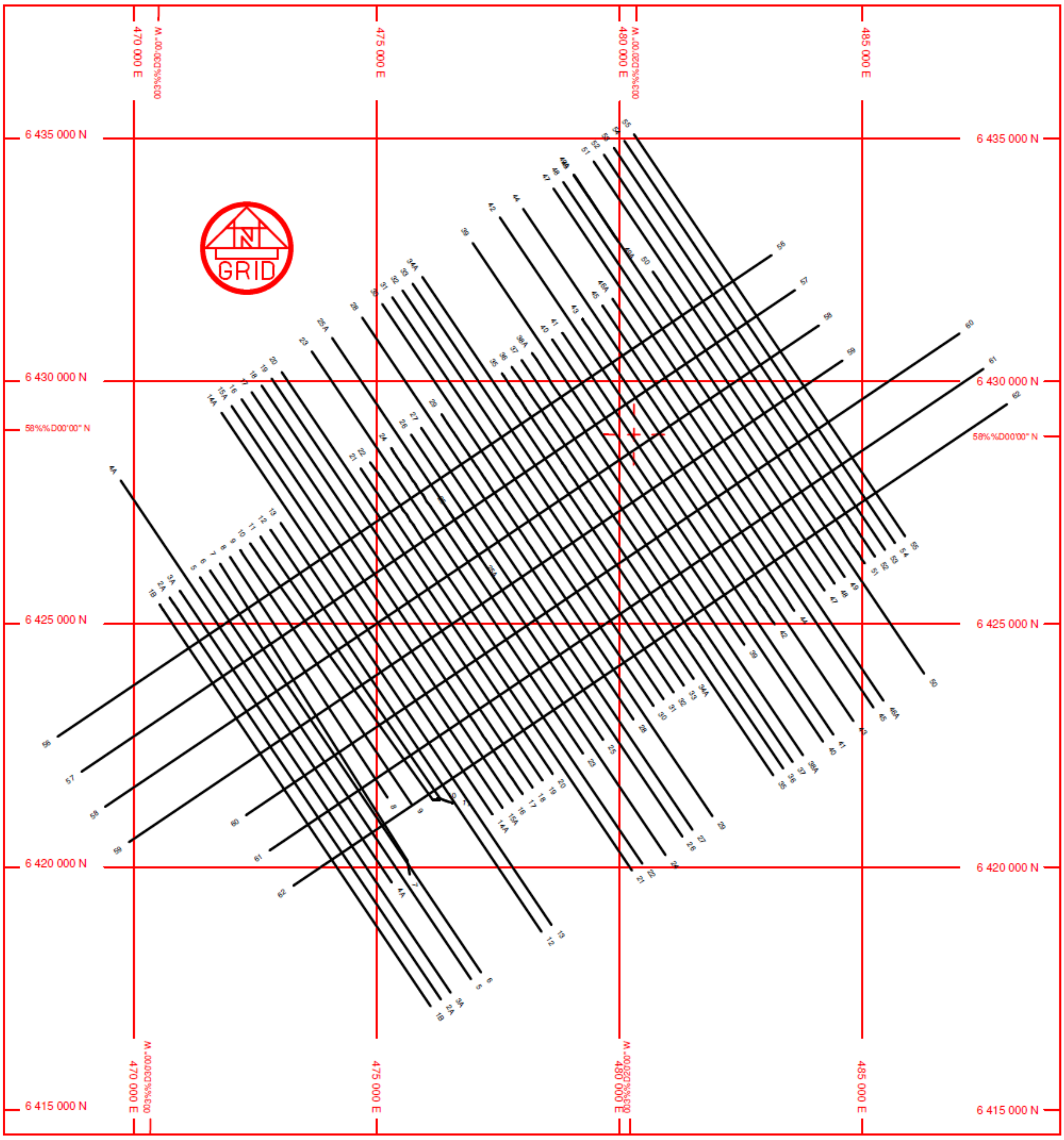

Figure 3.1 Completed line plan for the Inner Moray Firth 2D survey

3.4 Operators Procedures

The survey was run in accordance with the JNCC's '*Guidelines for minimising the risk of injury and acoustic disturbance to marine mammals from seismic surveys, August 2010*' as requested by PA Resources. These Guidelines require that a watch for marine animals be performed at least 30 minutes prior to the use of airguns (in water less than 200 m deep) or 60 minutes (in water >200 m) prior to the use of airguns during daylight hours. Should marine animals be present within 500 m of the vessel and/or airguns during this period, the start of the source should be delayed by at least 20 minutes after the last sighting to allow animals to move out of the vicinity.

The JNCC Guidelines also require that a 'soft start' procedure be operated prior to use of the airguns. During this soft start, the source volume is built up slowly from a low energy start-up over a period of 20 minutes before reaching the level required for survey production. It is intended that this slow build up will allow marine animals in the vicinity of the seismic vessel to move away from the area of the airguns.

During a typical survey, if the line turn length is expected to be less than 40 minutes, at the end of each line, the firing frequency is to be reduced until the line run in when the firing frequency is increased to that required for shooting the line. If at any point the line turn is expected to be longer than 40 minutes, firing of the guns should be stopped and the next line preceded by a soft start.

3.4.1 Conditions of the PoN14

In addition to the measures laid out in the JNCC's *'Guidelines for minimising the risk of injury and acoustic disturbance to marine mammals from seismic surveys, August 2010'*, specific conditions were laid out in the PoN14 issued by DECC for this survey (Appendix B). Firstly, two MMOs were required to undertake visual monitoring prior to and during all soft start procedures, as well as being available during all daylight seismic operations.

Secondly, there was communication with the JNCC regarding the line turns and if deviation from the JNCC Guidelines was appropriate in this instance. In response to concerns raised by Scottish Natural Heritage (SNH) and the designation of the survey site it was decided that, contrary to JNCC guidelines, by continuing to fire airguns during turns, instances of marine animals approaching the survey site would be reduced. At the end of each survey line, the volume of the airgun discharge was to be reduced to 60 - 100 cu in and the shot point interval extended to 3 - 5 minutes, with a standard 20-40 minute soft start required prior to the next line.

Additionally it was requested in the PoN14 that the consent holder cooperate fully with the University of Aberdeen, in order to facilitate the monitoring work being undertaken by the University during the seismic survey.

3.5 Observation Methods

The two Marine Mammal Observers (MMOs) carried out dedicated watches for marine animals during seismic operations in daylight hours and completed the relevant recording forms.

Watches were primarily carried out from the bridge, the bridge wings and the monkey island. Prior to beginning a watch, the time (UTC) and the weather conditions were recorded on the JNCC Location and Effort Form (Appendix D). Weather conditions such as Beaufort wind force, sea state and visibility were noted every hour and whenever a change in conditions occurred. The used definitions of Beaufort wind force and sea state are provided in Appendix C. In addition, the start and end times of marine animal watches and the start and end times of the firing of the airguns were recorded each day on the JNCC Record of Operations Form (Appendix D).

The primary observation technique used to spot marine animals was to scan the visible area of sea using the naked eye and scanning areas of interest with binoculars (magnification 10 x 42) (e.g. waves going against the prevailing direction, white water during calm periods, bird activity, bird transiting direction etc.). This technique gave both a wide field of view and the ability to have a sufficient range of 3 - 4 km in ideal conditions.

Identifications are based on a combination of the observer's previous experience, aided by the sources listed below:

- REID, J.B., EVANS P.G.H., NORTHRIDGE, S.P. 2003. *Atlas of Cetacean distribution in north-west European waters*. Joint Nature Conservation Committee, Peterborough.

- SHIRIHAI, H. & JARRETT, B., 2006. *Whales, Dolphins and Seals. A Field guide to the marine mammals of the world.* A & C Black Publishers.

The JNCC Marine Mammal Recording Forms were available to record sightings made by the MMOs. The information recorded included the date and time, the vessel's position, course, depth and seismic activity, the species, number of animals, behaviour, the distance from the vessel and direction of travel. Any additional information, such as details on the features used to identify the animals and the reaction of the animals to the airguns was noted.

3.6 Acoustic Monitoring

Passive Acoustic Monitoring (PAM) uses hydrophones (underwater microphones) to detect and monitor the presence of vocalising cetaceans. Cetaceans produce a wide variety of sounds, which range from very low frequency vocalisations (down to 15 Hz) of large baleen whales, to extreme high frequency echolocation clicks (up to 130 kHz) used by small cetaceans such as the harbour porpoise.

A Passive Acoustic Monitoring System (PAMS) was used to acoustically monitor cetaceans during pre-shooting periods of the survey, and during all seismic operations. The PAMS utilised a single hydrophone streamer array, described below (Section 3.6.1). The acoustic data from the hydrophone streamer was received both digitally through a computer and audibly to the PAMS operator. The computers utilised the PAMGUARD software system (see Section 3.6.2) to ensure effective monitoring. Figure 3.2 shows a diagrammatical representation of the PAMS used onboard during the survey.

Monitoring was conducted throughout the period of PAMS deployment and JNCC marine mammal recording forms were completed during all periods of PAMS use (see Appendix D).

3.6.1 Hydrophone streamer

The hydrophone array used was an array that was adapted from the design used on trials held in 1997 (Coates, 1998; Chappell *et al*, 2000). The hydrophone array consisted of four individual hydrophones that were of two related pairs (medium frequency, MF, and high frequency, HF). These pairs were connected to a set of pre-amplifiers and were situated on the end of a 250 m strengthened tow cable. The hydrophone was deployed from the stern of the vessel, using the portside boom, and sat at a water depth of around 20 m.

3.6.2 Monitoring system

PAMGUARD v.1.10.0 software was used to detect the whistles and clicks of vocalising marine mammals. PAMGUARD is open-source Passive Acoustic Modelling software based on a platform-independent (e.g. Windows or Linux), flexible, modular architecture. Two laptops were used, one medium frequency and one high frequency, both of which ran in real time, automatically passing detection and effort data to the central user-interface and a database. Whenever possible, during the survey, the software was left monitoring continuously.

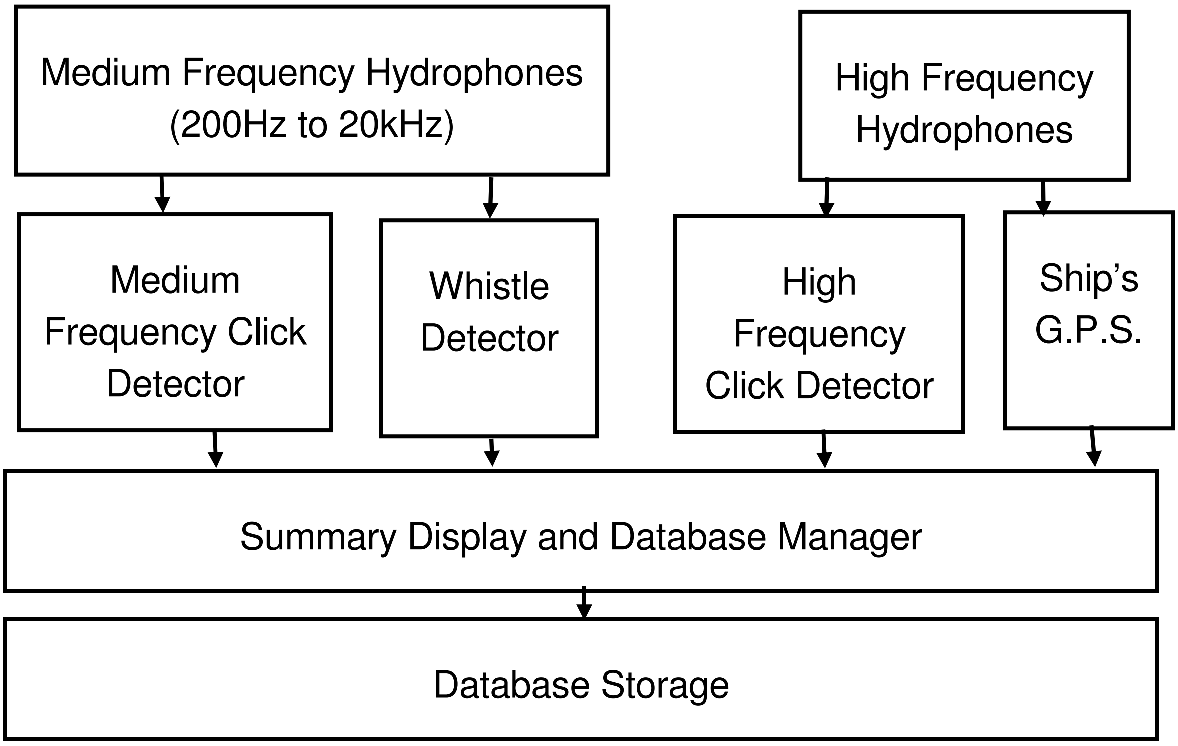

Figure 3.2 Systematic diagram of the passive acoustic monitoring system.

4. RESULTS

4.1 Survey Coverage

The *M.V. Sea Surveyor* mobilised in Montrose, Scotland on 29th August 2011 and sailed for site at 17:30h on 30th August arriving on site at 07:02h the following day. Gun tests were carried out between 15:15h on 1st September and 02:16h on 2nd September. The first line commenced with a soft start at 02:41h on 2nd September and 2D seismic acquisition continued uninterrupted until 18:22h on 9th September when the survey was deemed complete.

During the survey a total of 75 2D seismic lines were run, including 12 reruns and six gun tests. These lines were obtained over nine days of the 12-day survey (Table 4.1).

Table 4.1 Summary of 2D data acquisition for the Inner Moray Forth 2D seismic survey

Data acquisition	Inner Moray Firth
Number lines (inc. reruns)	63 (75)
Number of gun tests	6
Total hours (hrs:min)	160:32
Total km	480.4
Number soft starts	77
Number daylight soft starts	47
Average length of soft start (mins)	25
Average length of line turn (mins)	68

4.2 Weather Conditions

A total of 128 hours and 11 minutes of dedicated watches were carried out by the MMOs whilst 196 hours and 10 minutes of PAMS monitoring was carried out between 29th August and 9th September 2011. Weather conditions recorded during the survey were good to moderate with low swell throughout. Sea state was predominantly slight or choppy (99% of the time; Figure 4.1) with mostly good visibility (77%; Figure 4.2). Wind force was highly variable, ranging between Beaufort 1 and 8, but was between force 2 and 5 for 84% of the time (Figure 4.3).

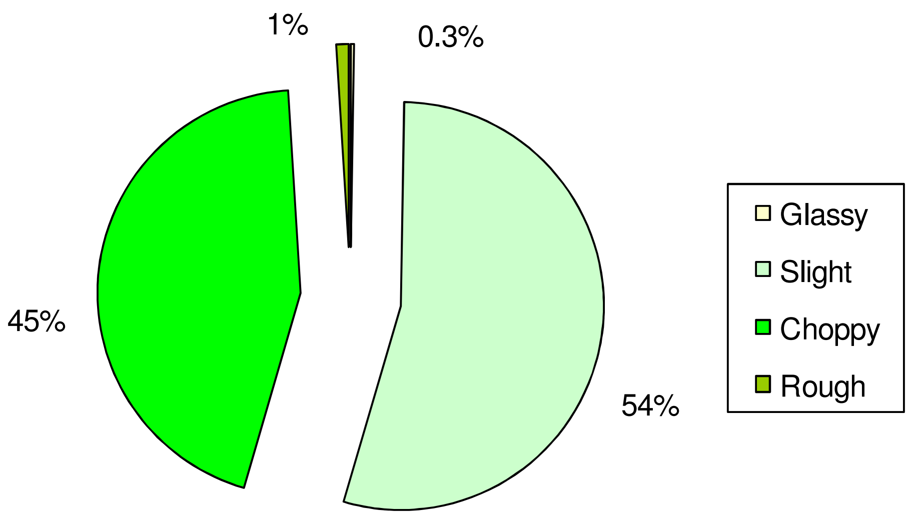

Figure 4.1 Sea state recorded during dedicated watches on the Inner Moray Firth 2D survey.

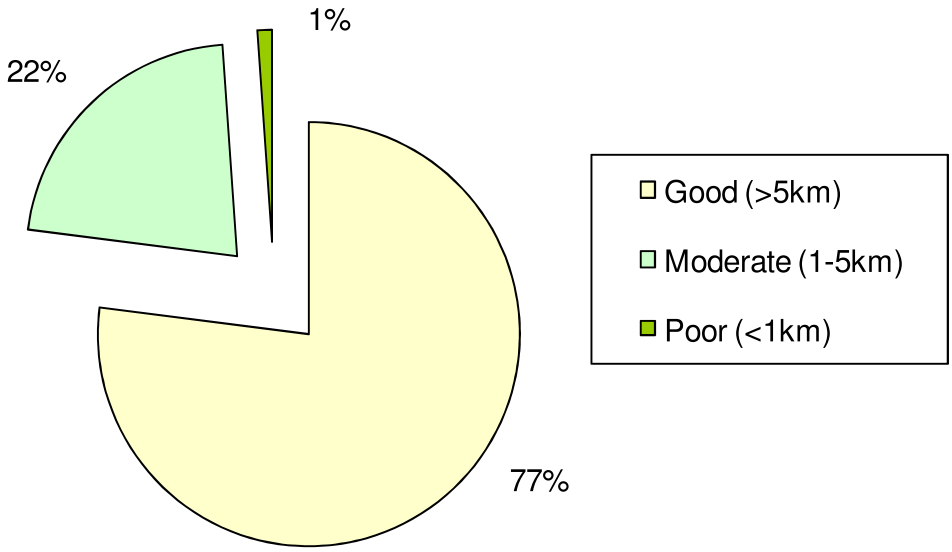

Figure 4.2 Visibility recorded during dedicated watches on the Inner Moray Firth 2D survey.

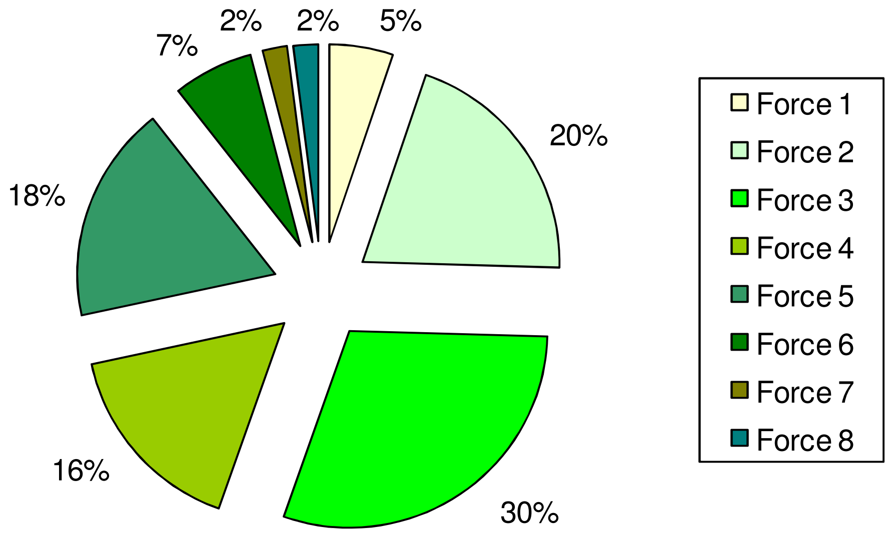

Figure 4.3 Wind force recorded during dedicated watches on the Inner Moray Firth 2D survey.

4.3 Compliance with JNCC Guidelines

Requirements for MMOs are varied according to the energy source volume, energy source pressure level, sound frequency and survey location. The Inner Moray Firth is considered by the JNCC to be a highly sensitive area in relation to marine animals so PA Resources requested the MMOs and PAMS operators to carry out dedicated monitoring during seismic data acquisition.

There were a total of 77 soft starts during the survey; 47 of these were during daylight hours and full pre-shoot visual watches were conducted beforehand. All soft starts, whether conducted during day or night, were preceded by a full pre-shoot monitoring period on the PAMS. All soft starts that occurred were between 20 and 40 minutes in length. Communication between the survey team, MMOs and PAMS operators was excellent throughout the survey.

As requested by the PoN14, firing continued around line turns regardless of their duration, with the airgun volume being reduced to 60 cu in and the shot point interval increased to 4 minutes. There were two line turns where the airguns had to be switched off (after Line 15 on 2nd September and Line 34 on 3rd September) due to necessary equipment maintenance. Full pre-shoot watches and acoustic monitoring were conducted following both occasions, prior to a soft start procedure on approach to the start of the next line. In addition, it was requested by DECC that the airguns stop firing during seven other line turns (see Section 4.3.1).

There were no delays to 2D seismic data acquisition due to marine mammal, marine turtle or basking shark sightings.

4.3.1 Variations to the PoN14

During the survey, a limited study was carried out by Aberdeen University to compare the amended line turn requirements of continued firing (as per the PoN14 – Appendix B) with normal line turn requirements (as per the JNCC's *'Guidelines for minimising the risk of injury and acoustic disturbance to marine mammals from seismic surveys, August 2010'*- Appendix A). On request from DECC, guns were stopped at the end of Line 54 at 10:21h on 8th September and a full pre-shoot monitoring period was conducted by the MMOs and PAMS operator prior to a full soft start before the start of the next line. This line turn method was used for the subsequent six line turns and at the end of Line 61 at 08:05h on 9th September, the line turn requirements laid out in the PoN14 were reverted to, and the guns continued to fire at reduced power and increased shot point interval around every line turn once more.

4.4 Marine Animal Sightings

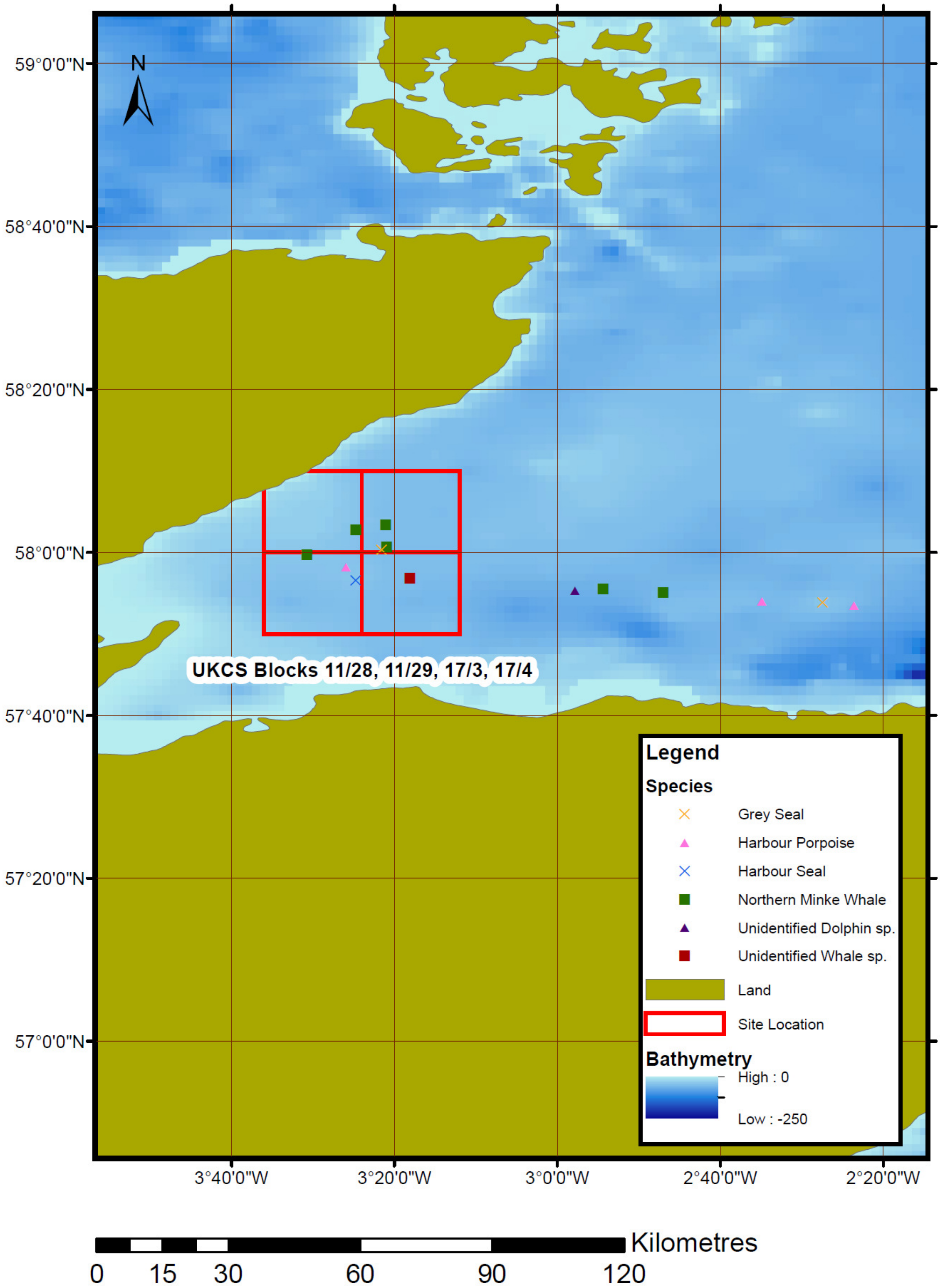

Figure 4.4 Sightings from 29th August to 9th September

There were 14 marine animal sightings throughout the survey, from 29th August to 9th September including sightings of northern minke whale, harbour porpoise, grey seal and common seal (Figure 4.4). Ten of the sightings occurred on site prior to commencement of the survey whilst four occurred on site whilst the guns were firing. The species seen are described below.

4.4.1 Northern minke whale *(Balaenoptera acutorostrata)*

Minke whales are distributed from the tropics to the ice edges. The species is frequently seen in inshore northern and western coastal waters of the UK, and occasional records have been reported from the channel coast of mainland Europe. The minke whale is the smallest member of the rorqual family of baleen (filter-feeding) whales reaching a maximum length of 10.7 m (Jefferson et al, 1993). It has a sharply pointed snout, slender, streamlined body, and a tall, falcate dorsal fin, positioned slightly less than two-thirds of the way down the back (Shirihai & Jarrett, 2007). The back of the minke whale is black, brown, or dark grey in colour, whereas the belly and underside of the flippers are usually white. The most conspicuous feature useful in identification, is a diagonal white band on the upper surface of each flipper, however the extent and orientation of this band varies (Shirihai & Jarrett, 2007). The tail flukes are broad and may be pale grey, blue-grey or white on the underside, usually with a dark margin. Minke whales tend to feed on the most abundant food source in a given area, primarily krill and small schooling fish, but occasionally larger fish such as mature Arctic cod and haddock. Feeding minke whales are often seen near the surface chasing fish. The species has been reported to feed in one of two ways: lunge feeding or 'bird association' feeding. Minke whales are fast moving and may swim at speeds in excess of 20 km per hour. On surfacing, the dorsal fin typically becomes visible simultaneously with the blow, although the blow is small and not very obvious, even in calm conditions (Shirihai & Jarrett, 2007). Minke whales are generally solitary or seen in pairs or threes. In northern Scotland, aggregations can number 10 to 15 individuals. They are notoriously inquisitive and often approach boats. They are also known to breach more often than other baleen whales, leaping clear of the surface. Minke whales are classified as Least Concern on IUCN latest Red List (IUCN, 2011).

There were six sightings of northern minke whales during the survey. On 31st August there were two incidental sightings of minke whales at 18:33h and 19:30h. On 1st September there were a further three sightings of minke whales, at 08:35h, 17:51h and 19:25h, respectively. During these five sightings, the airguns were not firing. The final minke whale sighting occurred on 6th September at 10:45h whilst the guns were firing at reduced power. It was approximately 300 m from the vessel, travelling south-west. All of the sightings of minke whale were of single animals either travelling or slowly swimming between 100 and 600 m from the vessel.

Figure 4.5 Northern minke whale sighting on 31st August 2011.

4.4.2 Harbour porpoise (*Phocoena phocoena*)

The harbour porpoise is found in cold temperate and sub-arctic waters of the Northern Hemisphere, commonly inhabiting shallow coastal bays, estuaries and tidal channels, but generally only occupying continental shelf waters. It is the smallest cetacean in the Northern Atlantic, measuring just 1.3 to 1.9 m in length and weighing between 45 and 70 kg (Shirihai & Jarrett, 2007). It has a short, rotund body with a blunt snout and no obvious beak. The dorsal fin is small and triangular in shape. Colouration is typically dark grey fins and head all the way along the back to the flukes. The flanks gradually merge from dark grey to white on the undersides. Harbour porpoise appear to feed upon a variety of fish and cephalopods; their diet varying with location and availability of prey items. The species usually hunts singly or in small groups, but they may form loose aggregations if there is a large amount of food, despite still tending to feed semi-independently. Harbour porpoises are usually seen in small groups of less than ten animals. The swimming motion of the harbour porpoise is generally inconspicuous, involving surfacing with a rolling motion (Shirihai & Jarrett, 2007), and their small size make it difficult to observe these animals in all but calm sea conditions. Moreover, the species is notoriously shy and generally avoids approaching boats. Their conservation status is classed as Least Concern on the IUCN Red List (IUCN, 2011), and they are listed on Annex II and IV of the EU Habitats Directive.

Throughout the survey there were three harbour porpoise sightings; the first two occurred while seismic equipment was being deployed, so the guns were not firing. The third sighting occurred whilst running a 2D seismic line, when the airguns were firing at full power. The first sighting occurred at 13:55h on 31st August when two porpoise were seen milling 400 m from the vessel. At 15:36h on the same day, five porpoise were seen transiting in a northerly direction. The final sighting occurred at 17:37h on 2nd September when one harbour porpoise was seen at a distance of 600 m, porpoising as it travelled away from the vessel.

Figure 4.6 Harbour porpoise sighting on 31st August 2011

4.4.3 Grey seal (*Halichoerus grypus*)

There are three main populations of grey seal in the world, found in the eastern Atlantic, western Atlantic and the Baltic Sea. The eastern Atlantic stock occurs in Iceland, the Faroe Islands, in Norway and around the British Isles. The grey seal has very pronounced sexual dimorphism. Males are dark with light patches and are up to 2.3 m in length and up to 310 kg in weight (Jefferson et al, 1993). Females are light coloured with dark spots, and are much smaller, reaching up to 2 m in length and weighing up to 190 kg (Jefferson et al, 1993). The distinctive muzzle is particularly long, rectangular, and its shape has led to the common name "horsehead". In adult males, the top of the muzzle is convex, while in adult females and subadults, it is more flat or slightly concave (Jefferson et al, 1993). The nostrils are widely separated and almost parallel to each other (Shirihai & Jarrett, 2007). The grey seal feeds on local inshore fish species, cephalopods and crustaceans such as dab, sole, sand eel, cod and whiting (IUCN, 2011). Many of the fish species in the grey seals' diet are commercially exploited, so there can be competition for resources with the fisheries. Grey seals are gregarious and gather together for breeding, moulting and hauling out. The grey seal is currently listed as a protected species under Annex II and Annex V of the European Habitats Directive. They are considered Least Concern on IUCN Red List (IUCN, 2011).

Two grey seals were sighted during the survey, one on 31st August at 16:05h at a distance of 100 m and one on 1st September at 10:08h at a distance of 120 m. Both were seen surfacing briefly before disappearing again and both sightings occurred prior to data acquisition, therefore the airguns were not firing.

Figure 4.7 Grey seal sighting on 1st September 2011

4.4.4 Common seal (*Phoca vitulina*)

The common seal is one of the most widespread of all the pinnipeds. They are found in the Northern Hemisphere from temperate to Polar regions. The common seal has a stout body and the head is small and cat-like (Jefferson et al, 1993). The nostrils are small, forming a "V" that meets at the bottom, and it has large eyes (Shirihai & Jarrett, 2007). They are light to dark grey-brown with fine spots, ring-like markings and some blotches (Jefferson et al, 1993). Common seals are not sexually dimorphic and reach up to 2 m in length and weigh between 70 – 170 kg (Shirihai & Jarrett, 2007). The common seal feeds on a wide variety of fish species, cephalopods and crustaceans. Common seals are gregarious and gather together for breeding, moulting and hauling out. The common seal is currently listed as a protected species under Annex II and Annex V of the European Habitats Directive, they are considered Least Concern on the IUCN Red List (IUCN, 2011).

There was one sighting of a common seal on 5th September at 10:25h; it surfaced approximately 200 m from the vessel whilst the guns were firing at full power.

4.4.5 Unidentified whale

On 6th September at 12:30h, two bushy blows were seen approximately 800 m ahead of the vessel. Due to strong winds and choppy seas, no body or dorsal fin was seen and the shape of the blow was indistinctive, therefore the species of whale could not be identified. This sighting occurred whilst running a 2D seismic line, when the airguns were firing at full power.

4.4.6 Unidentified dolphin

An unidentified dolphin was seen breaching out of the water twice on 31st August at 19:13h. It was only 100 m from the vessel; however identification was not possible due to the brevity of the sighting.

4.5 Acoustic Detections

Throughout the duration of survey from 29th August to 9th September there were no detections of marine mammals using the passive acoustic monitoring system.

5. DISCUSSION

5.1 Marine Animal Detection

There were a number of factors that may have influenced the detection of marine animals within the survey area.

Weather can affect the ability to detect marine animals in a number of ways, with increasing sea state, wind force and decreasing visibility reducing the detection probability of marine animals (Forney, 2000) particularly those with inconspicuous surfacing behaviour like harbour porpoise (Northridge *et al*, 1995; Palka, 1996). The weather conditions were predominantly good to moderate, however there were also some periods of high winds, poorer visibility and choppy to rough seas. These poor weather conditions would have reduced the ability of the MMOs to visually detect marine animals and therefore some animals within the area may not have been recorded. In particular, the harbour porpoise is one of the commonly recorded species in the area (Bailey & Thompson, 2009) but is known for its elusive nature and inconspicuous surfacing behaviour (Shirihai & Jarrett, 2006). The weather conditions should not, however have affected the ability of the PAMS to detect vocalising marine animals.

The spatio-temporal distribution and the high mobility of marine animals may have had an effect on detection. Cetaceans migrate at certain times of the year, primarily in relation to prey abundance and distribution, breeding opportunities and availability of space (Northridge *et al*, 1995; Stern, 2002). Studies indicate that within the Moray Firth the bottlenose dolphin population may be highly mobile and also undertake distinct seasonal movements. Whilst the coastal margins in the outer part of the Inner Moray Firth are used most of the year (Hastie *et al*, 2003), sightings of dolphins are concentrated, particularly during the summer months from June to September, in three main areas at the head of the Firth (Wilson *et al*, 1997). This increase in the numbers of dolphins is due to a stratified movement of all individuals rather than an influx of incomers to the resident population (Wilson *et al*, 1997) and this movement is related to foraging (Hastie *et al,* 2004). Further research has also indicated that areas along the southern Outer Moray Firth also represent an important part of the bottlenose dolphin's habitat (Culloch & Robinson, 2008) and that the species may have expanded its range beyond the Inner Moray Firth area since the 1980s (Wilson *et al*, 2004).

Whilst the occurrence of harbour porpoise is more dispersed through the Inner Moray Firth area (Hastie *et al*, 2003; Bailey & Thompson, 2009) their distribution is also related to various environmental variables (Bailey & Thompson, 2009). Studies suggest that that the influence of these variables is related to their effects on prey distribution (Johnston *et al*, 2005). However recent discoveries that bottlenose dolphins attack and kill harbour porpoises in the area (Ross & Wilson, 1996) cannot exclude the possibility that porpoises are actively avoiding areas with higher dolphin densities.

Although sighted regularly in the offshore areas of the Inner Moray Firth, few studies have related minke whale sightings to environmental variables due to small sample sizes (Bailey & Thompson, 2009). However studies in the southern Outer Moray Firth indicate minke whale distribution is influenced by physiographic features particularly water depth and sediment type (Robinson *et al*,

2009) and mesoscale oceanographic features (Tetley *et al*, 2008) through the influence on prey distribution.

Similar to cetaceans the distribution and movement of seals is also related to prey abundance and availability (Thompson & Miller, 1990; Thompson *et al*, 1991; McConnell *et al*, 1999). However in contrast to cetaceans seal distribution is also related to haul-out and breeding sites (Thompson *et al*, 1996) with seals often returning to the same haul-out sites (Thompson & Miller, 1990; McConnell *et al*, 1999). Foraging distances varies between species: common seals forage within 60 km of haul-out sites whilst grey seals are more likely to forage over wider distances, up to 145 km from sites (Thompson *et al,* 1996). Movements between haul-out sites also vary with common seals moving to alternative sites within a range of 75 km, whilst grey seals have been reported moving to sites 125 – 365 km away indicating regular interchange between the Moray Firth, Orkney and the Farne Islands (Thompson *et al*, 1996).

The high mobility and movement of marine animals within the survey area and between other areas, means that species may not have been present or present in abundance during the survey period.

5.2 Marine Animal Observation

Marine animal research carried out previously within the waters of the Inner Moray Firth has recorded a range of cetacean species occurring throughout the year (Thompson *et al*, 2010). While these species can occur in spatially distinct areas (Hastie *et al*, 2003; Bailey & Thompson, 2009) and therefore not necessarily in the current survey area, it must be remembered that marine animals are highly mobile. It was therefore anticipated that marine animal sightings were possible, and as such MMO duties and passive acoustic monitoring were carried out during all seismic data acquisition.

During the 2D seismic survey, between 29th August and 9th September 2011, there were 14 sightings of marine animals. These sightings consisted of six different species, four of which are commonly seen within the Inner Moray Firth; harbour porpoise, minke whale, grey seal and common seal (Thompson *et al*, 1996; Hastie *et al*, 2003; Bailey & Thompson, 2009).

One sighting of a dolphin could not be identified to species level. Whilst a resident population of bottlenose dolphins occur within the Moray Firth (Wilson *et al*, 1997), other species of dolphin are also occasionally reported in the area including common dolphin (*Delphinus delphis*), white-beaked dolphin (*Lagenorhynchus albirostris*) and Risso's dolphin (*Grampus griseus*) (Thompson *et al*, 2010).

A further sighting of a whale blow could not be identified to species level. Minke whales are frequently recorded within the offshore areas of the Inner Moray Firth (Bailey & Thompson, 2009) however their blow tends to be weak and inconspicuous or invisible (Shirihai & Jarrett, 2006). Large whales however are less common within the shallow waters of the Inner Moray Firth, although occasional sightings of fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera noveangliae*) and sperm whale (*Physeter macrocephalus*) have been reported in the area (Thompson *et al*, 2010) and there are incidental sightings of large whales within the Inner Moray Firth (Sea Watch Foundation, 2011).

The majority of sightings occurred on 31st August and 1st September 2011 whilst the vessel was on site but the guns were not firing. Seven of these sightings were incidental as the PAMS equipment was being set up therefore dedicated watches were not taking place. It is possible that more sightings would have been recorded with dedicated monitoring. During the 2D survey, between 1st and 9th September, dedicated monitoring was carried out at all times when the guns were firing; however there were only four marine animal sightings during this nine-day period. This drop in the number of sightings could indicate an avoidance response of marine animals to the noise of the airguns. Previous studies have provided evidence of possible displacement and avoidance of active seismic airguns, particularly by small odontocetes (Stone & Tasker, 2006). Stone and Tasker (2006) also highlighted that different cetacean species react in different ways and that responses are greatest to large volume airgun arrays. Other studies have also highlighted possible displacement and avoidance by bottlenose dolphins (Leeney *et* al, 2007), harbour porpoise (Koschinski *et* al, 2003) and common seals (Teilmann *et al,* 2006) in response to underwater noise. However responses exhibited vary between species and are dependent on the source level (Kastelein *et al*, 2006).

Even during line turns, when the gun volume was reduced and shot point interval increased, animals did not appear to return to the area surrounding the vessel. Similarly, no marine animals were visually or acoustically detected during the six line turns where the guns were turned off, however sea conditions were not ideal for visual detections. This could indicate that animals may not only avoid the gun noise but may subsequently take some time to return to the site following cessation of the guns.

Of the four sightings that occurred whilst the guns were firing at full power, all were different marine mammal species; minke whale, harbour porpoise, common seal and an unidentified whale species. Three were seen swimming away from the vessel whilst the direction of the unidentified whale could not be determined due to choppy seas.

Due to the short duration of the survey and limited data collated no definitive conclusions on the effect of airguns on marine animals can be made. Studies by Aberdeen University during this period and in conjunction with PA Resources and DECC are likely to offer more comprehensive results. Data that was collected onboard the *M.V. Surveyor,* initially indicates that there might have been some disturbance and displacement of marine animals due to seismic airgun noise and as such, it is important to use trained MMOs and PAMS operators during seismic surveys. Gardline Environmental supports the use of two MMOs during long daylight hours in the summer months and in such an ecologically sensitive area, in conjunction with 24-hour PAMS monitoring.

6. REFERENCES

ADAMS, J.A. AND MARTIN, J.H.A. 1986. The hydrography and plankton of the Moray Firth. *The Marine Environment of the Moray Firth* (ed. HAWTHORN, J.), pp 37-56. Royal Society of Edinburgh, Edinburgh.

BAILEY, H. AND THOMPSON, P.M. 2009. Using marine mammal habitat modelling to identify priority conservation zones within a marine protected area. *Marine Ecology Progress Series*, 378: 279-287.

BARTOL, S.M., MUSICK, J.A. AND LENHARDT, M.L. 1999. Auditory Evoked Potentials of the Loggerhead Sea Turtle (Caretta caretta). *Copeia*, 3:836-840.

BLOOMFIELD, A. & SOLANDT, J. 2007. The Marine Conservation Society Basking Shark Watch. http://www.mcsuk.org/downloads/wildlife/basking_sharks/BSW20%20Report.pdf Viewed on 18/08/2011.

BUTLER, J.R.A. 2004. Moray Firth Seal Management Plan. *A Pilot Project for Managing Interactions Between Seals and Salmon in Scotland.* Spey District Salmon Fishery Board, Aberlour (pp 64).

CASPER, B.M. & MANN, D.A. 2006. Dipole hearing measurements in elasmobranch fishes. *Journal of Experimental Biology*, 210: 75- 81.

CHAPPELL, O., LEWIS, T., GILLESPIE, D., SWIFT, R., BOISSEAU, O. AND GORDON, J., 2000. *The development of acoustic techniques for cetacean monitoring on the guard vessel Hunter, 1998.* Report submitted to Shell UK Ltd.

CLARK, C.W. & GAGNON, G.C. 2006. Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales. Paper SC/58/E9 presented to the IWC Scientific Committee, June 2006.

COATES, R., 1998. *Report on Cetacean Array Fabrication*. Report submitted to Shell UK Ltd.

CULLOCH, R.M. AND ROBINSON, K.P. 2008. Bottlenose dolphins using coastal regions adjacent to a Special Area of Conservation in north-east Scotland. *Journal of the Marine Biological Association of the United Kingdom*, 88: 1237-1243.

DERUITER, S.L., TYACK P.L.. Lin, Y.T., Newhall, A.E., Lynch J.F., Miller P.J.O. 2006. Modeling acoustic propagation of airgun array pulses recorded on tagged sperm whales (*Physeter macrocephalus*). *The Journal of the Acoustical Society of America*, 120(6): 4100- 4114.

EISFIELD, S., KEITH, S., POPE, A., STILL, D., DOLMAN, S. AND SIMMONDS, M. 2009. Outer Moray Firth Cetacean Research 2008. *Project report for the BBC Wildlife Fund*. Whale and Dolphin Conservation Society.

ELEFTHERIOU, A., BASFORD, D. AND MOORE, D.C. 2004. Synthesis of Information on the Benthos of Area SEA 5. *Report for the Department of Trade and Industry* (pp 84)

ELLETT, D.J. & BLINDHEIM, J. 1992. Climate and hydrographic variability in the ICES area during the 1980s. ICES Marine Science Symposium, 195: 11- 31.

EVANS, P.G.H. 1990. European cetaceans and seabirds in an oceanographic context. *Lutra*, 33: 95- 125.

EVANS, P.G.H. AND NICE, H. 1996. *Review of the effects of underwater sound generated by seismic surveys on cetaceans*. Sea Watch Foundation Publications, Oxford.

FINNERAN, J.J., SCHLUNDT, C.E., DEAR, R., CARDER, D.A. & RIDGWAY S.H. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. *The Journal of the Acoustical Society of America*, 111(6): 2929- 2940.

FORNEY, K.A. 2000. Environmental models of cetacean abundance: reducing uncertainty in population trends. *Conservation Biology*, 14: 1271-1286.

FOSTER-SMITH, R., SOTHERAN, I. AND FOSTER-SMITH, D. 2009. Sublittoral Biotope Mapping of the Moray Firth SAC. *Scottish Natural Heritage Commissioned Report No. 338.* Scottish Natural Heritage, Inverness (pp 166).

FRIEDLAENDER, A.S., HALPIN, P.N., QIAN, S.S., LAWSON, G.L., WIEBE, P.H., THIELE, D. AND READ, A.J. 2006. Whale distribution in relation to prey abundance and oceanographic processes in shelf waters of the Western Antarctic Peninsula. *Marine Ecology Progress Series*, 317: 297-310.

GORDON, J., GILLESPIE, D., POTTER, J., FRANTZIS, A., SIMMONDS, M., SWIFT, R. & THOMPSON, D. 2003. A review of the effects of seismic surveys on marine mammals. *Marine Technology Society Journal*, 37(4): 16- 34.

GOTZ, T., HASTIE, G., HATCH, L.T., RAUSTEIN, O., SOUTHALL, B.L. & TASKER, M. 2009. Overview of the impacts of anthropogenic sound. Ospar commission.

GREENSTREET, S.P.R., MCMILLAN, J.A. AND ARMSTRONG, E. 1998. Seasonal variation in the importance of pelagic fish in the diet of piscivorous fish in the Moray Firth, NE Scotland: a response to variation in prey abundance? *ICES Journal of Marine Science,* 55:121-133.

HASTIE, G.D., BARTON, T.R., GRELLIER, K., HAMMOND, P.S., SWIFT, R.J., THOMPSON, P.M. AND WILSON, B. 2003. Distribution of small cetaceans within a candidate Special Area of Conservation: implications for management. *Journal of Cetacean Research and Management*, 5:261-266.

HASTIE, G.D., WILSON, B., WILSON, L.J., PARSONS, K.M. AND THOMPSON, P.M. 2004. Functional mechanisms underlying cetacean distribution patterns: hotspots for bottlenose dolphins are linked to foraging. *Marine Biology*, 144: 397-403.

HOLMES, R., BULAT, J., HENNI, P., HOLT, J., JAMES, C., KENYON, N., LESLIE, A., LONG, D., MORRI, C., MUSSON, R., PEARSON, S. AND STEWART, H. 2004. DTI Strategic Environmental Assessment Area 5 (SEA 5): Seabed and superficial geology and processes. *British Geological Survey Report CR/04/064N*, British Geological Survey, Edinburgh.

HUNT, JR., G.L. & SCHNEIDER, D.C. 1987. Scale dependant processes in the physical and biological environment of marine birds. *In Seabirds: Feeding ecology and role in marine ecosystems*, ed., Croxall, J.P. pp 7- 41. Cambridge University Press, Cambridge.

INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE AND NATURAL RESOURCES 2011. IUCN Red List of Threatened Species. Version 2011.1.

JEFFERSON, T.A., LEATHERWOOD, S. & WEBBER, M.A. 1993. FAO species identification guide. Marine Mammals of the World. FAO, Rome.

JOHNS, D. 2004. Plankton Report for Strategic Environment Assessment Area 5. *Contract for the Department of Trade and Industry* (pp 29).

JOHNSTON, D.W., WESTGATE, A.J. AND READ, A.J. 2005. Effects of fine-scale oceanographic features on the distribution and movements of harbour porpoises *Phocoena phocoena* in the Bay of Fundy. *Marine Ecology Progress Series*, 295: 279-293.

KASTELEIN, R.A., JENNINGS, N., VERBOOM, W.C., DE HAAN, D. AND SCHOONEMAN, N.M. 2006. Differences in the response of a striped dolphin (*Stenella coeruleoalba*) and a harbour porpoise (*Phocoena phocoena*) to an acoustic alarm. *Marine Environmental Research*, 61: 363-378.

KOSCHINSKI, S., CULIK, B.M., DAMSGAARD HENRIKSEN, O., TREGENZA, N., ELLIS, G., JANSEN, C. AND KATHE, G. 2003. Behavioural reactions of free-ranging porpoises and seals to the noise of a simulated 2 MW windpower generator. *Marine Ecology Progress Series*, 265: 263-273.

LE FÈVRE, J. 1986. Aspects of the biology of frontal systems. *Advances in Marine Biology*, 23: 163-299.

LEENEY, R.H., BERROW, S., MCGRATH, D., O'BRIEN, J., COSGROVE, R. AND GODLEY, B. 2007. Effects of pingers on the behaviour of bottlenose dolphins. *Journal of the Marine Biological Association of the United Kingdom*, 87: 129-133.

LUCKE, K., SIEBERT, U., LEPPER, P. A. & BLANCHET, M.-A. 2009. Temporary shift in masked hearing thresholds in a harbour porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *The Journal of the Acoustical Society of America*, 125(6): 4060- 4070.

MACLEOD, K., FAIRBAIRNS, R., GILL, A., FAIRBAIRNS, B., GORDON, J., BLAIR-MYERS, C. AND PARSONS, E.C.M. 2004. Seasonal distribution of minke whales *Balaenoptera acustorostrata* in relation to physiography and prey off the Isle of Mull, Scotland. *Marine Ecology Progress Series*, 277: 263-274.

McConnell et al. 1999. Movements and foraging areas of grey seals in the North Sea. *Journal of Applied Ecology*, 36: 573-590.

MENDES, S., TURRELL, W., LÜTKEBOHLE, T. AND THOMPSON, P. 2002. Influence of the tidal cycle and a tidal intrusion front on the spatio-temporal distribution of coastal bottlenose dolphins. *Marine Ecology Progress Series*, 239: 221-229.

MORAY FIRTH SAC MANAGEMENT GROUP. 2009. *The Moray Firth Special Area of Conservation Management Scheme, Revision 2*. The Moray Firth Partnership, Inverness (pp 86).

MORTON, A. B. & SYMONDS, H. K. 2002. Displacement of Orcinus orca (L.) by high amplitude sound in British Columbia, Canada. *ICES Journal of Marine Science*, 59(1): 71- 80.

NRC (NATIONAL RESEARCH COUNCIL) 2005. Marine mammal populations and ocean noise: Determining when noise causes biologically significant effects, The National Academies Press, Washington DC.

NIEUKIRK, S.L., STAFFORD K.M., MELLINGER, D.K., DZIAK, P. & FOX, C.G. 2004. Low frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. *The Journal of the Acoustical Society of America*, 115(4): 1832- 1843.

NORTHRIDGE S. P., TASKER, M. L., WEBB, A., WILLIAMS, J, M., 1995. Distribution and relative abundance of harbour porpoises (*Phocena phocena* L.), white-beaked dolphins (*Lagenorhynchus albirostris* Gray), and minke whales (*Balaenoptera acutorostrata* Lacepede) around the British Isles. *Journal of Marine Science,* 52: 55– 66.

PALKA, D. 1996. Effects of Beaufort Sea State on the Sightability of Harbor Porpoises in the Gulf of Maine. *Reports of the International Whaling Commission*, 46: 575-582.

REID, J. B., EVANS, P.G.H. & NORTHRIDGE, S.P. 2003. *Atlas of Cetacean distribution in north-west European Waters*. Peterborough, Joint Nature Conservation Committee.

ROBINSON, K.P., TETLEY, M.J. AND MITCHELSON-JACOB, E.G. 2009. The distribution and habitat preference of coastally occurring minke whales (*Balaenoptera acutorostrata*) in the outer southern Moray Firth, northeast Scotland. *Journal of Coastal Conservation*, 13:39-48.

ROSS, H.M. AND WILSON, B. 1996. Violent interactions between Bottlenose Dolphins and Harbour Porpoises. *Proceedings of the Royal Society B,* 263: 283-286.

SEA WATCH FOUNDATION. 2011. *News Archive*. Available: http://www.seawatchfoundation.org.uk/newsarchive.php Last accessed 21/09/2011.

SHIRIHAI, H. & JARRETT, B. 2006. Whales, Dolphins and Seals. A Field guide to the marine mammals of the world. A & C Black Publishers.

STERN, J. 2002. Migration and Movement Patterns. *In: Marine Mammals*, ed., Perrin, W. F., Wursig B, Thewissen, J. G. M., pp 742– 749. Academic Press San Diego, USA.

STONE, C.J. AND TASKER, M.L. 2006. The effects of seismic airguns on cetaceans in UK waters. *Journal of Cetacean Research and Management*, 8: 255-263.

TEILMANN, J., TOUGAARD, J., CARSTENSEN, J., DIETZ, R., TOUGAARD, S. 2006. Summary on seal monitoring 1999-2005 around Nysted and Horns Rev Offshore Wind Farms. Technical report to Energi E2 A/S and Vattenfall A/S.

TETLEY, M.J., MITCHELSON-JACOB, E.G. AND ROBINSON, K.P. 2008. The summer distribution of coastal minke whales (*Balaenoptera acutorostrata*) in the southern outer Moray Firth, NE Scotland, in relation to co-occurring mesoscale oceanographic features. *Remote sensing of Environment*, 112: 3449-3454.

THOMPSON, P.M. AND MILLER, D. 1990. Summer foraging activity and movements of radio-tagged common seals (*Phoca vitulina*. L.) in the Moray Firth, Scotland. *Journal of Applied Ecology*, 27: 492-501.

THOMPSON, P.M. & OLLASON, J.C. 2001. Lagged effects of ocean climate change on fulmar population dynamics. *Nature*, 413: 417- 420.

THOMPSON, P.M., PIERCE, G.J., HISLOP, J.R.G., MILLER, D. & DIACK, J.S.W. 1991. Winter foraging by common seals (*Phoca vitulina*) in relation to food availability in the inner Moray Firth, N.E. Scotland. *Journal of Animal Ecology*, *60*: 283-294.

THOMPSON, P.M., MCCONNELL, B.J., TOLLIT, D.J., MACKAY, A., HUNTER, C. AND RACEY, P.A. 1996. Comparative distribution, movements and diet of harbour and grey seals from the Moray Firth, N.E. Scotland. *Journal of Applied Ecology*, 33: 1572-1584.

THOMPSON, P.M., BROOKES, K., CHENEY, B., CÂNDIDO, A., BATES, H., RICHARDSON, N. & BARTON, T. 2010. Assessing the potential impact of oil and gas exploration operations on cetaceans in the Moray Firth. University of Aberdeen report for DECC, Scottish Government, Cowrie and Oil & Gas UK.

WHALEY, A.R. 2004. The distribution and relative abundance of the harbour porpoise *(Phocoena phocoena L.)* in the southern outer Moray Firth, NE Scotland. Thesis (BSc.), Birkbeck College, University of London.

WILSON, B., THOMPSON, P.M. AND HAMMOND, P.S. 1997. Habitat use by bottlenose dolphins: seasonal distribution and stratified movement patterns in the Moray Firth, Scotland. *Journal of Applied Ecology*, 34:1365-1374.

WILSON, B., REID, R.J., GRELLIER, K., THOMPSON, P.M. AND HAMMOND, P.S. 2004. Considering the temporal when managing the spatial: a population range expansion impacts protected areas-based management for bottlenose dolphins. *Animal Conservation*, 7: 331-338.

7. APPENDICES

APPENDIX A – JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys

August 2010

The guidelines have been written for activities on the United Kingdom Continental Shelf and are aimed at minimising the risk of injury and acoustic disturbance from seismic surveys to marine mammals including seals, whales, dolphins and porpoises. Whilst there are no objections to these guidelines being used out-with UK waters JNCC would encourage all operators to determine if any special or local circumstances pertain, as we would not wish these guidelines to be used where a local management tool has already been adopted (for instance in the Gulf of Mexico OCS Region). In this context, JNCC notes that other fauna, for example turtles, occur in waters where these guidelines may be used, and would suggest that, whilst the appropriate mitigation may require further investigation, the soft-start procedures for marine mammals would also be appropriate for marine turtles and basking sharks[1]. The guidelines require the use of trained Marine Mammal Observers (MMOs) whose role is to advise on the use of the guidelines and conduct pre-shooting searches for marine mammals before commencement of any seismic activity. A further duty is to ensure that the JNCC reporting forms are completed for inclusion in the MMO report. In addition to the visual mitigation provided by MMOs, if seismic surveys are planned to start during hours of darkness or low visibility it is considered best practice to deploy Passive Acoustic monitoring (PAM). The 2010 version of the JNCC seismic guidelines reflects amendments (2007 and 2009 amendments) to the Conservation (Natural Habitats &c.) Regulations 1994 (Habitat Regulations, HR) for England and Wales[2] and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (Offshore Marine Regulations, OMR, as amended in 2009 and 2010). Both regulations have revised the definition of deliberate disturbance of 'European Protected Species' (EPS), which now excludes trivial disturbance from the offence. Both regulations now also include the offence of deliberate injury. European Protected Species include cetaceans and turtles.

It has been recognised that sound generated from seismic sources has the potential to cause injury and possibly also disturbance to marine mammals. Seismic surveys have therefore the potential to cause a deliberate injury offence as defined under regulations 41(1)(a) and 39(1)(a) and a deliberate disturbance offence as in 41(1)(b) and 39(1)(b) of the HR and OMR, respectively. The JNCC seismic guidelines reflect best practice for operators to follow during the planning, operational and reporting stages. It is considered that compliance with the recommendations in these guidelines will reduce the risk of injury to EPS to negligible levels.
Please note that the mitigation measures recommended in the existing guidelines are more relevant to the prevention of injury rather than disturbance as defined in regulations 41(2) and 39(1A), of the HR and OMR, respectively. The onus should be on the entity responsible for the activity to assess whether a disturbance offence is likely to occur. Guidance on how to carry out

[1] Basking sharks are protected from intentional capture or disturbance in British waters (up to 12 miles offshore) under a 1998 listing on the Wildlife and Countryside Act (1981), Schedule 5.
[2] In 2010 a consolidated version of the regulations came into force: The Conservation of Habitats and Species Regulations 2010.

such risk assessment is provided in the JNCC, NE and CCW document 'The protection of marine European Protected Species from injury and disturbance'.

In relation to oil and gas seismic surveys in the UKCS, it is a requirement of the consent issued under regulation 4 of the Petroleum Activities (Conservation of Habitats) Regulations 2001 (& 2007 Amendments) by the Department for Energy Climate Change (DECC), that the JNCC Seismic Guidelines must be followed, and the elements of the guidelines that are relevant to a particular survey are incorporated into the legally-binding condition of consent. It should be noted that it is the responsibility of the company issued consent by DECC[3], referred to in these guidelines as the 'applicant', to ensure that these guidelines are followed, and it is recommended that a copy of the JNCC guidelines are available onboard all vessels undertaking seismic activities in UK waters. Where relevant, when the survey is completed a MMO report must be submitted to the JNCC.

[3] Department of Energy and Climate Change was formerly known as Department for Business and Regulatory Reform (BERR)

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Terminology

Marine European Protected Species: These are marine species in Annex IV(a) of the Habitats Directive that occur naturally in the waters of the United Kingdom. These consist of several species of cetaceans (whales, dolphins and porpoises), turtles, and the Atlantic Sturgeon.

Marine Mammal Observer (MMO): Individual responsible for conducting visual watches for marine mammals. For some seismic surveys it may be requested that observers are trained, dedicated and / or experienced. The MMO may also be a PAM operative if trained.

- **Trained MMO:** Has been on a JNCC recognised course
- **Dedicated MMO:** Trained observer whose role on board is to conduct visual watches for marine mammals (although it could double up as a PAM operative)
- **Experienced MMO:** Trained observer with 3 years of field experience observing for marine mammals, and practical experience of implementing the JNCC guidelines
- **PAM Operative:** Person experienced in the use of PAM software and hardware and marine mammal acoustics

Mitigation Zone: The area where a Marine Mammal Observer keeps watch for marine mammals (and delays the start of activity should any marine mammals be detected).

Passive Acoustic Monitoring (PAM): Software system that utilises hydrophones to detect the vocalisations of marine mammals.

Seismic Survey: Any survey that uses airguns, including 2D/3D/4D and OBC (On-Bottom Cabling) surveys and any similar techniques that use airguns. Surveys using multibeam systems and sub-bottom profiling equipment such as boomers, pingers etc are not considered in these guidelines. However, the guidelines can be adapted and applied to the operation of such systems if considered appropriate.

Shot Point Interval (SPI): Interval between firing of the airgun or airguns.

Site Survey: Seismic survey of a limited area proposed for drilling, infrastructure emplacement etc (typically with source size of 180 cubic inches or less).

Soft-Start: Turning on the airguns at low power and gradually and systematically increasing the output until full power is achieved (usually over a period of 20 minutes). The appropriate soft-start method is dependant upon the type of seismic survey and is discussed in section 3.

United Kingdom Waters: Parts of the sea in or adjacent to the United Kingdom from the low water mark up to the limits of the United Kingdom Continental Shelf.

Vertical Seismic Profiling (VSP) or Borehole Seismic: Seismic survey undertaken ‘down hole’ in connection with well operations (typically with a source size of 500 cubic inches).

Section 1 – Assessing and minimising the risk of injury

1.1 The Planning Stage

When a seismic survey is being planned, the applicant should consider the following recommendations and best practice advice:

- Determine what marine mammal species are likely to be present in the survey area and assess if there are any seasonal considerations that need to be taken into account, for example periods of migration, breeding, calving or pupping. For UKCS activities the 'Atlas of cetacean distribution in north-west European waters' (Reid *et al*, 2003) is a useful starting point.
- Consult the latest relevant regulatory guidance notes; in the UK, DECC issues guidance notes for oil and gas seismic activities.
- As part of the environmental impact assessment, assess the likelihood of injuring or disturbing a European Protected Species. In the UK, it will be necessary to assess the likelihood of committing an offence as defined in the HR and in the OMR.
- Consult the JNCC, NE and CCW guidance on 'The protection of marine European Protected Species from injury and disturbance' to assist in the environmental impact assessment. To obtain a copy of the latest draft version of the guidance please contact JNCC.

The operator should whenever possible implement the following best practice measures:

- If marine mammals are likely to be in the area, only commence seismic activities during the hours of daylight when visual mitigation using Marine Mammal Observers (MMOs) is possible.
- Only commence seismic activities during the hours of darkness, or low visibility, or during periods when the sea state is not conducive to visual mitigation, if a Passive Acoustic Monitoring (PAM) system is in use to detect marine mammals likely to be in the area, noting the limitations of available PAM technology (seismic surveys that commence during periods of darkness, or low visibility, or during periods when the observation conditions are not conducive to visual mitigation, could pose a risk of committing an injury offence).
- Plan surveys so that the timing will reduce the likelihood of encounters with marine mammals. For example, this might be an important consideration in certain areas/times, e.g. during seal pupping periods near Special Areas of Conservation for common seals or grey seals.
- Provide trained MMOs to implement the JNCC guidelines.
- Use the lowest practicable power levels to achieve the geophysical objectives of the survey.
- Seek methods to reduce and/or baffle unnecessary high frequency noise produced by the airguns (this would also be relevant for other acoustic energy sources).

Section 2 - Marine Mammal Observers

2.1. Role of an MMO

The primary role of an MMO is to act as an observer for marine mammals and to recommend a delay in the commencement of seismic activity should any marine mammals be detected. In addition, a MMO should be able to advise the crew on the procedures set out in the JNCC guidelines and to provide advice to ensure that the survey programme is undertaken in accordance with the guidelines. Before the survey commences it is important to attend any pre-mobilisation meetings to discuss the working arrangements that will be in place, and to request a copy of the survey consent issued by DECC (if applicable). An MMO may also work closely with Passive Acoustic Monitoring operatives. As the MMO role in relation to the vessel and survey operations is purely advisory, it is important to be aware of the command hierarchy and communication channels that will be in place, and determine who the main MMO / PAM operative contacts should be.

In a typical vessel based seismic survey, the MMO / PAM operative may pass advice to the party chief and client's representative through the navigators or seismic observers, and it is important to establish what the working arrangements are, as this may vary from one survey to the other. The MMOs should consider themselves as part of the crew and respect the chain of command that is in place.

MMOs should make certain that their efforts are concentrated on the pre-shooting search before the soft-start. These guidelines cannot be interpreted to imply that MMOs should keep a watch during all daylight hours, but JNCC would encourage all MMOs to manage their time to ensure that they are available to carry out a watch to the best of their ability during the crucial time - the 30 minutes before commencement of the firing of the seismic source (or 60 minutes if surveying where deep diving marine mammals are likely to be present). Whilst JNCC appreciates the efforts of MMOs to collect data at other times, this should be managed to ensure that those observations are not detrimental to the ability to undertake a watch prior to a soft-start. Where two MMOs are onboard a seismic vessel, JNCC would encourage collaboration to ensure that cetacean monitoring is always undertaken during all daylight hours.

2.2. Training requirements for MMOs

A prerequisite for an MMO to be classified as a 'trained MMO' is that they must have received formal training on a JNCC recognised course. (Further information on MMO course providers is available at: http://www.jncc.gov.uk/page-4703)

2.3. MMO equipment and reporting forms

MMOs should be equipped with binoculars, a copy of the JNCC guidelines and the 'Marine Mammal Recording Form' which is an Excel spreadsheet and has embedded worksheets named: 'Cover Page', 'Operations', 'Effort' and 'Sightings'. A Word document named 'Deckforms' is also available, and MMOs may prefer to use this when observing before transferring the details to the Excel spreadsheets.

The ability to determine range is a key skill for MMOs to have, and a useful tool to perform this function is a range finding stick.

All MMO forms, including a guide to completing the forms, and instructions on how to make and use a range finding stick are available on the JNCC website.

2.4. Reporting requirements – the MMO report

A report, the 'MMO report', should be sent to the JNCC after the survey has been completed. It is the responsibility of the consent holder to ensure that the MMO report is sent to JNCC. Ideally the MMO report should be sent via e-mail to seismic@jncc.gov.uk, or it can be posted to the address on the front page of these guidelines. Reports should include completed JNCC marine mammal recording forms and contain details of the following:

- The seismic survey reference number provided to the applicant by DECC.
- Date and location of survey.
- Total number and volume of the airguns used.
- Nature of airgun array discharge frequency (in Hz), intensity (in dB re. 1μPa or bar metres) and firing interval (seconds), and / or details of any other acoustic energy used.
- Number and types of vessels involved in the survey.
- A record of all occasions when the airguns were used.
- A record of the watches made for marine mammals, including details of any sightings and the seismic activity during the watches.
- Details of any problems encountered during the seismic survey including instances of non-compliance with the JNCC guidelines.

If there are instances of non-compliance with the JNCC guidelines that constitute a breach of the survey consent conditions, JNCC will copy the report, and their comments on the potential breach to DECC. It is therefore essential that MMO reports are completed as soon as possible after the survey has been completed.

Section 3 – Guidance before and during seismic activity

All observations should be undertaken from the source vessel (where the airguns are being deployed from), unless alternative arrangements have been agreed with DECC. The MMO should be positioned on a high platform with a clear unobstructed view of the horizon, and communication channels between the MMO and the crew should be in place before commencement of the pre-shooting search (this may require portable VHF radios). The MMO should be aware of the timings of the proposed operations, so that there is adequate time to conduct the pre-shooting search. Figure 1 illustrates a typical seismic survey with decision making pathways in the event a marine mammal is detected.

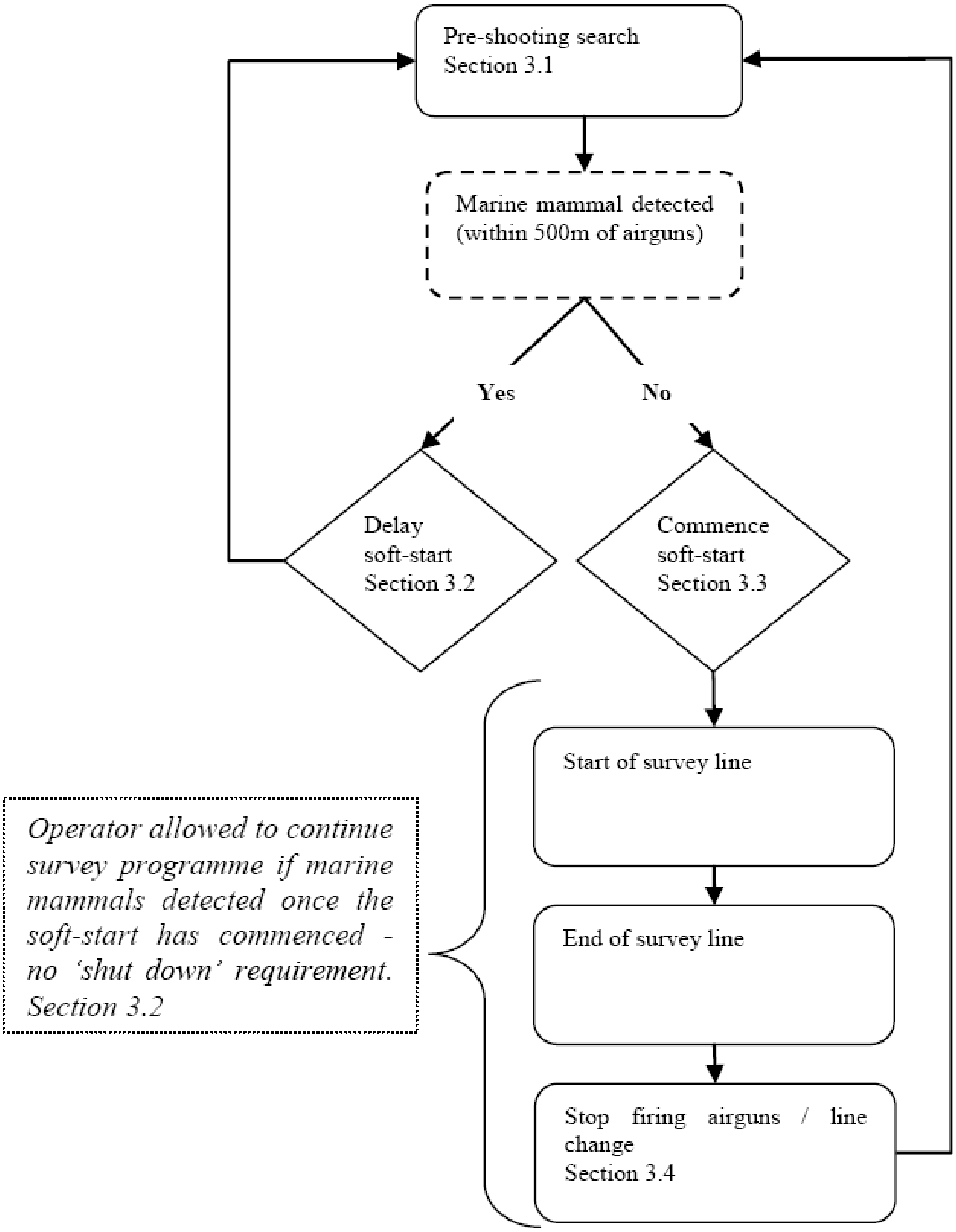

Figure 1. Flowchart illustrating the decision making pathway of a Marine Mammal Observer during a seismic survey.

3.1 Pre-shooting search

The pre-shooting search should normally be conducted over a period of 30 minutes before commencement of any use of the airguns. The MMO should make a visual assessment to determine if any marine mammals are within 500 metres of the centre of the airgun array.

In deep waters (>200 m) the pre-shooting search should extend to 60 minutes as deep diving species (e.g. sperm whale and beaked whale) are known to dive for longer than 30 minutes. A longer search time in such areas is likely to lead to a greater detection and tracking of deep diving marine mammals. To facilitate more effective timing of proposed operations when surveying in deeper waters, the searches for marine mammals can commence before the end of the survey line (whilst the airguns are still firing); this condition may be necessary for surveys which have relatively fast line turn times. If any marine mammals are detected whilst the airguns are still firing, then no action is required other than for the MMO to monitor and track any marine mammals. The commencement of the soft-start for any subsequent survey lines should be delayed for at least 20 minutes if marine mammals are detected when the airguns have ceased firing.

If PAM is used in conjunction with visual monitoring the PAM operatives should ensure the system is deployed and being monitored for vocalisations during each designated pre-shooting period.

3.2 Delay if marine mammals are detected within the mitigation zone (500 metres)

If marine mammals are detected within 500 metres of the centre of the airgun array during the pre-shooting search, the soft-start of the seismic sources should be delayed until their passage, or the transit of the vessel, results in the marine mammals being more than 500 metres away from the source. In both cases, there should be a 20 minute delay from the time of the last sighting within 500 metres of the source to the commencement of the soft-start, in order to determine whether the animals have left the area. If PAM is used it is the responsibility of the PAM operatives to assess any acoustic detections and determine if there are likely to be marine mammals within 500 metres of the source. If the PAM operatives consider marine mammals are present within that range then the start of the operation should be delayed as outlined above.

If marine mammals are detected within 500 metres of the centre of the airgun array whilst the airguns are firing, either during the soft-start procedure or whilst at full power, there is no requirement to stop firing the airguns.

In situations where seal(s) are congregating around a drilling or production platform that is within the survey area, it is recommended that the soft-start should commence at a location at least 500 metres from the platform.

3.3 The soft-start

The soft-start is defined as the time that airguns commence shooting till the time that full operational power is obtained. Power should be built up slowly from a low energy start-up (e.g. starting with the smallest airgun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the area. This build up of power should occur in uniform stages to provide a constant increase in output. There should be a soft-start every time the airguns are used, the only exceptions being for certain types of airgun testing (section 3.3.2), and the use of a ‘mini-airgun’ (single gun volume less than 10 cubic inches), these are used on site-surveys (section 3.3.1). The duration of the pre-shooting search (at least 30 minutes) and the soft-start procedure (at least 20 minutes) should be factored into the survey design.

General advice to follow for soft-starts:

- To minimise additional noise in the marine environment, a soft-start (from commencement of soft-start to commencement of the line) should not be significantly longer than 20 minutes (for example, soft-starts greater than 40 minutes are considered to be excessive, and an explanation should be provided within the MMO report).
- Where possible, soft-starts should be planned so that they commence within daylight hours.
- Once the soft-start has been performed and the airguns are at full power the survey line should start immediately. Operators should avoid unnecessary firing at full power before commencement of the line.
- If, for any reason, firing of the airguns has stopped and not restarted for at least 10 minutes, then a pre-shooting search and 20 minute soft-start should be carried out (the requirement for a pre-shooting search only applies if there was no MMO on duty and observing at this time, and if the break in firing occurred during the hours of daylight). After any unplanned break in firing for less than 10 minutes the MMO should make a visual assessment for marine mammals (not a pre-shooting search) within 500 metres of the centre of the airgun array. If a marine mammal is detected whilst the airguns are not firing the MMO should advise to delay commencement, as per the pre-shooting search, delay and soft start instructions above. If no marine mammals are present then they can advise to commence firing the airguns.
- When time-sharing, where two or more vessels are operating in adjacent areas and take turns to shoot to avoid causing seismic interference with each other, the soft-start and delay procedures for each vessel should be communicated to, and applied on, all the vessels involved in the surveying.

3.3.1 Soft-start requirements for site survey or Vertical Seismic Profiling (VSP)

Surveys should be planned so that, whenever possible, the soft-start procedures for site surveys and Vertical Seismic Profiles (VSP's) commence during daylight hours. Whilst it is appreciated that high resolution site surveys / VSP operations may produce lower acoustic output than 2D or 3D surveys it is still considered desirable to undertake a soft-start to allow for marine mammals to move away from the seismic source.

For ultra high resolution site surveys that only use a 'mini-airgun' (single airgun with a volume of less than 10 cubic inches) there is no requirement to perform a soft-start, however, a pre-shooting search should still be conducted before its use.

For site surveys and VSPs, a number of options are available to effect a soft-start.

- The standard method, where power is built up slowly from a low energy start-up (e.g. starting with the smallest airgun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the vicinity.

- As the relationship between acoustic output and pressure of the air contained in the airgun is close to linear and most site surveys / VSP operations use only a small number of airguns and a soft-start can be achieved by slowly increasing the air pressure in 500 psi steps. From our understanding, the minimum air pressure which the airgun array can be set to will vary, as this is dependent on the make and model of the airgun being used. The time from initial airgun start up to full power should be at least 20 minutes.

- Over a minimum time period of 20 minutes the airguns should be fired at an increasing frequency (by decreasing the Shot Point Interval (SPI)) until the desired firing frequency is reached.

3.3.2 Soft-starts and airgun testing

Airgun tests may be required before a survey commences, or to test damaged or misfiring guns following repair, or to trial new arrays. Individual airguns, or the whole array may need testing, and the airguns may be tested at varying power levels. The following guidance is provided to clarify when a soft-start is required:

- If the intention is to test all airguns at full power then a 20 minute soft-start is required.
- If the intention is to test a single airgun on low power then a soft-start is not required.
- If the intention is to test a single airgun, or a number of guns on high power, the airgun or airguns should be fired at lower power first, and the power then increased to the level of the required test; this should be carried out over a time period proportional to the number of guns being tested and ideally not exceed 20 minutes in duration.

MMOs should maintain a watch as outlined in the pre-shooting search guidance (section 3.1) before any instances of gun testing.

3.4 Line Change

Seismic data is usually collected along predetermined survey lines. Line change is the term used to describe the activity of turning the vessel at the end of one line prior to commencement of the next line. Depending upon the type of seismic survey being undertaken, the time for a line change can vary. Line changes are not necessary for all types of seismic surveys, for example, in certain regional surveys where there is a significant distance between the lines, and for VSP operations.
The guidance relating to line change depends upon the airgun volume.

3.4.1 Seismic surveys with an airgun volume of 500 cubic inches or more

If the line change time is expected to be greater than 20 minutes, airgun firing should be terminated at the end of the line and a full 20 minute soft-start undertaken before the next line. A pre-shooting search should also be undertaken during the scheduled line change, and the soft-start delayed if marine mammals are seen within 500 metres of the centre of the airgun array.

3.4.2 Seismic surveys with an airgun volume of 180 cubic inches or less (site surveys)

If the line change time is expected to be greater than 40 minutes, airgun firing should be terminated at the end of the line and a full 20 minute soft-start undertaken before the next line. The pre-shooting search should also be undertaken during the scheduled line change, and the soft-start delayed if marine mammals are seen within 500 metres of the centre of the airgun array.
If the line change time is expected to be less than 40 minutes, airgun firing can continue during the turn, but the Shot Point Interval (SPI) should be increased (longer duration between shots). Ideally, the SPI should not exceed 5 minutes during the turn.

Depending upon the duration of the line turns and the nature of seismic survey it may be necessary to vary the soft-start procedures. If an applicant determines that an effective line change can not be achieved using the above methods please contact JNCC at the earliest possible opportunity to discuss the proposed alternative, and include the details of the agreed procedure and the consultation with the JNCC in the application for survey consent.

3.5 Undershoot operations

During an undershoot operation, one vessel is employed to tow the seismic source and a second vessel used to tow the hydrophone array, although the main vessel will still tow the hydrophone array. This procedure is used to facilitate shooting under platforms or other obstructions. The MMO may be too far away from the airguns to effectively monitor the mitigation zone, and it is therefore recommended to place the MMO on the source vessel. If this is not possible, for example for logistical reasons, or the health and safety implications of transferring personnel from one vessel to another, the application should explain that the recommended procedure cannot be followed in the application for the survey consent, or the application for a variation of that consent. Irrespective of the MMO location agreed with DECC, the pre-shooting search and soft-start procedures should still be followed prior to undertaking an undershoot operation.

Section 4 - Acoustic Monitoring

Visual observation is an ineffective mitigation tool during periods of darkness or poor visibility (such as fog), or during periods when the sea state is not conducive to visual mitigation, as it will not be possible to detect marine mammals in the vicinity of airgun sources. Under such conditions, PAM is considered to be the only currently available mitigation technique that can be used to detect marine mammals. Current PAM systems can be particularly helpful in detecting harbour porpoises within the 500 metre mitigation zone, although the systems have their limitations and can only be used to detect vocalising species of marine mammals.
PAM systems consist of hydrophones that are deployed into the water column, and the detected sounds are processed using specialised software. PAM operatives are needed to set up and deploy the equipment and to interpret the detected sounds.

4.1 <u>Use of PAM as a mitigation tool</u>:

PAM can provide a useful supplement to visual observations undertaken by MMOs and JNCC may recommend that it is used as a mitigation tool when commenting on applications for survey consents. However, in many cases it is not as accurate as visual observation for determining range, and this will mean that the mitigation zone will reflect the range accuracy of the system. For example, if the range accuracy of a system is estimated at +/-300 metres, animals detected and calculated to be within 500 metres from the source could, in reality, be 500 + 300 = 800 metres, but their detection would still lead to a delay in the soft-start. Although, at present it is not possible to express the range accuracy of most PAM systems in numerical terms, this example serves to illustrate that it is in the operator's best interests to use the most accurate system available, and for the PAM operative to factor in a realistic estimate of the range accuracy.

Some PAM systems do not have a reliable range determination facility or can only calculate the range for some species. In such cases, the detection of a confirmed cetacean vocalisation should still be used to initiate postponement of the soft-start if the PAM operator is able to make a judgement about the range of the animals from the airgun source, because of their experience gained in differentiating between distant and close vocalisations. In the absence of PAM systems capable of range determination, this expert judgement will constitute the basis for deciding whether an area is free from cetaceans prior to the soft-start.
In all cases where PAM is employed, a brief description of the system and an explanation of how the applicant intends to deploy PAM to greatest effect should be included in the application for survey consent.

In the last few years, software that processes and analyses cetacean sounds has been developed. An example of this is PAMGuard, an open source software that has been developed as part of the International Association of Oil and Gas Producers Joint Industry Project (JIP). JNCC recognises that PAMGuard is currently in a transition period between use as a research tool and widespread adoption as a monitoring technique. Moreover, JNCC recognises the need to balance proactive implementation of PAM with the need to further develop its capability, for example to include species recognition and baleen whale detection, and therefore encourages users of these systems to actively contribute to their development and refinement.

Section 5 – Requirements for MMOs and PAM

Any survey application or consultation received by JNCC will be considered on a case-by-case basis, and the mitigation measures advised to DECC will reflect the particulars of the survey and the importance of the survey area for marine mammals. The following paragraphs are provided as a guide to the advice applicants are likely to receive following submission of an application with JNCC.

For areas that are currently considered particularly important for marine mammals, for example in the UK this includes areas West of Scotland, the Moray Firth and Cardigan Bay, JNCC may recommend that:

- The MMOs should be experienced MMOs, and that PAM should be used.
- The PAM system should be used to supplement visual observations, or as the main mitigation tool if the seismic survey activity commences during periods of darkness or poor visibility, or during periods when the sea state is not conducive to visual mitigation.

JNCC will advise that two marine mammal observers should be used when daylight hours exceed approximately 12 hours per day (between 1st April and 1st October north of 57° latitude), or the survey is in an area considered particularly important for marine mammals.

When a non-dedicated MMO is recommended by JNCC (e.g. for VSPs and certain site-surveys), and the recommendation is incorporated into the conditions of the survey consent, a member of the rig's or vessels crew can perform the duties providing the crew member is a trained MMO.

When a dedicated MMO is recommended and this is a condition of the survey consent, the MMO should be employed solely for the purpose of monitoring the implementation of the guidelines and undertaking visual observations to detect marine mammals during periods of seismic activity.

When two dedicated MMOs are requested and this is a condition of the survey consent, both should be employed solely for the purposes of monitoring the implementation of the guidelines and undertaking visual observations, and the use of a crew member with other responsibilities as the second observer is not considered to be an adequate substitute for a dedicated MMO, or to be in compliance with the conditions of the survey consent.

Section 6 - Background Information

These guidelines were originally prepared by a Working Group convened by the Department of the Environment, and were developed from a draft prepared by the Sea Mammal Research Unit (SMRU). The guidelines have subsequently been reviewed three times by the Joint Nature Conservation Committee, following consultation with interested parties.

6.1. Existing protection to cetaceans

Section 9 of the Wildlife and Countryside Act 1981 (CRoW amended) prohibits the intentional or reckless killing, injuring or disturbance of any cetacean. The UK is also a signatory to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) and has applied its provisions in all UK waters. Amongst other actions required to conserve and manage populations of small cetaceans, ASCOBANS requires range states to "work towards...the prevention of ...disturbance, especially of an acoustic nature".

Reflecting the requirements of the Convention on the Conservation of European Wildlife and Habitats (the Bern Convention) and Article 12 of the EC Habitats and Species Directive (92/43/EEC), the UK has the following legislation in place:

- The Conservation of Habitats and Species Regulations 2010
- The Conservation (Natural Habitats, & co.) Regulations 1995 (Northern Ireland) (and 2009 amendments)
- The Conservation (Natural Habitats, & co.) Amendment (No. 2) Regulations 2008 (Scotland) (and 2009 amendments)
- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (and 2007 amendments),
- The Offshore Marine Conservation (Natural Habitats, & co.) Regulations 2007 (and 2009 and 2010 amendments) (beyond 12 nautical miles UKCS)

Section 7 – References and contacts

Further information on DECC's survey consent procedure can be found at: http://www.og.decc.gov.uk/.
A copy of these guidelines, the standard forms (electronic and hard copy) and further background information is available from the above address, or can be found on the JNCC website at: http://www.jncc.gov.uk/page-1534
Reid, J.B., Evans, P.G.H., & Northridge, S.P. (2003). *'Atlas of cetacean distribution in north-west European waters'* (Online). http://www.jncc.gov.uk/page-2713
If you have any comments or questions relating to these guidelines, or suggestions on how they may be improved, please email seismic@jncc.gov.uk.

APPENDIX B PoN14 FOR UKCS BLOCKS 17/4b, 17/3, 11/28 and 11/29

DEPARTMENT OF ENERGY & CLIMATE CHANGE

2212

Energy Group
Energy Development Unit (EDU)
4th Floor
Atholl House
86-88 Guild Street
Aberdeen AB11 6AR

Tel +44 (0)1224 254042
Fax +44 (0)1224 254019

www.decc.gov.uk
EMT@decc.gsi.gov.uk

Jon Lucas
P A Resources
Waterfront
Hammersmith Embankment
Winslow Road
London
W6 9SF

08 August 2011

Dear Jon

THE OFFSHORE PETROLEUM ACTIVITIES (CONSERVATION OF HABITATS) REGULATIONS 2001 (AS AMENDED)

PON14 APPLICATION FOR SEISMIC SURVEY, BLOCKS 17/4b, 17/3, 11/28 AND 11/29

I refer to your request for clarification dated 29 June 2011.

Consent for the project detailed in your application, reference 2212, dated 6 May 2010 and updated 7 and 9 December 2010, has been amended and issued under regulation 4 of the above regulations. The amended consent notice, and any relevant conditions and comments, are attached.

If you have any queries in relation to this notification or the attachments, please do not hesitate to contact myself on 01224 254098 or e-mail the Environmental Management Team at emt@decc.gsi.gov.uk.

Yours sincerely

E. Pizzolla

Evelyn Pizzolla
Senior Environmental Manager

Enc

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Continuation **2**

THE OFFSHORE PETROLEUM ACTIVITIES (CONSERVATION OF HABITATS) REGULATIONS 2001 (AS AMENDED)

CONSENT TO CARRY OUT A GEOLOGICAL SURVEY

SEISMIC SURVEY, BLOCKS 17/4b, 17/3, 11/28 AND 11/29

Whereas P A Resources has made an application dated 6 May 2010, updated on 7 and 9 December 2010, containing the appropriate particulars as required under regulation 4 of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (As Amended); and whereas the Secretary of State has considered the application and is satisfied that the project is not likely to have a significant effect on relevant habitats and species; in exercise of the powers available to him under regulation 4, the Secretary of State hereby consents to the carrying out of the operation as described in the application for consent and in accordance with the conditions specified in the attached schedule

For and on behalf of the Secretary of State

E. Pizzolla
....

Evelyn Pizzolla
Authorised to act in that behalf
08 August 2011

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Continuation **3**

THE OFFSHORE PETROLEUM ACTIVITIES (CONSERVATION OF HABITATS REGULATIONS) 2001 (AS AMENDED)

SCHEDULE OF CONSENT CONDITIONS

1) Consent validity
The consent shall be valid from 1 August 2011 to 31 October 2011.

2) Temporal restrictions
If the start and finish dates detailed in the application for consent are likely to be amended or exceeded, the consent holder must immediately notify the Department of Energy and Climate Change (hereinafter called the Department) and request a post consent variation (PCV).

3) Exploration licences
Any survey undertaken for the purpose of searching for, or the getting of, petroleum in areas that are not covered by a current seaward areas production licence must be covered by a valid United Kingdom Continental Shelf exploration licence (as well as a consent).

4) Production licences
Any survey undertaken for the purpose of searching for, or the getting of, petroleum in areas that are covered by a current seaward area production licence must have the permission of the appropriate licence holder(s) unless the applicant is the licence holder.

5) Copies of the consent
The consent holder shall ensure that, prior to the start of the operations authorised under the consent, copies (electronic or paper) of the consent and any other relevant documents are available for inspection at:

a. the premises of the consent holder;

b. the premises of any agent or supplier acting on behalf of the consent holder; and

c. on board the vessel(s) undertaking the operations covered by the consent.

6) Joint Nature Conservation Committee (JNCC) guidelines
All seismic and high resolution site surveys must be undertaken in accordance with the latest version of the JNCC 'Guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys' and in accordance with the conditions detailed below. The guidelines must be fully implemented for all seals and cetaceans.

a. At least two dedicated Marine Mammal Observers (MMO) must be available to undertake visual monitoring prior to and during all soft start

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Continuation **4**

procedures, and during all daylight periods when the airguns are in operation.

b. The MMOs must be trained marine mammal observers, and must have experience of seismic surveys in UK waters; be familiar with the requirements of the JNCC guidelines and reporting forms; and have a good knowledge of the marine mammal species likely to be encountered in the area.

c. A proven Passive Acoustic Monitoring (PAM) system, i.e. one that has been successfully used in previous operations, must be available on the source vessel to undertake acoustic monitoring prior to and during the soft start procedure, and during all periods when the airguns are in operation.

d. Experienced PAM operatives must be provided to undertake the acoustic monitoring.

e. Agreed lines of communication must be established between the MMOs, the PAM operatives, the seismic survey contractor and the vessel's officers and crew, to facilitate co-ordination of the visual and acoustic detections of marine mammals and to ensure that the survey is undertaken in accordance with the JNCC guidelines.

f. The firing of the airguns at the start of any survey, or following any interruption of the firing operations for any reason, must not commence, or recommence, if marine mammals are visually or acoustically detected within 500 metres of the airgun array prior to commencement of the soft start procedure, and must not commence during periods of darkness or when the visibility or sea state prevents effective visual monitoring unless the acoustic monitoring confirms that vocalising marine mammals are not located within 500 metres of the airgun array.

g. The firing of the airguns should continue during the course of all line turns. At the end of each survey line, the volume of the airgun discharge (the "shot") should be reduced to 60 - 100 cubic inches, and the frequency of the firing (the "shot point interval") extended to 3 - 5 minutes, prior to undertaking a normal soft start procedure to gradually return to the proposed operating airgun volume and shot point interval during the 20 minutes before the start of the next survey line.

h. Adherence to the JNCC guidelines, and compliance with the specific conditions detailed above, must be reported within 28 days of the end of the survey operations, using the standard JNCC reporting forms. The latest versions of the guidance, reporting forms and related information can be found on the JNCC website at http://www.jncc.gov.uk/page-1534. The report must be sent to the Department and copied to JNCC, and must include the Department's survey reference number. The report should include details of line changes, soft start procedures, and any

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Continuation **5**

visual or acoustic detections, and include information relating to any difficulties encountered and recommendations for future surveys.

7) Cooperation with the University of Aberdeen

The consent holder must cooperate fully with the University of Aberdeen, in order to facilitate the monitoring work that will be undertaken during the seismic survey, and a copy of the survey report referred to in Condition 6g above, together with a complete copy of the PAM data, must be forwarded to the University of Aberdeen at the time of submission of the survey report to the Department and JNCC.

8) Survey close-out form

A survey closeout form must be completed and submitted to the Department within 12 weeks of completion of all seismic surveys and high-resolution site surveys undertaken using airguns. If the survey is cancelled for any reason, a close-out form must still be submitted to confirm that the survey was not undertaken. Copies of the standard survey closeout form can be found on the Department's website at https://www.og.decc.gov.uk/regulation/pons/index.htm.

9) Consent variation

In the event that the consent holder becomes aware that any of the information on which the issue of the consent was based has changed, the holder must notify the Department immediately. In the event that the consent holder wishes any of the particulars detailed in the application to be altered, the holder must notify the Department immediately so that the new information can be taken into consideration to determine whether a PCV (see Condition 2) should be issued. In the event that the consent holder determines that it is unable to follow the recommendation relating to the survey consent (order of surveys) that is appended to this schedule of consent conditions, it must as soon as possible:

a. notify the Department of the reasons;

b. provide details of an alternative; and

c. take into consideration any further recommendations received from the Department.

RECOMMENDATION RELATING TO SURVEY CONSENT

1) Order of surveys

The Department recommends that the proposed survey should be undertaken prior to any consented surveys of the Helmsdale, Forse, Braemore, Berriedale and Burrigill Prospects being undertaken on behalf of Caithness Petroleum Limited.

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Continuation **6**

NOTES RELATING TO SURVEY CONSENT

1) You are deemed to have satisfied yourself that there are no barriers, legal or otherwise, to the carrying out of the operations covered by the consent. The issue of the consent does not absolve the consent holder from obtaining such authorisations, consents etc which may be required under any other legislation.

2) Further information in relation to the consenting process can be found in the Department's 'Guidance Notes for Procedures For Oil and Gas Surveys (Including Seismic Surveys) and Shallow Drilling, Incorporating Guidance Implementing the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001' (As Amended).

3) The JNCC guidance, reporting forms and related information have recently been updated. The latest versions should be used, and they can be found on the JNCC website at http://www.jncc.gov.uk/page-1534.

4) All communications relating to the consent should be addressed to:

emt@decc.gsi.gov.uk

Department of Energy and Climate Change
Environmental Management Team
Energy Development Unit (EDU)
4th Floor, Atholl House
86-88 Guild Street
ABERDEEN AB11 6AR

Tel numbers: (01224) 254045
Fax number: (01224) 254019

COMMENTS ON THE APPLICATION FOR CONSENT

1) The Department does not require any additional information in support of the application for consent.

2) The Department would not wish to offer any further comments on the application for consent.

APPENDIX C BEAUFORT WIND, SEA CONDITIONS AND VISIBILITY

WIND SPEED

Beaufort Scale	Name	Knots	Metres/second
0	Calm	0 – 1	0 - 0.2
1	Light air	1 – 3	0.3 - 1.5
2	Light breeze	4 – 6	1.6 - 3.3
3	Gentle breeze	7 – 10	3.4 - 5.4
4	Moderate breeze	11 – 16	5.5 - 7.9
5	Fresh breeze	17 – 21	8.0 - 10.7
6	Strong breeze	22 – 27	10.8 - 13.8
7	Near gale	28 – 33	13.9 - 17.1
8	Gale	34 – 40	17.2 - 20.7
9	Strong gale	41 – 47	20.8 - 24.4
10	Storm	48 – 55	24.5 - 28.4
11	Violent storm	56 – 63	28.5 - 32.6
12	Hurricane	64+	32.7+

SEA STATE

Symbol	Name	Height in metres
0	Calm (glassy)	0
1	Calm (rippled)	0 – 0.10
2	Smooth (wavelets)	0.10 – 0.50
3	Slight	0.50 – 1.25
4	Moderate	1.25 – 2.50
5	Rough	2.50 – 4.00
6	Very rough	4.00 – 6.00
7	High	6.00 – 9.00
8	Very high	9.00 – 14.00
9	Phenomenal	14.00+

VISIBILITY

Name	Visibility (nautical miles)
Fog or dense snow fall	Less than 0.5
Poor visibility	0.5 – 2.0
Moderate visibility	2.0 – 5.0
Good visibility	5.0 – 25.0
Very good visibility	More than 25.0

APPENDIX D COMPLETED JNCC RECORDING FORMS

Record of Operations

01/09/2011	t	22:12					22:30			21:33	23:01	n	n	did not reach full power
01/09/2011	t	22:33	22:57	22:57			00:44			21:33	23:01	n	n	reached full power - test line
02/09/2011	t	01:58					02:16			00:44	03:24	n	n	did not reach full power
02/09/2011	l	02:41	03:07	03:14	03:23	03:23				00:44	03:24	n	n	Line 1. Aborted. Continue firing at reduced output
02/09/2011	l	04:56	05:21	05:24	06:41	06:41				03:24	05:19	n	n	Line 1A
02/09/2011	l	07:02	07:25	07:31	08:48	08:48		04:55	07:29	06:37	07:29	d	n	Line 4
02/09/2011	l	09:15	09:39	09:44	11:00	11:00		07:38	10:39	08:05	10:39	d	n	Line 2
02/09/2011	l	11:34	11:58	12:06	13:23	13:25		10:39	12:06	10:39	12:06	d	n	Line 14
02/09/2011	l	13:59	14:24	14:31	15:48	15:48		13:04	14:31	13:04	14:31	d	n	Line 3
02/09/2011	l	16:26	16:52	16:59	17:49		17:49	15:48	16:26	15:48	16:26	d	n	Line 15, aborted due to gun failure
02/09/2011	t	18:18	18:42	18:48	19:00	19:00		16:26	19:00	16:26	19:00	d	n	Test fixes at full power
02/09/2011	l	20:28	20:53	20:56	22:12	22:12				19:24	20:56	n	n	Line 27
02/09/2011	l	22:33	23:00	23:06	00:24	00:24				21:28	23:06	n	n	Line 30
03/09/2011	l	00:44	01:11	01:19	02:36	02:36				23:06	01:19	n	n	Line 26
03/09/2011	l	02:54	03:19	03:30	04:47	04:47				01:19	03:30	n	n	Line 32
03/09/2011	l	05:07	05:33	05:41	06:57	06:57		04:59	05:41	03:30	05:41	w	n	Line 29
03/09/2011	l	07:13	07:38	07:48	09:04		09:04	05:07	07:41	05:41	07:41	d	n	Line 34. Guns stopped for compressor maintenance
03/09/2011	l	10:10	10:34	10:48	12:05	12:05		09:04	10:48	07:41	10:48	d	n	Line 1B
03/09/2011	l	12:24	12:48	12:57	14:15	14:15		11:21	12:58	10:48	12:58	d	n	Line 4A
03/09/2011	l	14:32	14:59	15:06	17:22	17:22		13:47	15:09	12:58	15:09	d	n	Line 2A
03/09/2011	l	16:56	17:21	17:27	18:44	18:44		16:23	17:27	15:09	17:27	d	n	Line 14A

Date	Reason for firing	Time soft start/ ramp-up began (UTC)	Time of full power (UTC)	Time of start of line (UTC)	Time of end of line (UTC)	Time of reduced output (UTC) (if relevant)	Time airguns/ source stopped (UTC)	Time pre-shooting search began (UTC)	Time search ended (UTC)	Time PAM began (UTC)	Time PAM ended (UTC)	Was it day or night in the period prior to firing?	Was any mitigating action required?	Comments
03/09/2011	l	12:24	12:48	12:57	14:15	14:15		11:21	12:58	10:48	12:58	d	n	Line 4A
03/09/2011	l	14:32	14:59	15:06	17:22	17:22		13:47	15:09	12:58	15:09	d	n	Line 2A
03/09/2011	l	16:56	17:21	17:27	18:44	18:44		16:23	17:27	15:09	17:27	d	n	Line 14A
03/09/2011	l	19:14	19:38	19:47	21:04	21:04		18:44	19:40	17:27	19:47	k	n	Line 3A
03/09/2011	l	21:41	22:03	22:12	23:28	23:28				19:47	22:12	n	n	Line 15A
03/09/2011	l	23:58	00:24	00:31	01:49	01:49				22:12	00:31	n	n	Line 5
04/09/2011	l	02:20	02:45	02:54	04:11	04:11				00:31	02:54	n	n	Line 16
04/09/2011	l	04:40	05:06	05:12	06:28	06:28				02:54	05:12	n	n	Line 6
04/09/2011	l	06:56	07:22	07:30	08:46	08:46		05:43	07:30	05:43	07:30	d	n	Line 17
04/09/2011	l	09:16	09:41	09:47	10:46	10:46		08:07	09:47	08:07	09:47	d	n	Line 7
04/09/2011	l	11:39	12:03	12:11	13:29	13:29		10:46	12:11	10:46	12:11	d	n	Line 18
04/09/2011	l	13:58	14:23	14:33	15:18	15:18		13:07	14:33	13:07	14:33	d	n	Line 8
04/09/2011	l	16:22	16:47	16:57	18:14	18:14		15:08	16:57	15:08	16:57	d	n	Line 19
04/09/2011	l	18:43	19:08	19:17	20:06	20:06		17:55	19:19	17:55	19:19	d	n	Line 9
04/09/2011	l	21:05	21:30	21:39	22:56	22:56				20:06	21:40	n	n	Line 20
04/09/2011	l	23:26	23:53	00:01	00:52	00:52				21:40	00:01	n	n	Line 10
05/09/2011	l	01:52	02:17	02:26	03:43	03:43				00:01	02:26	n	n	Line 31
05/09/2011	l	04:29	04:54	05:02	05:55	05:55				02:26	05:02	n	n	Line 11
05/09/2011	l	06:46	07:12	07:20	08:37	08:37		05:55	07:20	05:02	07:20	d	n	Line 28
05/09/2011	l	09:17	09:42	09:51	11:08	11:08		07:20	09:51	07:20	09:51	d	n	Line 12
05/09/2011	l	11:40	12:05	12:15	13:32	13:32		09:51	11:41	09:51	11:41	d	n	Line 23
05/09/2011	l	14:02	14:28	14:38	15:54	15:54		11:41	14:28	11:41	14:28	d	n	Line 13
05/09/2011	l	16:25	16:50	16:59	17:44	17:44		15:54	17:01	15:54	17:01	d	n	Line 25, cut short due to compressor problems
05/09/2011	l	18:55	19:22	19:31	20:13	20:13		17:44	19:18	17:44	19:33	k	n	Line 25A
05/09/2011	l	20:33	20:58	21:05	22:23	22:23				19:33	21:06	n	n	Line 21
05/09/2011	l	22:59	23:27	23:34	00:51	00:51				21:06	23:34	n	n	Line 33
06/09/2011	l	01:24	01:50	02:00	03:18	03:18				23:34	02:00	n	n	Line 22
06/09/2011	l	03:52	04:18	04:24	05:41	05:41				02:00	04:49	n	n	Line 34A

Date	Reason for firing	Time soft start/ ramp-up began (UTC)	Time of full power (UTC)	Time of start of line (UTC)	Time of end of line (UTC)	Time of reduced output (UTC) (if relevant)	Time airguns/ source stopped (UTC)	Time pre-shooting search began (UTC)	Time search ended (UTC)	Time PAM began (UTC)	Time PAM ended (UTC)	Was it day or night in the period prior to firing?	Was any mitigating action required?	Comments
06/09/2011	l	06:12	06:36	06:45	08:03	08:03		05:06	06:12	05:16	07:00	d	n	Line 24
06/09/2011	l	08:40	09:06	09:14	10:32	10:32		07:00	09:30	07:00	09:30	d	n	Line 39
06/09/2011	l	10:53	11:18	11:25	12:43	12:43		09:43	11:31	09:43	11:31	d	n	Line 35
06/09/2011	l	13:09	13:34	13:42	15:01	15:01		12:19	13:44	12:19	13:44	d	n	Line 42
06/09/2011	l	15:23	15:48	15:57	17:14	17:14		13:44	16:17	13:44	16:17	d	n	Line 36
06/09/2011	l	17:40	18:04	18:14	19:31	19:31		16:39	18:14	16:39	18:14	d	n	Line 44
06/09/2011	l	19:52	20:17	20:28	21:45	21:45				19:14	20:28	n	n	Line 37
06/09/2011	l	22:20	22:44	22:52	00:08	00:08				20:28	22:52	n	n	Line 46
07/09/2011	l	00:36	01:01	01:06	02:21	02:21				23:23	01:06	n	n	Line 38
07/09/2011	l	02:51	03:16	03:25	04:42	04:42				01:06	03:25	n	n	Line 48
07/09/2011	l	05:09	05:35	05:40	06:57	06:57		05:09	05:41	03:45	05:41	w	n	Line 41
07/09/2011	l	07:20	07:45	07:53	09:06	09:06		05:41	07:53	05:41	07:53	d	n	Line 47
07/09/2011	l	09:30	09:55	10:02	11:19	11:19		07:53	10:02	07:53	10:02	d	n	Line 40
07/09/2011	l	11:50	12:15	12:23	13:40	13:40		11:19	12:23	11:19	12:23	d	n	Line 49
07/09/2011	l	14:13	14:38	14:47	16:04	16:04		13:40	14:49	13:40	14:49	d	n	Line 38A
07/09/2011	l	16:43	17:08	17:16	18:32	18:32		15:48	17:16	15:48	17:16	d	n	Line 51
07/09/2011	l	19:59	20:25	20:31	20:44	20:44				19:10	21:44	n	n	Line 49A
07/09/2011	l	21:09	21:34	21:43	23:00	23:00				19:10	21:44	n	n	Line 43
07/09/2011	l	23:33	23:58	00:07	01:22	01:22				21:44	00:07	n	n	Line 53
08/09/2011	l	01:50	02:16	02:22	03:39	03:39				00:07	02:22	n	n	Line 45
08/09/2011	l	04:10	04:36	04:42	05:59	05:59				02:22	04:42	n	n	Line 55
08/09/2011	l	06:22	06:47	06:53	08:11	08:11		05:07	06:53	05:07	06:53	d	n	Line 50
08/09/2011	l	08:30	08:56	09:04	10:21		10:21	07:28	09:04	07:28	09:04	d	n	Line 54
08/09/2011	l	10:45	11:09				11:18	10:10	11:18	10:10	11:18	d	n	Line abandoned due to bird missing off streamer
08/09/2011	l	13:10	13:36	13:43	15:01		15:01	12:35	13:44	12:35	13:44	d	n	Line 46A
08/09/2011	l	15:24	15:49	15:58	17:15		17:15	13:44	17:15	13:44	17:15	d	n	Line 52
08/09/2011	l	19:06	19:31	19:36	21:55		21:55	18:28	19:15	18:28	19:40	k	n	Line 56
08/09/2011	l	22:33	22:57	23:01	01:21		01:21			19:40	23:01	n	n	Line 60
09/09/2011	l	01:50	02:15	02:25	04:41		04:41			00:00	02:25	n	n	Line 57

Date	Reason for firing	Time soft start/ ramp-up began (UTC)	Time of full power (UTC)	Time of start of line (UTC)	Time of end of line (UTC)	Time of reduced output (UTC) (if relevant)	Time airguns/ source stopped (UTC)	Time pre-shooting search began (UTC)	Time search ended (UTC)	Time PAM began (UTC)	Time PAM ended (UTC)	Was it day or night in the period prior to firing?	Was any mitigating action required?	Comments
09/09/2011	l	05:17	05:42	05:50	08:05	08:05		05:10	05:50	02:25	08:05	w	n	Line 61
09/09/2011	l	08:45	09:07	09:09	11:26	11:26		07:30	09:09	08:05	09:09	d	n	Line 58
09/09/2011	l	12:09	12:34	12:40	14:58	14:58		11:26	12:40	11:26	12:40	d	n	Line 62
09/09/2011	l	15:35	16:00	16:06	18:22		18:22	14:46	16:28	14:46	16:46	d	n	Line 59

Effort Forms

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start postion (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
31/08/2011	v	K. Preston	04:50	06:00	57.79	n	2.27	w	85.0	57.88	n	2.90	w	81.0	8.0	n	nw	4.0	s	o	m	n
31/08/2011	v	K. Preston	06:00	07:04	57.88	n	2.90	w	81.0	57.93	n	3.20	w	80.0	6.0	n	nw	4.0	s	o	g	n
31/08/2011	v	K. Preston	07:04	08:20	57.93	n	3.20	w	80.0	57.98	n	3.35	w	47.0	2.0	n	nw	3.0	s	o	g	n
31/08/2011	v	K. Preston	09:40	10:20	57.94	n	3.18	w	47.0	57.93	n	3.11	w	46.0	4.4	n	nw	2.0	s	o	g	v
31/08/2011	v	K. Preston, Z. Allen	12:51	14:35	57.90	n	2.74	w	67.4	57.9	n	2.50	w	64.7	4.1	n	nw	2.0	s	o	g	v
01/09/2011	v	K. Preston, Z. Allen	04:58	05:59	57.96	n	3.51	w	52.9	57.97	n	3.44	w	43.5	4.0	n	nw	2.0	s	o	m	n
01/09/2011	v	Z. Allen, K. Preston	05:59	06:58	57.97	n	3.44	w	43.5	58.01	n	3.32	w	51.7	4.6	n	s	2.0	s	o	g	n
01/09/2011	v	Z. Allen	06:58	08:01	58.01	n	3.32	w	51.7	58.03	n	3.28	w	53.0	4.6	n	e	2.0	s	o	g	n
01/09/2011	v	Z. Allen, K. Preston	08:01	08:50	58.03	n	3.28	w	53.0	58	n	3.44	w	43.8	4.7	n	se	2.0	c	o	g	n
01/09/2011	v	K. Preston	08:50	09:20	58.00	n	3.44	w	43.8	57.98	n	3.44	w	45.1	5.0	n	se	2.0	s	o	g	n
01/09/2011	v	Z. Allen, K. Preston	09:20	09:40	57.98	n	3.44	w	45.1	57.99	n	3.41	w	41.5	2.8	n	se	2.0	s	o	g	n
01/09/2011	p	N. Russell	12:03	13:14	58.08	n	3.17	w	53.0	58.03	n	3.33	w	56.1	5.3	n	s	2.0	s	o	0.0	0.0
01/09/2011	v	Z. Allen	12:17	12:54	58.07	n	3.20	w	53.1	58.05	n	3.28	w	58.5	4.6	n	s	2.0	s	o	g	n
01/09/2011	v	Z. Allen	12:54	13:52	58.05	n	3.28	w	58.5	58.01	n	3.41	w	48.5	4.7	n	s	2.0	s	o	g	n
01/09/2011	p	N. Russell	13:14	14:14	58.03	n	3.33	w	56.1	58	n	3.46	w	51.4	4.7	n	s	2.0	s	o	0.0	0.0
01/09/2011	v	Z. Allen, N. Duthie	13:52	14:51	58.01	n	3.41	w	48.5	57.98	n	3.53	w	51.0	4.6	n	se	2.0	s	o	g	n
01/09/2011	p	N. Russell	14:14	15:20	58.00	n	3.46	w	51.4	57.97	n	3.53	w	52.4	4.5	n	se	2.0	s	o	0.0	0.0
01/09/2011	v	Z. Allen, N. Duthie	14:51	15:20	57.98	n	3.53	w	51.0	57.97	n	3.53	w	52.4	4.2	n	se	2.0	s	o	g	v
01/09/2011	v	Z. Allen, N. Duthie	15:20	15:24	57.97	n	3.53	w	52.4	57.97	n	3.52	w	52.0	4.4	s	se	2.0	s	o	g	v
01/09/2011	p	N. Russell	15:20	15:24	57.97	n	3.53	w	52.4	57.97	n	3.52	w	52.0	4.4	s	se	2.0	s	o	0.0	0.0
01/09/2011	v	Z. Allen, N. Duthie	15:24	15:58	57.97	n	3.52	w	52.0	58	n	3.45	w	49.0	4.3	n	se	2.0	s	o	g	v

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start position (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
01/09/2011	p	N. Russell	15:24	15:58	57.97	n	3.53	w	52.4	58	n	3.45	w	49.0	4.3	n	se	2.0	s	o	0.0	0.0
01/09/2011	v	Z. Allen, N. Duthie	16:25	17:35	58.03	n	3.38	w	47.0	58.07	n	3.31	w	55.2	4.2	n	se	2.0	s	o	g	v
01/09/2011	p	N. Russell	16:25	17:35	58.02	n	3.41	w	48.3	58.07	n	3.31	w	55.2	4.2	n	se	3.0	s	o	g	v
01/09/2011	v	Z. Allen, N. Duthie	17:35	18:35	58.07	n	3.31	w	55.2	58.03	n	3.42	w	49.7	4.3	n	se	2.0	s	o	g	w
01/09/2011	p	N. Russell	17:35	18:35	58.07	n	3.31	w	55.2	58.03	n	3.42	w	49.7	4.3	n	se	2.0	s	o	0.0	0.0
01/09/2011	v	Z. Allen, N. Duthie	18:35	19:20	58.03	n	3.42	w	49.7	58	n	3.50	w	50.2	4.2	n	se	2.0	s	o	g	w
01/09/2011	p	N. Russell	18:35	19:20	58.03	n	3.42	w	49.7	58	n	3.50	w	50.2	4.2	n	se	2.0	s	o	0.0	0.0
01/09/2011	p	N. Russell	19:20	20:30	58.00	n	3.50	w	50.2	58.01	n	3.44	w	48.3	4.3	n	se	2.0	s	o	0.0	0.0
01/09/2011	p	N. Russell	20:30	21:33	58.01	n	3.44	w	48.3	58.04	n	3.32	w	58.0	4.1	n	se	2.0	s	o	0.0	0.0
01/09/2011	p	N. Russell	21:33	22:05	58.04	n	3.32	w	58.0	58.05	n	3.31	w	55.0	3.1	n	se	2.0	s	o	0.0	0.0
01/09/2011	p	N. Russell	22:05	22:07	58.05	n	3.31	w	55.0	58.05	n	3.32	w	55.0	4.4	s	se	2.0	s	o	0.0	0.0
01/09/2011	p	N. Russell	22:07	22:12	58.05	n	3.32	w	55.0	58.05	n	3.33	w	55.0	4.3	n	se	2.0	s	o	0.0	0.0
01/09/2011	p	N. Russell	22:12	22:30	58.05	n	3.33	w	55.0	58.05	n	3.37	w	53.0	4.3	s	se	2.0	s	o	0.0	0.0
01/09/2011	p	N. Russell	22:30	22:33	58.05	n	3.37	w	53.0	58.05	n	3.37	w	51.0	4.0	n	se	2.0	s	o	0.0	0.0
01/09/2011	p	N. Russell	22:33	23:01	58.05	n	3.37	w	51.0	58.03	n	3.43	w	49.2	4.1	s	se	2.0	s	o	0.0	0.0
01/09/2011	p	K. Preston	23:01	23:59	58.03	n	3.43	w	49.2	57.99	n	3.56	w	46.0	4.1	f	se	2.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	00:00	00:44	57.99	n	3.56	w	46.0	57.97	n	3.61	w	47.2	4.1	f	se	2.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	00:44	01:54	57.97	n	3.61	w	47.2	57.99	n	3.51	w	0.0	4.3	n	se	2.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	01:54	02:01	57.99	n	3.51	w	55.0	58	n	3.50	w	55.4	4.5	n	se	3.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	02:01	02:17	58.00	n	3.50	w	55.4	58.01	n	3.52	w	51.0	4.6	s	se	3.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	02:17	02:40	58.01	n	3.52	w	51.0	58	n	3.54	w	52.0	4.5	n	se	3.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	02:40	03:05	58.00	n	3.54	w	52.0	57.98	n	3.51	w	47.8	4.1	s	se	3.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	03:05	03:24	57.98	n	3.51	w	47.8	57.95	n	3.48	w	46.4	4.2	f	se	3.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	03:24	04:41	57.95	n	3.48	w	46.4	58.01	n	3.52	w	50.9	4.4	r	se	3.0	s	o	0.0	0.0

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start position (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
02/09/2011	p	K. Preston	03:24	04:41	57.95	n	3.48	w	46.4	58.01	n	3.52	w	50.9	4.4	r	se	3.0	s	o	0.0	0.0
02/09/2011	p	K. Preston	04:41	04:55	58.01	n	3.52	w	50.9	58	n	3.54	w	50.3	4.5	r	se	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen	04:55	05:19	58.00	n	3.54	w	50.3	57.97	n	3.50	w	54.0	4.5	s	se	3.0	s	o	p	n
02/09/2011	p	K. Preston	04:55	05:19	58.00	n	3.54	w	50.3	58	n	3.54	w	50.3	4.5	s	se	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen	05:19	06:37	57.97	n	3.50	w	54.0	57.95	n	3.48	w	53.0	4.3	f	se	3.0	s	o	m	n
02/09/2011	p	K. Preston	05:19	06:37	57.97	n	3.50	w	54.0	57.95	n	3.48	w	53.0	4.3	f	se	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Duthie	06:37	06:41	57.95	n	3.48	w	53.0	57.89	n	3.40	w	59.4	4.2	f	se	3.0	s	o	m	n
02/09/2011	p	K. Preston	06:37	06:41	57.95	n	3.48	w	53.0	57.89	n	3.40	w	59.4	4.2	f	se	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Duthie	06:41	07:05	57.89	n	3.40	w	59.4	57.89	n	3.39	w	59.3	4.3	r	se	2.0	s	o	g	v
02/09/2011	p	K. Preston	06:41	07:05	57.89	n	3.40	w	59.4	57.89	n	3.39	w	59.3	4.3	r	se	2.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Duthie	07:05	07:29	57.89	n	3.39	w	59.3	57.91	n	3.42	w	54.9	4.2	s	se	3.0	s	o	g	v
02/09/2011	p	K. Preston	07:05	07:29	57.89	n	3.39	w	59.3	57.91	n	3.42	w	54.9	4.2	s	se	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Duthie	07:29	07:38	57.91	n	3.42	w	54.9	57.92	n	3.43	w	54.4	4.2	f	se	3.0	s	o	g	v
02/09/2011	p	K. Preston	07:29	07:38	57.91	n	3.42	w	54.9	57.92	n	3.43	w	54.4	4.2	f	se	3.0	s	o	0.0	0.0
02/09/2011	v	K. Preston	07:38	08:48	57.92	n	3.43	w	54.4	57.99	n	3.52	w	49.7	4.2	f	se	3.0	s	o	m	v
02/09/2011	p	N. Duthie	07:38	08:05	57.92	n	3.43	w	54.4	57.96	n	3.47	w	52.6	4.2	f	se	3.0	s	o	0.0	0.0
02/09/2011	p	Z. Allen	08:05	08:48	57.96	n	3.47	w	52.6	57.99	n	3.52	w	49.7	4.2	f	se	3.0	s	o	0.0	0.0
02/09/2011	v	K. Preston, N. Duthie	08:48	09:14	57.99	n	3.52	w	49.7	58	n	3.53	w	48.6	4.1	r	s	2.0	s	o	g	n
02/09/2011	p	Z. Allen	08:48	09:14	57.99	n	3.52	w	49.7	58	n	3.53	w	48.6	4.1	r	s	2.0	s	o	0.0	0.0
02/09/2011	v	K. Preston, N. Duthie	09:14	10:39	58.00	n	3.53	w	48.6	58	n	3.53	w	52.8	4.2	s	s	3.0	s	o	g	n
02/09/2011	p	Z. Allen	09:14	10:39	58.00	n	3.53	w	48.6	58	n	3.53	w	52.8	4.2	s	s	3.0	s	o	0.0	0.0
02/09/2011	v	K. Preston	10:39	11:10	58.00	n	3.53	w	52.8	57.89	n	3.38	w	62.0	4.4	f	s	3.0	s	o	g	n
02/09/2011	p	N. Duthie	10:39	11:10	58.00	n	3.53	w	52.8	57.89	n	3.38	w	62.0	4.4	f	s	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Russell	11:10	11:35	57.89	n	3.38	w	62.0	57.9	n	3.35	w	59.2	4.2	r	sw	3.0	s	o	g	s

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start postion (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
02/09/2011	p	N. Duthie	11:10	11:35	57.89	n	3.38	w	62.0	57.9	n	3.35	w	59.2	4.2	r	sw	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Russell	11:35	12:06	57.90	n	3.35	w	59.2	57.93	n	3.39	w	52.0	4.1	s	sw	3.0	s	o	g	s
02/09/2011	p	N. Duthie	11:35	12:06	57.90	n	3.35	w	59.2	57.93	n	3.39	w	52.0	4.1	s	sw	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen	12:06	13:04	57.93	n	3.39	w	52.0	57.99	n	3.46	w	47.7	4.2	f	sw	3.0	s	o	g	w
02/09/2011	p	N. Russell	12:06	13:04	57.93	n	3.39	w	52.0	57.99	n	3.46	w	47.7	4.2	f	sw	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen	13:04	13:25	57.99	n	3.46	w	47.7	58.01	n	3.48	w	53.7	4.1	f	sw	3.0	s	o	g	v
02/09/2011	p	N. Russell	13:04	13:25	57.99	n	3.46	w	47.7	58.01	n	3.48	w	53.7	4.1	f	sw	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Duthie	13:25	13:59	58.01	n	3.48	w	53.7	58	n	3.53	w	50.2	4.1	r	sw	3.0	s	o	g	v
02/09/2011	p	N. Russell	13:25	13:59	58.01	n	3.48	w	53.7	58	n	3.53	w	50.2	4.1	r	sw	3.0	s	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Duthie	13:59	14:31	58.00	n	3.53	w	50.2	57.97	n	3.49	w	52.0	4.1	s	sw	3.0	s	o	g	w
02/09/2011	p	N. Russell	13:59	14:31	58.00	n	3.53	w	50.2	57.97	n	3.49	w	52.0	4.1	s	sw	3.0	s	o	0.0	0.0
02/09/2011	v	N. Duthie	14:31	15:31	57.97	n	3.49	w	52.0	57.91	n	3.42	w	57.6	4.2	f	sw	4.0	c	o	g	v
02/09/2011	p	N. Russell	14:31	15:31	57.97	n	3.49	w	52.0	57.91	n	3.42	w	57.6	4.2	f	sw	4.0	c	o	0.0	0.0
02/09/2011	v	Z. Allen, N.Duthie	15:31	15:48	57.91	n	3.42	w	57.6	57.89	n	3.39	w	60.6	4.3	f	sw	4.0	c	o	g	w
02/09/2011	p	N. Russell	15:31	15:48	57.91	n	3.42	w	57.6	57.89	n	3.39	w	60.6	4.3	f	sw	4.0	c	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Duthie	15:48	16:26	57.89	n	3.39	w	60.6	57.9	n	3.34	w	58.5	4.2	r	sw	5.0	c	o	g	n
02/09/2011	p	N. Russell	15:48	16:26	57.89	n	3.39	w	60.6	57.9	n	3.34	w	58.5	4.2	r	sw	5.0	c	o	0.0	0.0
02/09/2011	v	Z. Allen, N. Duthie	16:26	16:59	57.90	n	3.34	w	58.5	57.92	n	3.38	w	54.6	4.1	s	sw	5.0	c	o	g	n
02/09/2011	p	N. Russell	16:26	16:59	57.90	n	3.34	w	58.5	57.92	n	3.38	w	54.6	4.1	s	sw	5.0	c	o	0.0	0.0
02/09/2011	v	Z. Allen	16:59	17:29	57.92	n	3.38	w	54.6	57.97	n	3.43	w	45.5	4.2	f	sw	4.0	c	o	g	n
02/09/2011	p	N. Russell	16:59	17:37	57.92	n	3.38	w	54.6	57.97	n	3.43	w	45.5	4.2	f	sw	4.0	c	o	0.0	0.0
02/09/2011	v	N. Duthie	17:29	17:49	57.96	n	3.42	w	44.0	57.98	n	3.44	w	45.8	4.4	f	sw	4.0	c	o	g	n
02/09/2011	p	Z. Allen	17:37	17:49	57.97	n	3.43	w	45.5	57.98	n	3.44	w	45.8	4.4	f	sw	4.0	c	o	0.0	0.0
02/09/2011	v	N. Duthie, N. Russell	17:49	18:16	57.98	n	3.44	w	45.8	58	n	3.45	w	53.0	4.4	n	sw	4.0	c	o	g	n

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start postion (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
02/09/2011	v	N. Duthie, N. Russell	17:49	18:16	57.98	n	3.44	w	45.8	58	n	3.45	w	53.0	4.4	n	sw	4.0	c	o	g	n
02/09/2011	p	Z. Allen	17:49	18:16	57.98	n	3.44	w	45.8	58	n	3.45	w	53.0	4.4	n	sw	4.0	c	o	0.0	0.0
02/09/2011	v	N. Duthie, N. Russell	18:16	18:42	58.00	n	3.45	w	53.0	57.98	n	3.45	w	43.7	4.4	s	sw	5.0	c	o	g	n
02/09/2011	p	Z. Allen	18:16	18:42	58.00	n	3.45	w	53.0	57.98	n	3.45	w	43.7	4.4	s	sw	5.0	c	o	0.0	0.0
02/09/2011	v	N. Duthie, N. Russell	18:42	19:00	57.98	n	3.45	w	43.7	57.99	n	3.43	w	43.7	4.3	v	s	5.0	c	o	g	n
02/09/2011	p	Z. Allen	18:42	19:00	57.98	n	3.45	w	43.7	57.99	n	3.43	w	43.7	4.3	v	s	5.0	c	o	0.0	0.0
02/09/2011	v	N. Duthie, N. Russell	19:00	19:24	57.99	n	3.43	w	43.7	58.01	n	3.38	w	45.2	4.3	r	s	5.0	c	o	g	n
02/09/2011	p	Z. Allen	19:00	19:24	57.99	n	3.43	w	43.7	58.01	n	3.38	w	45.2	4.3	r	s	5.0	c	o	0.0	0.0
02/09/2011	p	N. Russell	19:24	20:24	58.01	n	3.38	w	45.2	58.03	n	3.44	w	45.7	4.3	r	sw	4.0	c	o	0.0	0.0
02/09/2011	p	N. Russell	20:24	20:56	58.03	n	3.44	w	45.7	58	n	3.41	w	45.5	4.3	s	sw	4.0	c	o	0.0	0.0
02/09/2011	p	N. Russell	20:56	21:28	58.00	n	3.41	w	45.5	57.94	n	3.33	w	53.4	4.3	f	sw	5.0	c	o	0.0	0.0
02/09/2011	p	N. Russell	21:28	22:12	57.94	n	3.33	w	53.4	57.92	n	3.31	w	54.6	4.2	f	sw	5.0	c	o	0.0	0.0
02/09/2011	p	N. Russell	22:12	22:33	57.92	n	3.31	w	54.6	57.92	n	3.29	w	56.6	4.2	r	sw	5.0	c	o	0.0	0.0
02/09/2011	p	N. Russell	22:33	23:06	57.92	n	3.29	w	56.6	57.95	n	3.33	w	53.0	4.4	s	sw	5.0	c	o	0.0	0.0
02/09/2011	p	K. Preston	23:06	23:59	57.95	n	3.33	w	53.0	58	n	3.38	w	52.3	4.2	f	sw	5.0	c	o	0.0	0.0
03/09/2011	p	K. Preston	00:00	00:24	58.00	n	3.38	w	52.3	58.02	n	3.42	w	51.7	4.1	f	sw	5.0	c	o	0.0	0.0
03/09/2011	p	K. Preston	00:24	00:44	58.02	n	3.42	w	51.7	58.03	n	3.46	w	46.2	4.1	r	sw	5.0	c	o	0.0	0.0
03/09/2011	p	K. Preston	00:44	01:19	58.03	n	3.46	w	46.2	58	n	3.41	w	50.5	4.3	s	sw	4.0	c	o	0.0	0.0
03/09/2011	p	K. Preston	01:19	02:36	58.00	n	3.41	w	50.5	57.92	n	3.32	w	56.0	4.3	f	sw	4.0	c	o	0.0	0.0
03/09/2011	p	K. Preston	02:36	02:54	57.92	n	3.32	w	56.0	57.92	n	3.29	w	58.0	4.2	r	sw	4.0	c	o	0.0	0.0
03/09/2011	p	K. Preston	02:54	03:30	57.92	n	3.29	w	58.0	57.95	n	3.32	w	59.0	4.2	s	sw	4.0	c	o	0.0	0.0
03/09/2011	p	K. Preston	03:30	04:47	57.95	n	3.32	w	59.0	58.03	n	3.42	w	51.7	4.2	f	sw	4.0	c	o	0.0	0.0
03/09/2011	p	K. Preston	04:47	05:07	58.03	n	3.42	w	51.7	58.03	n	3.44	w	50.0	4.3	r	sw	3.0	s	o	0.0	0.0
03/09/2011	v	Z. Allen	04:59	05:07	58.04	n	3.43	w	52.0	58.03	n	3.44	w	50.0	4.3	r	sw	3.0	s	o	p	n

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03/09/2011	v	Z. Allen	05:07	05:41	58.03	n	3.44	w	50.0	58	n	3.40	w	42.5	4.9	s	sw	3.0	s	o	m	n
03/09/2011	p	K. Preston	05:07	05:41	58.03	n	3.44	w	50.0	58	n	3.40	w	42.5	4.9	s	sw	3.0	s	o	0.0	0.0
03/09/2011	v	Z. Allen, N. Duthie	05:41	06:31	58.00	n	3.40	w	42.5	57.95	n	3.34	w	52.7	4.3	f	sw	3.0	s	o	m	n
03/09/2011	p	K. Preston	05:41	06:31	58.00	n	3.40	w	42.5	57.95	n	3.34	w	52.7	4.3	f	sw	3.0	s	o	0.0	0.0
03/09/2011	v	Z. Allen, N. Duthie	06:31	06:46	57.95	n	3.34	w	52.7	57.94	n	3.32	w	54.3	4.2	f	sw	4.0	c	o	m	n
03/09/2011	p	K. Preston	06:31	06:46	57.95	n	3.34	w	52.7	57.94	n	3.32	w	54.3	4.2	f	sw	4.0	c	o	0.0	0.0
03/09/2011	v	Z. Allen, N. Duthie	06:46	06:57	57.94	n	3.32	w	54.3	57.93	n	3.31	w	57.7	4.1	f	sw	5.0	c	o	m	n
03/09/2011	p	K. Preston	06:46	06:57	57.94	n	3.32	w	54.3	57.93	n	3.31	w	57.7	4.1	f	sw	5.0	c	o	0.0	0.0
03/09/2011	v	Z. Allen, N. Duthie	06:57	07:13	57.93	n	3.31	w	57.7	57.92	n	3.28	w	56.0	4.2	r	sw	5.0	c	o	m	n
03/09/2011	p	K. Preston	06:57	07:13	57.93	n	3.31	w	57.7	57.92	n	3.28	w	56.0	4.2	r	sw	5.0	c	o	0.0	0.0
03/09/2011	v	Z. Allen, N. Duthie	07:13	07:41	57.92	n	3.28	w	51.0	57.95	n	3.31	w	51.0	4.3	s	sw	4.0	c	o	m	n
03/09/2011	p	K. Preston	07:13	07:41	57.92	n	3.28	w	51.0	57.95	n	3.31	w	51.0	4.3	s	sw	4.0	c	o	0.0	0.0
03/09/2011	v	Z. Allen, K. Preston	07:41	09:04	57.95	n	3.31	w	49.0	57.95	n	3.31	w	48.0	4.2	f	sw	3.0	c	o	g	n
03/09/2011	p	N. Duthie	07:41	09:04	57.95	n	3.31	w	49.0	57.95	n	3.31	w	48.0	4.2	f	sw	3.0	c	o	0.0	0.0
03/09/2011	v	Z. Allen, K. Preston	09:04	10:10	57.95	n	3.31	w	50.0	58	n	3.53	w	50.0	4.0	n	sw	3.0	c	o	g	n
03/09/2011	p	N. Duthie	09:04	10:10	57.95	n	3.31	w	50.0	58	n	3.53	w	50.0	4.0	n	sw	3.0	c	o	0.0	0.0
03/09/2011	v	Z. Allen, K. Preston	10:10	10:48	58.00	n	3.53	w	48.0	57.97	n	3.50	w	48.0	4.3	s	sw	3.0	s	o	g	v
03/09/2011	p	N. Duthie	10:10	10:48	58.00	n	3.53	w	48.0	57.97	n	3.50	w	48.0	4.3	s	sw	3.0	s	o	0.0	0.0
03/09/2011	v	N. Russell	10:48	11:21	57.97	n	3.50	w	47.0	57.93	n	3.46	w	47.0	4.2	f	sw	3.0	s	o	g	v
03/09/2011	p	N. Duthie	10:48	11:21	57.97	n	3.50	w	47.0	57.93	n	3.46	w	47.0	4.2	f	sw	3.0	s	o	0.0	0.0
03/09/2011	v	N. Russell	11:21	12:05	57.93	n	3.46	w	56.0	57.89	n	3.40	w	59.9	4.2	f	sw	2.0	s	o	g	v
03/09/2011	p	Z. Allen	11:21	12:05	57.93	n	3.46	w	56.0	57.89	n	3.40	w	59.9	4.2	f	sw	2.0	s	o	0.0	0.0
03/09/2011	v	N. Duthie, N. Russell	12:05	12:24	57.89	n	3.40	w	59.9	57.89	n	3.38	w	63.1	4.3	r	s	2.0	s	o	g	v
03/09/2011	p	Z. Allen	12:05	12:24	57.89	n	3.40	w	59.9	57.89	n	3.38	w	63.1	4.3	r	s	2.0	s	o	0.0	0.0

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03/09/2011	v	N. Duthie, N. Russell	12:24	12:58	57.89	n	3.38	w	63.1	57.92	n	3.42	w	60.1	4.0	s	s	2.0	s	o	g
03/09/2011	p	Z. Allen	12:24	12:58	57.89	n	3.38	w	63.1	57.92	n	3.42	w	60.1	4.0	s	s	2.0	s	o	0.0
03/09/2011	v	N. Duthie	12:58	13:47	57.92	n	3.42	w	60.1	57.96	n	3.48	w	53.7	4.2	f	s	2.0	s	o	g
03/09/2011	p	N. Russell	12:58	14:03	57.92	n	3.42	w	60.1	57.98	n	3.50	w	53.5	4.2	f	s	2.0	s	o	0.0
03/09/2011	v	Z. Allen	13:47	14:15	57.96	n	3.48	w	53.7	57.99	n	3.52	w	54.0	4.2	f	s	2.0	s	o	g
03/09/2011	p	N. Russell	14:03	14:15	57.98	n	3.50	w	53.5	57.99	n	3.52	w	54.0	4.2	f	s	2.0	s	o	0.0
03/09/2011	v	Z. Allen, N. Duthie	14:15	14:33	57.99	n	3.52	w	54.0	58	n	3.53	w	46.3	4.1	r	s	2.0	s	o	g
03/09/2011	p	N. Russell	14:15	14:33	57.99	n	3.52	w	54.0	58	n	3.53	w	46.3	4.1	r	s	2.0	s	o	0.0
03/09/2011	v	Z. Allen, N. Duthie	14:33	15:09	58.00	n	3.53	w	46.3	57.96	n	3.49	w	55.1	4.5	s	s	2.0	s	o	g
03/09/2011	p	N. Russell	14:33	15:09	58.00	n	3.53	w	46.3	57.96	n	3.49	w	55.1	4.5	s	s	2.0	s	o	0.0
03/09/2011	v	Z. Allen, N. Duthie	15:09	15:59	57.96	n	3.49	w	55.1	57.92	n	3.43	w	56.5	4.2	f	s	2.0	s	o	g
03/09/2011	p	N. Russell	15:09	15:59	57.96	n	3.49	w	55.1	57.91	n	3.42	w	60.8	4.2	f	s	2.0	s	o	0.0
03/09/2011	v	N. Duthie	15:59	16:10	57.92	n	3.43	w	56.5	57.91	n	3.42	w	60.8	4.3	f	s	2.0	s	o	m
03/09/2011	v	N. Duthie	16:10	16:23	57.91	n	3.42	w	60.8	57.89	n	3.40	w	63.9	4.3	r	sw	2.0	s	o	g
03/09/2011	p	Z. Allen	16:10	16:23	57.91	n	3.42	w	60.8	57.89	n	3.40	w	63.9	4.3	r	sw	2.0	s	o	0.0
03/09/2011	v	N. Duthie, N. Russell	16:23	16:59	57.89	n	3.40	w	63.9	57.9	n	3.35	w	58.5	4.3	r	sw	2.0	s	o	g
03/09/2011	p	Z. Allen	16:23	16:59	57.89	n	3.40	w	63.9	57.9	n	3.35	w	58.5	4.3	r	sw	2.0	s	o	0.0
03/09/2011	v	N. Duthie, N. Russell	16:59	17:28	57.90	n	3.35	w	58.5	57.93	n	3.39	w	53.3	4.3	s	w	2.0	s	o	g
03/09/2011	p	Z. Allen	16:59	17:28	57.90	n	3.35	w	58.5	57.93	n	3.39	w	53.3	4.3	s	w	2.0	s	o	0.0
03/09/2011	v	N. Russell	17:28	18:44	57.93	n	3.39	w	53.3	58.01	n	3.49	w	49.0	4.3	f	nw	3.0	s	o	g
03/09/2011	p	Z. Allen	17:28	18:04	57.93	n	3.39	w	53.3	57.96	n	3.43	w	44.8	4.3	f	nw	3.0	s	o	0.0
03/09/2011	p	N. Duthie	18:04	18:44	57.96	n	3.43	w	44.8	58.01	n	3.49	w	49.0	4.3	f	nw	3.0	s	o	0.0
03/09/2011	v	Z. Allen, N. Russell	18:44	19:16	58.01	n	3.49	w	49.0	57.99	n	3.51	w	49.0	4.2	r	nw	3.0	s	o	g
03/09/2011	p	N. Duthie	18:44	19:16	58.01	n	3.49	w	49.0	57.99	n	3.51	w	49.0	4.2	r	nw	3.0	s	o	0.0

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03/09/2011	v	Z. Allen, N. Russell	19:16	19:40	57.99	n	3.51	w	49.0	57.97	n	3.49	w	51.0	4.2	s	nw	3.0	s	o	g	n
03/09/2011	p	N. Duthie	19:16	19:40	57.99	n	3.51	w	49.0	57.97	n	3.49	w	51.0	4.2	s	nw	2.0	s	o	0.0	0.0
03/09/2011	p	N. Russell	19:40	19:47	57.97	n	3.49	w	51.0	57.97	n	3.49	w	52.5	4.2	s	nw	2.0	s	o	0.0	0.0
03/09/2011	p	N. Russell	19:47	20:56	57.97	n	3.49	w	52.5	57.9	n	3.41	w	59.0	4.2	f	nw	2.0	s	o	0.0	0.0
03/09/2011	p	N. Russell	20:56	21:05	57.90	n	3.41	w	59.0	57.89	n	3.40	w	59.0	4.1	f	nw	2.0	s	o	0.0	0.0
03/09/2011	p	N. Russell	21:05	21:41	57.89	n	3.40	w	59.0	57.08	n	3.34	w	57.6	4.3	r	nw	2.0	s	o	0.0	0.0
03/09/2011	p	N. Russell	21:41	22:12	57.08	n	3.34	w	57.6	57.93	n	3.38	w	54.8	4.2	s	var	1.0	s	o	0.0	0.0
03/09/2011	p	N. Russell	22:12	22:57	57.93	n	3.38	w	54.8	57.98	n	3.44	w	45.6	4.3	f	var	1.0	s	o	0.0	0.0
03/09/2011	p	K. Preston	22:57	23:28	57.98	n	3.44	w	45.6	58.01	n	3.48	w	50.5	4.3	f	var	1.0	s	o	0.0	0.0
03/09/2011	p	K. Preston	23:28	23:58	58.01	n	3.48	w	50.5	58	n	3.52	w	49.9	4.3	r	var	1.0	s	o	0.0	0.0
03/09/2011	p	K. Preston	23:58	23:59	58.00	n	3.52	w	49.9	58	n	3.52	w	49.8	4.1	s	var	1.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	00:00	00:31	58.00	n	3.52	w	49.8	57.97	n	3.48	w	54.0	4.1	s	var	1.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	00:31	01:49	57.97	n	3.48	w	54.0	57.9	n	3.39	w	60.6	4.3	f	var	1.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	01:49	02:20	57.90	n	3.39	w	60.6	57.9	n	3.34	w	58.7	4.2	r	var	1.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	02:20	02:54	57.90	n	3.34	w	58.7	57.93	n	3.38	w	55.5	4.0	s	var	1.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	02:54	04:11	57.93	n	3.38	w	55.5	58.01	n	3.47	w	50.4	4.2	f	var	1.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	04:11	04:40	58.01	n	3.47	w	50.4	58	n	3.52	w	51.0	4.2	r	var	1.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	04:40	05:12	58.00	n	3.52	w	51.0	57.97	n	3.48	w	51.1	4.4	s	var	1.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen	04:59	05:12	57.99	n	3.50	w	53.4	57.97	n	3.48	w	51.1	4.4	s	var	1.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen	05:12	05:43	57.97	n	3.48	w	51.1	57.94	n	3.44	w	54.0	4.3	f	sw	2.0	s	o	m	w
04/09/2011	p	K. Preston	05:12	06:28	57.97	n	3.48	w	51.1	57.9	n	3.39	w	60.1	4.3	f	sw	2.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen, N. Duthie	05:43	06:28	57.94	n	3.44	w	54.0	57.9	n	3.39	w	60.1	4.3	f	sw	2.0	s	o	g	v
04/09/2011	v	Z. Allen, N. Duthie	06:28	06:56	57.90	n	3.39	w	60.1	57.9	n	3.33	w	57.2	4.3	r	sw	2.0	s	o	g	v
04/09/2011	p	K. Preston	06:28	06:56	57.90	n	3.39	w	60.1	57.9	n	3.33	w	57.2	4.3	r	sw	2.0	s	o	0.0	0.0

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start postion (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
04/09/2011	v	Z. Allen, N. Duthie	06:56	07:30	57.90	n	3.33	w	57.2	57.93	n	3.38	w	53.8	4.5	s	sw	2.0	s	o	g	v
04/09/2011	p	K. Preston	06:56	07:30	57.90	n	3.33	w	57.2	57.93	n	3.38	w	53.8	4.5	s	sw	2.0	s	o	0.0	0.0
04/09/2011	v	N. Duthie	07:30	08:07	57.93	n	3.38	w	53.8	57.97	n	3.42	w	44.0	4.4	f	sw	2.0	s	o	g	v
04/09/2011	p	K. Preston	07:30	08:07	57.93	n	3.38	w	53.8	57.97	n	3.42	w	44.0	4.4	f	sw	2.0	s	o	0.0	0.0
04/09/2011	v	K. Preston	08:07	08:46	57.97	n	3.42	w	44.0	58.01	n	3.47	w	46.0	4.3	f	sw	3.0	s	o	g	v
04/09/2011	p	Z. Allen	08:07	08:46	57.97	n	3.42	w	44.0	58.01	n	3.47	w	46.0	4.3	f	sw	3.0	s	o	0.0	0.0
04/09/2011	v	K. Preston, Z. Allen	08:46	09:16	58.01	n	3.47	w	46.0	58	n	3.52	w	45.0	4.3	f	sw	3.0	s	o	g	v
04/09/2011	p	N. Duthie	08:46	09:16	58.01	n	3.47	w	46.0	58	n	3.52	w	45.0	4.3	r	sw	3.0	s	o	0.0	0.0
04/09/2011	v	K. Preston, Z. Allen	09:16	09:47	58.00	n	3.52	w	45.0	57.96	n	3.47	w	49.0	4.2	s	sw	3.0	s	o	g	s
04/09/2011	p	N. Duthie	09:16	09:47	58.00	n	3.52	w	45.0	57.96	n	3.47	w	49.0	4.2	s	sw	3.0	s	o	0.0	0.0
04/09/2011	v	K. Preston, Z. Allen	09:47	10:46	57.96	n	3.47	w	49.0	58.53	n	3.88	w	58.0	4.2	f	sw	2.0	s	o	g	s
04/09/2011	p	N. Duthie	09:47	10:46	57.96	n	3.47	w	49.0	58.53	n	3.88	w	58.0	4.2	f	sw	2.0	s	o	0.0	0.0
04/09/2011	v	K. Preston, N. Russell	10:46	11:12	58.53	n	3.88	w	52.1	57.89	n	3.38	w	55.9	4.2	r	sw	2.0	s	o	g	s
04/09/2011	p	N. Duthie	10:46	11:12	58.53	n	3.88	w	52.1	57.89	n	3.38	w	55.9	4.2	r	sw	2.0	s	o	0.0	0.0
04/09/2011	v	K. Preston, N. Russell	11:12	11:18	57.89	n	3.38	w	55.9	57.89	n	3.35	w	59.4	4.3	r	s	2.0	s	o	g	s
04/09/2011	p	Z. Allen	11:12	11:18	57.89	n	3.38	w	55.9	57.89	n	3.35	w	59.4	4.3	r	s	2.0	s	o	0.0	0.0
04/09/2011	v	K. Preston, N. Russell	11:18	11:38	57.89	n	3.35	w	59.4	57.9	n	3.33	w	56.3	4.5	r	var	1.0	s	o	g	s
04/09/2011	p	Z. Allen	11:18	11:38	57.89	n	3.35	w	59.4	57.9	n	3.33	w	56.3	4.5	r	var	1.0	s	o	0.0	0.0
04/09/2011	v	N. Russell, N. Duthie	11:38	12:11	57.90	n	3.33	w	56.3	57.94	n	3.37	w	52.8	4.3	s	var	1.0	s	o	g	s
04/09/2011	p	Z. Allen	11:38	12:11	57.90	n	3.33	w	56.3	57.94	n	3.37	w	52.8	4.3	s	var	1.0	s	o	0.0	0.0
04/09/2011	v	N. Russell, N. Duthie	12:11	12:24	57.94	n	3.37	w	52.8	57.95	n	3.39	w	41.0	4.3	f	var	1.0	g	o	g	s
04/09/2011	p	Z. Allen	12:11	12:24	57.94	n	3.37	w	52.8	57.95	n	3.39	w	41.0	4.3	f	var	1.0	g	o	0.0	0.0
04/09/2011	v	N. Duthie	12:24	12:43	57.95	n	3.39	w	41.0	57.97	n	3.41	w	46.0	4.3	f	var	1.0	g	o	g	s
04/09/2011	p	N. Russell	12:24	12:43	57.95	n	3.39	w	41.0	57.97	n	3.41	w	46.0	4.3	f	var	1.0	g	o	0.0	0.0

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04/09/2011	v	N. Duthie	12:43	13:07	57.97	n	3.41	w	46.0	57.99	n	3.44	w	45.0	4.2	f	ne	1.0	s	o	g	s
04/09/2011	p	N. Russell	12:43	13:29	57.97	n	3.41	w	46.0	58.01	n	3.47	w	47.0	4.2	f	ne	1.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen	13:07	13:29	57.99	n	3.44	w	45.0	58.01	n	3.47	w	47.0	4.2	f	ne	1.0	s	o	g	s
04/09/2011	v	Z. Allen, N. Duthie	13:29	13:58	58.01	n	3.47	w	47.0	58.01	n	3.52	w	51.0	4.2	r	ne	1.0	s	o	g	s
04/09/2011	p	N. Russell	13:29	13:58	58.01	n	3.47	w	47.0	58.01	n	3.52	w	51.0	4.2	r	ne	1.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen, N. Duthie	13:58	14:33	58.01	n	3.52	w	51.0	57.97	n	3.47	w	48.9	4.1	s	se	2.0	s	o	g	s
04/09/2011	p	N. Russell	13:58	14:33	58.01	n	3.52	w	51.0	57.97	n	3.47	w	48.9	4.1	s	se	2.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen	14:33	15:15	57.97	n	3.47	w	48.9	57.93	n	3.42	w	55.0	4.3	f	se	2.0	s	o	g	s
04/09/2011	p	N. Russell	14:33	15:15	57.97	n	3.47	w	48.9	57.93	n	3.42	w	55.0	4.3	f	se	2.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen, N. Duthie	15:15	15:18	57.93	n	3.42	w	55.0	57.93	n	3.42	w	55.0	4.3	f	se	3.0	s	o	g	s
04/09/2011	p	N. Russell	15:15	15:18	57.93	n	3.42	w	55.0	57.93	n	3.42	w	55.0	4.3	f	se	3.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen, N. Duthie	15:18	16:23	57.93	n	3.42	w	55.0	57.9	n	3.33	w	59.0	4.3	r	se	3.0	s	o	g	s
04/09/2011	p	N. Russell	15:18	16:23	57.93	n	3.42	w	55.0	57.9	n	3.33	w	59.0	4.3	r	se	3.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen, N. Duthie	16:23	16:57	57.90	n	3.33	w	59.0	57.94	n	3.37	w	53.0	4.5	s	se	3.0	s	o	g	s
04/09/2011	p	N. Russell	16:23	16:57	57.90	n	3.33	w	59.0	57.94	n	3.37	w	53.0	4.5	s	se	3.0	s	o	0.0	0.0
04/09/2011	v	N. Duthie	16:57	17:13	57.94	n	3.37	w	53.0	57.95	n	3.39	w	45.0	4.3	f	se	3.0	s	o	g	w
04/09/2011	p	N. Russell	16:57	17:13	57.94	n	3.37	w	53.0	57.95	n	3.39	w	45.0	4.3	f	se	3.0	s	o	0.0	0.0
04/09/2011	v	N. Russell	17:13	17:36	57.95	n	3.39	w	45.0	57.98	n	3.42	w	46.0	4.2	f	se	3.0	s	o	g	n
04/09/2011	p	Z. Allen	17:13	17:36	57.95	n	3.39	w	45.0	57.98	n	3.42	w	46.0	4.2	f	se	3.0	s	o	0.0	0.0
04/09/2011	v	N.Duthie	17:36	17:55	57.98	n	3.42	w	46.0	57.99	n	3.44	w	48.0	4.2	f	se	2.0	s	o	g	n
04/09/2011	p	Z. Allen	17:36	17:55	57.98	n	3.42	w	46.0	57.99	n	3.44	w	48.0	4.2	f	se	2.0	s	o	0.0	0.0
04/09/2011	v	N. Duthie	17:55	18:14	57.99	n	3.44	w	48.0	57.98	n	3.46	w	49.0	4.3	f	se	2.0	s	o	g	n
04/09/2011	p	N. Russell	17:55	18:14	57.99	n	3.44	w	48.0	57.98	n	3.46	w	49.0	4.3	f	se	2.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen, N. Duthie	18:14	18:43	57.98	n	3.46	w	49.0	58.01	n	3.51	w	50.0	4.2	r	se	3.0	s	o	g	n

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04/09/2011	p	N. Russell	18:14	18:43	57.98	n	3.46	w	49.0	58.01	n	3.51	w	50.0	4.2	r	se	3.0	s	o	0.0	0.0
04/09/2011	v	Z. Allen, N. Duthie	18:43	19:19	58.01	n	3.51	w	50.0	57.98	n	3.47	w	49.0	4.3	s	se	3.0	s	o	g	n
04/09/2011	p	N. Russell	18:43	19:19	58.01	n	3.51	w	50.0	57.98	n	3.47	w	49.0	4.2	s	se	3.0	s	o	0.0	0.0
04/09/2011	p	N. Russell	19:19	20:06	57.98	n	3.47	w	49.0	57.93	n	3.41	w	59.0	4.2	f	se	3.0	s	o	0.0	0.0
04/09/2011	p	N. Russell	20:06	21:05	57.93	n	3.41	w	59.0	57.9	n	3.33	w	57.0	4.2	r	se	3.0	s	o	0.0	0.0
04/09/2011	p	N. Russell	21:05	21:40	57.90	n	3.33	w	57.0	57.94	n	3.37	w	55.0	4.3	s	e	3.0	s	o	0.0	0.0
04/09/2011	p	N. Russell	21:40	22:27	57.94	n	3.37	w	55.0	58.01	n	3.46	w	50.0	4.2	f	e	3.0	s	o	0.0	0.0
04/09/2011	p	N. Russell	22:27	23:00	58.01	n	3.46	w	50.0	58.02	n	3.48	w	46.4	4.0	r	ne	3.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	23:00	23:26	58.02	n	3.48	w	46.4	58.01	n	3.51	w	50.0	4.3	r	ne	3.0	s	o	0.0	0.0
04/09/2011	p	K. Preston	23:26	23:59	58.01	n	3.51	w	50.0	57.98	n	3.47	w	47.0	3.9	s	ne	3.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	00:00	00:01	57.98	n	3.47	w	47.0	57.98	n	3.47	w	46.0	4.1	s	ne	3.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	00:01	00:52	57.98	n	3.47	w	46.0	57.93	n	3.40	w	54.3	4.2	f	ne	3.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	00:52	01:44	57.93	n	3.40	w	54.3	57.91	n	3.30	w	55.0	4.2	r	ne	3.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	01:44	01:52	57.91	n	3.30	w	55.0	57.92	n	3.28	w	57.3	4.2	r	ne	4.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	01:52	02:26	57.92	n	3.28	w	57.3	57.95	n	3.33	w	54.0	4.2	s	ne	4.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	02:26	03:43	57.95	n	3.33	w	54.0	58.03	n	3.42	w	52.3	4.3	f	ne	3.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	03:43	04:29	58.03	n	3.42	w	52.3	58.01	n	3.51	w	52.0	4.4	r	ne	3.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	04:29	05:02	58.01	n	3.51	w	52.0	57.98	n	3.46	w	49.6	4.5	s	ne	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen	05:02	05:55	57.98	n	3.46	w	49.6	57.93	n	3.39	w	49.6	4.2	f	ne	3.0	s	o	m	n
05/09/2011	p	K. Preston	05:02	05:55	57.98	n	3.46	w	49.6	57.93	n	3.39	w	49.6	4.2	f	ne	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	05:55	06:46	57.93	n	3.39	w	57.1	57.91	n	3.30	w	42.0	4.2	r	ne	3.0	s	o	m	n
05/09/2011	p	K. Preston	05:55	06:46	57.93	n	3.39	w	57.1	57.91	n	3.30	w	42.0	4.2	r	ne	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	06:46	07:20	57.91	n	3.30	w	42.0	57.95	n	3.34	w	53.4	4.2	s	ne	3.0	s	o	m	n
05/09/2011	p	K. Preston	06:46	07:20	57.91	n	3.30	w	42.0	57.95	n	3.34	w	53.4	4.2	s	ne	3.0	s	o	0.0	0.0

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05/09/2011	v	Z. Allen, N. Duthie	07:20	08:16	57.95	n	3.34	w	53.4	58	n	3.41	w	44.7	4.2	f	ne	2.0	s	o	m	n
05/09/2011	p	K. Preston	07:20	08:16	57.95	n	3.34	w	53.4	58	n	3.41	w	44.7	4.2	f	ne	2.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen	08:16	08:37	58.00	n	3.41	w	44.7	58.02	n	3.43	w	48.8	4.2	f	ne	3.0	s	o	g	n
05/09/2011	p	K. Preston	08:16	08:37	58.00	n	3.41	w	44.7	58.02	n	3.43	w	48.8	4.2	f	ne	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	08:37	09:05	58.02	n	3.43	w	48.8	58.02	n	3.48	w	49.8	4.2	r	ne	3.0	s	o	g	n
05/09/2011	p	K. Preston	08:37	09:05	58.02	n	3.43	w	48.8	58.02	n	3.48	w	49.8	4.2	r	ne	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	09:05	09:17	58.02	n	3.48	w	49.8	58.01	n	3.65	w	50.0	4.2	r	ne	2.0	s	o	g	w
05/09/2011	p	K. Preston	09:05	09:17	58.02	n	3.48	w	49.8	58.01	n	3.65	w	50.0	4.2	r	ne	2.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, K. Preston	09:17	09:51	58.01	n	3.65	w	50.0	57.98	n	3.46	w	48.0	4.2	s	ne	2.0	s	o	g	w
05/09/2011	p	N. Duthie	09:17	09:51	58.01	n	3.65	w	50.0	57.98	n	3.46	w	48.0	4.2	s	ne	2.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	09:51	10:22	57.98	n	3.46	w	48.0	57.95	n	3.42	w	49.0	4.2	f	ne	2.0	s	o	g	w
05/09/2011	p	K. Preston	09:51	11:08	57.98	n	3.46	w	48.0	57.91	n	3.36	w	56.0	4.2	f	ne	2.0	s	o	0.0	0.0
05/09/2011	v	N. Duthie	10:22	10:57	57.95	n	3.42	w	49.0	57.92	n	3.38	w	50.0	4.2	f	ne	2.0	s	o	g	w
05/09/2011	v	Z. Allen, N. Duthie	10:57	11:08	57.92	n	3.38	w	50.0	57.91	n	3.36	w	56.0	4.2	f	ne	2.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Russell	11:08	11:41	57.91	n	3.36	w	56.0	57.91	n	3.31	w	59.0	4.2	r	ne	2.0	s	o	g	w
05/09/2011	p	N. Duthie	11:08	11:41	57.91	n	3.36	w	56.0	57.91	n	3.31	w	59.0	4.2	r	ne	2.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Russell	11:41	12:15	57.91	n	3.31	w	59.0	57.94	n	3.83	w	54.0	4.3	s	ne	2.0	s	o	g	w
05/09/2011	p	N. Duthie	11:41	12:15	57.91	n	3.31	w	59.0	57.94	n	3.83	w	54.0	4.3	s	ne	2.0	s	o	0.0	0.0
05/09/2011	v	N. Russell	12:15	13:07	57.94	n	3.83	w	54.0	57.99	n	3.42	w	48.0	4.3	f	ne	2.0	s	o	g	w
05/09/2011	p	N. Duthie	12:15	13:07	57.94	n	3.83	w	54.0	57.99	n	3.42	w	48.0	4.3	f	ne	2.0	s	o	0.0	0.0
05/09/2011	v	N. Russell, N. Duthie	13:07	13:32	57.99	n	3.42	w	48.0	58.02	n	3.45	w	51.8	4.3	f	e	3.0	s	o	g	w
05/09/2011	p	Z. Allen	13:07	13:32	57.99	n	3.42	w	48.0	58.02	n	3.45	w	51.8	4.3	f	e	3.0	s	o	0.0	0.0
05/09/2011	v	N. Russell, N. Duthie	13:32	14:02	58.02	n	3.45	w	51.8	58.02	n	3.50	w	51.2	4.1	r	e	3.0	s	o	g	w
05/09/2011	p	Z. Allen	13:32	14:02	58.02	n	3.45	w	51.8	58.02	n	3.50	w	51.2	4.1	r	e	3.0	s	o	0.0	0.0

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05/09/2011	v	N. Russell, N. Duthie	14:02	14:38	58.02	n	3.50	w	51.2	57.98	n	3.46	w	48.1	4.2	s	e	3.0	s	o	g	n
05/09/2011	p	Z. Allen	14:02	14:38	58.02	n	3.50	w	51.2	57.98	n	3.46	w	48.1	4.2	s	e	3.0	s	o	0.0	0.0
05/09/2011	v	N. Russell	14:38	15:22	57.98	n	3.46	w	48.1	57.94	n	3.40	w	53.0	4.1	f	e	3.0	s	o	g	n
05/09/2011	p	Z. Allen	14:38	15:22	57.98	n	3.46	w	48.1	57.94	n	3.40	w	53.0	4.1	f	e	3.0	s	o	0.0	0.0
05/09/2011	p	N. Russell	15:22	15:54	57.94	n	3.40	w	53.0	57.91	n	3.36	w	57.0	4.2	f	e	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen	15:42	15:54	57.92	n	3.38	w	54.0	57.91	n	3.36	w	57.0	4.2	f	e	3.0	s	o	g	n
05/09/2011	v	Z. Allen, N. Duthie	15:54	16:25	57.91	n	3.36	w	57.0	57.91	n	3.31	w	57.5	4.2	r	e	3.0	s	o	g	n
05/09/2011	p	N. Russell	15:54	16:25	57.91	n	3.36	w	57.0	57.91	n	3.31	w	57.5	4.2	r	e	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	16:25	16:39	57.91	n	3.31	w	57.5	57.92	n	3.32	w	56.0	4.4	s	e	3.0	s	o	g	n
05/09/2011	p	N. Russell	16:25	16:39	57.91	n	3.31	w	57.5	57.92	n	3.32	w	56.0	4.4	s	e	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	16:39	17:01	57.92	n	3.32	w	56.0	57.94	n	3.35	w	57.0	4.3	s	e	4.0	s	o	g	n
05/09/2011	p	N. Russell	16:39	17:01	57.92	n	3.32	w	56.0	57.94	n	3.35	w	57.0	4.3	s	e	4.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen	17:01	17:22	57.94	n	3.35	w	57.0	57.97	n	3.37	w	49.0	4.3	f	e	4.0	s	o	g	n
05/09/2011	p	N. Russell	17:01	17:28	57.94	n	3.35	w	57.0	57.97	n	3.38	w	46.9	4.3	f	e	4.0	s	o	0.0	0.0
05/09/2011	v	N. Duthie	17:22	17:44	57.97	n	3.37	w	49.0	57.99	n	3.40	w	43.7	4.2	f	w	4.0	s	o	g	v
05/09/2011	p	Z. Allen	17:28	17:44	57.97	n	3.38	w	46.9	57.99	n	3.40	w	43.7	4.0	f	w	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	17:44	18:39	57.99	n	3.40	w	43.7	57.95	n	3.37	w	48.0	4.2	r	w	3.0	s	o	g	v
05/09/2011	p	N. Russell	17:44	18:39	57.99	n	3.40	w	43.7	57.95	n	3.37	w	48.0	4.2	r	w	3.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	18:39	18:55	57.95	n	3.37	w	48.0	57.94	n	3.35	w	53.0	4.6	r	nw	2.0	s	o	g	n
05/09/2011	p	N. Russell	18:39	18:55	57.95	n	3.37	w	48.0	57.94	n	3.35	w	53.0	4.6	r	nw	2.0	s	o	0.0	0.0
05/09/2011	v	Z. Allen, N. Duthie	18:55	19:18	57.94	n	3.35	w	53.0	57.97	n	3.37	w	52.0	4.3	s	nw	2.0	s	o	g	n
05/09/2011	p	N. Russell	18:55	19:33	57.94	n	3.35	w	53.0	57.98	n	3.39	w	45.0	4.3	s	nw	2.0	s	o	0.0	0.0
05/09/2011	p	N. Russell	19:33	20:13	57.98	n	3.39	w	45.0	58.02	n	3.44	w	49.0	4.3	f	nw	2.0	s	o	0.0	0.0
05/09/2011	p	N. Russell	20:13	20:33	58.02	n	3.44	w	49.0	58.02	n	3.47	w	49.0	4.4	r	nw	2.0	s	o	0.0	0.0

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05/09/2011	p	N. Russell	20:33	21:06	58.02	n	3.47	w	49.0	57.99	n	3.41	w	47.0	4.3	s	nw	2.0	s	o	0.0	0.0
05/09/2011	p	N. Russell	21:06	22:07	57.99	n	3.41	w	47.0	57.93	n	3.35	w	50.0	4.3	f	nw	2.0	s	o	0.0	0.0
05/09/2011	p	N. Russell	22:07	22:24	57.93	n	3.35	w	50.0	57.92	n	3.33	w	54.0	4.2	f	se	3.0	s	o	0.0	0.0
05/09/2011	p	N. Russell	22:24	22:59	57.92	n	3.33	w	54.0	57.92	n	3.28	w	56.0	4.2	r	se	3.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	22:59	23:34	57.92	n	3.28	w	56.0	57.95	n	3.32	w	54.0	4.1	s	se	3.0	s	o	0.0	0.0
05/09/2011	p	K. Preston	23:34	23:59	57.95	n	3.32	w	54.0	57.98	n	3.35	w	51.0	4.4	f	se	3.0	s	o	0.0	0.0
06/09/2011	p	K. Preston	00:00	00:51	57.98	n	3.35	w	51.0	58.03	n	3.41	w	49.9	4.2	f	se	3.0	s	o	0.0	0.0
06/09/2011	p	K. Preston	00:51	01:24	58.03	n	3.41	w	49.9	58.03	n	3.47	w	45.0	4.2	r	se	3.0	s	o	0.0	0.0
06/09/2011	p	K. Preston	01:24	02:00	58.03	n	3.47	w	45.0	57.99	n	3.43	w	48.0	4.2	s	se	4.0	c	o	0.0	0.0
06/09/2011	p	K. Preston	02:00	03:18	57.99	n	3.43	w	48.0	57.92	n	3.33	w	45.0	4.2	f	se	5.0	c	o	0.0	0.0
06/09/2011	p	K. Preston	03:18	03:52	57.92	n	3.33	w	45.0	57.92	n	3.27	w	57.5	4.2	r	se	5.0	c	o	0.0	0.0
06/09/2011	p	K. Preston	03:52	04:24	57.92	n	3.27	w	57.5	57.96	n	3.32	w	56.0	4.2	s	se	5.0	c	o	0.0	0.0
06/09/2011	p	K. Preston	04:24	04:49	57.96	n	3.32	w	56.0	57.98	n	3.35	w	53.0	4.2	f	se	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen	05:06	05:36	58.00	n	3.37	w	48.0	58.02	n	3.40	w	46.0	4.2	f	se	4.0	c	o	m	n
06/09/2011	p	K. Preston	05:16	05:41	58.00	n	3.37	w	47.5	58.03	n	3.41	w	52.0	4.2	f	se	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, N. Duthie	05:36	05:41	58.02	n	3.40	w	46.0	58.03	n	3.41	w	52.0	4.2	f	se	4.0	c	o	m	n
06/09/2011	v	Z. Allen, K. Preston	05:41	06:12	58.03	n	3.41	w	52.0	58.03	n	3.46	w	54.0	4.0	r	se	4.0	c	o	m	n
06/09/2011	p	N.Duthie	05:41	06:12	58.03	n	3.41	w	52.0	58.03	n	3.46	w	54.0	4.0	r	se	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, K. Preston	06:12	06:45	58.03	n	3.46	w	54.0	57.99	n	3.42	w	45.0	4.1	s	se	5.0	c	o	g	w
06/09/2011	p	N.Duthie	06:12	06:45	58.03	n	3.46	w	54.0	57.99	n	3.42	w	45.0	4.1	s	se	5.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, K. Preston	06:45	07:00	57.99	n	3.42	w	45.0	57.98	n	3.40	w	48.4	4.2	f	se	5.0	c	o	g	v
06/09/2011	p	N.Duthie	06:45	07:00	57.99	n	3.42	w	45.0	57.98	n	3.40	w	48.4	4.2	f	se	5.0	c	o	0.0	0.0
06/09/2011	v	K. Preston	07:00	08:03	57.98	n	3.40	w	48.4	57.91	n	3.31	w	56.0	4.2	f	sw	5.0	c	o	g	w
06/09/2011	p	N.Duthie	07:00	08:03	57.98	n	3.40	w	48.4	57.91	n	3.31	w	56.0	4.2	f	sw	5.0	c	o	0.0	0.0

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06/09/2011	v	Z. Allen, K. Preston	08:03	08:40	57.91	n	3.31	w	56.0	57.93	n	3.26	w	55.0	4.3	r	sw	4.0	c	o	g	v
06/09/2011	p	N.Duthie	08:03	08:40	57.91	n	3.31	w	56.0	57.93	n	3.26	w	55.0	4.3	r	sw	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, K. Preston	08:40	09:14	57.93	n	3.26	w	55.0	57.96	n	3.29	w	54.0	4.3	s	sw	4.0	c	o	g	v
06/09/2011	p	N.Duthie	08:40	09:14	57.93	n	3.26	w	55.0	57.96	n	3.29	w	54.0	4.3	s	sw	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, K. Preston	09:14	09:30	57.96	n	3.29	w	54.0	57.98	n	3.32	w	50.2	4.2	f	sw	5.0	c	o	g	v
06/09/2011	p	N. Duthie	09:14	09:30	57.96	n	3.29	w	54.0	57.98	n	3.32	w	50.2	4.2	f	sw	5.0	c	o	0.0	0.0
06/09/2011	v	N. Duthie	09:30	09:43	57.98	n	3.32	w	50.2	57.99	n	3.33	w	50.2	4.2	f	sw	5.0	c	o	g	v
06/09/2011	p	Z. Allen	09:30	09:43	57.98	n	3.32	w	50.2	57.99	n	3.33	w	50.2	4.2	f	sw	5.0	c	o	0.0	0.0
06/09/2011	v	N. Duthie, K. Preston	09:43	10:32	57.99	n	3.33	w	50.2	58.04	n	3.39	w	51.1	4.2	f	sw	4.0	c	o	g	v
06/09/2011	p	Z. Allen	09:43	10:32	57.99	n	3.33	w	50.2	58.04	n	3.39	w	51.1	4.2	f	sw	4.0	c	o	0.0	0.0
06/09/2011	v	N. Duthie, K. Preston	10:32	10:54	58.04	n	3.39	w	51.1	58.04	n	3.42	w	49.0	4.2	r	sw	4.0	c	o	g	v
06/09/2011	p	Z. Allen	10:32	10:45	58.04	n	3.39	w	51.1	58.05	n	3.41	e	51.9	4.2	r	sw	4.0	c	o	0.0	0.0
06/09/2011	p	N. Russell	10:45	10:54	58.05	n	3.41	w	51.9	58.04	n	3.42	w	49.0	4.4	r	sw	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, N. Duthie	10:53	11:31	58.04	n	3.42	w	49.0	58	n	3.37	w	46.7	4.4	s	sw	5.0	c	o	g	v
06/09/2011	p	N. Russell	10:53	11:31	58.04	n	3.42	w	49.0	58	n	3.37	w	46.7	4.4	s	sw	5.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen	11:31	12:19	58.00	n	3.37	w	46.7	57.96	n	3.32	w	51.5	4.2	f	sw	4.0	c	o	g	v
06/09/2011	p	N. Russell	11:31	12:19	58.00	n	3.37	w	46.7	57.96	n	3.32	w	51.5	4.2	f	sw	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, N. Duthie	12:19	12:44	57.96	n	3.32	w	51.5	57.93	n	3.28	w	54.0	4.1	f	sw	5.0	c	o	g	v
06/09/2011	p	N. Russell	12:19	12:44	57.96	n	3.32	w	51.5	57.93	n	3.28	w	54.0	4.1	f	sw	5.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, N. Duthie	12:44	13:09	57.93	n	3.28	w	54.0	57.93	n	3.25	w	55.4	4.2	r	sw	4.0	c	o	g	v
06/09/2011	p	N. Russell	12:44	13:09	57.93	n	3.28	w	54.0	57.93	n	3.25	w	55.4	4.2	r	sw	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, N. Duthie	13:09	13:44	57.93	n	3.25	w	55.4	57.97	n	3.29	w	55.0	4.5	s	sw	4.0	c	o	g	s
06/09/2011	p	N. Russell	13:09	13:44	57.93	n	3.25	w	55.4	57.97	n	3.29	w	55.0	4.5	s	sw	4.0	c	o	0.0	0.0
06/09/2011	v	N. Duthie	13:44	14:24	57.97	n	3.29	w	55.0	58	n	3.34	w	50.2	4.3	f	sw	5.0	c	o	g	v

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06/09/2011	p	N. Russell	13:44	15:01	57.97	n	3.29	w	55.0	58.04	n	3.39	w	52.0	4.3	f	sw	5.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, N. Duthie	14:24	15:01	58.00	n	3.34	w	50.2	58.04	n	3.39	w	52.0	4.1	f	sw	5.0	c	o	m	n
06/09/2011	v	Z. Allen, N. Duthie	15:01	15:24	58.04	n	3.39	w	52.0	58.04	n	3.42	w	51.6	4.3	r	sw	4.0	c	o	g	n
06/09/2011	p	N. Russell	15:01	15:24	58.04	n	3.39	w	52.0	58.04	n	3.42	w	51.6	4.3	r	sw	4.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen, N. Duthie	15:24	15:57	58.04	n	3.42	w	51.6	58.02	n	3.38	w	43.6	4.3	s	w	5.0	c	o	g	s
06/09/2011	p	N. Russell	15:24	15:57	58.04	n	3.42	w	51.6	58.02	n	3.38	w	43.6	4.3	s	w	5.0	c	o	0.0	0.0
06/09/2011	v	Z. Allen	15:57	16:17	58.02	n	3.38	w	43.6	57.99	n	3.35	w	48.1	4.5	f	w	6.0	r	o	g	s
06/09/2011	p	N. Russell	15:57	16:17	58.02	n	3.38	w	43.6	57.99	n	3.35	w	48.1	4.5	f	w	6.0	r	o	0.0	0.0
06/09/2011	v	N. Duthie	16:17	16:39	57.99	n	3.35	w	48.1	57.97	n	3.32	w	52.2	4.2	f	w	5.0	c	o	g	v
06/09/2011	p	N. Russell	16:17	16:39	57.99	n	3.35	w	48.1	57.97	n	3.32	w	52.2	4.2	f	w	5.0	c	o	0.0	0.0
06/09/2011	v	N. Duthie	16:39	16:58	57.97	n	3.32	w	52.2	57.95	n	3.30	w	53.4	4.3	f	w	6.0	r	o	g	v
06/09/2011	p	Z. Allen	16:39	17:14	57.97	n	3.32	w	52.2	57.94	n	3.28	w	55.6	4.3	f	w	6.0	r	o	0.0	0.0
06/09/2011	v	N. Duthie, N. Russell	16:58	17:14	57.95	n	3.30	w	53.4	57.94	n	3.28	w	55.6	4.3	f	w	6.0	r	o	g	v
06/09/2011	v	N. Duthie, N. Russell	17:14	17:30	57.94	n	3.28	w	55.6	57.93	n	3.25	w	59.9	4.3	r	w	6.0	r	o	g	v
06/09/2011	p	Z. Allen	17:14	17:30	57.94	n	3.28	w	55.6	57.93	n	3.25	w	59.9	4.3	r	w	6.0	r	o	0.0	0.0
06/09/2011	v	N. Duthie, N. Russell	17:30	17:40	57.93	n	3.25	w	59.9	57.93	n	2.24	w	56.7	4.3	r	w	6.0	r	o	m	n
06/09/2011	p	Z. Allen	17:30	17:40	57.93	n	3.25	w	59.9	57.93	n	2.24	w	56.7	4.3	r	w	6.0	r	o	0.0	0.0
06/09/2011	v	N. Duthie, N. Russell	17:40	18:14	57.93	n	3.24	w	56.7	57.97	n	3.28	w	56.1	4.3	s	nw	6.0	r	o	m	n
06/09/2011	p	Z. Allen	17:40	18:14	57.93	n	3.24	w	56.7	57.97	n	3.28	w	56.1	4.3	s	w	6.0	r	o	0.0	0.0
06/09/2011	p	N. Russell	18:14	19:14	57.97	n	3.28	w	56.1	58.02	n	3.35	w	52.0	4.3	f	nw	6.0	c	o	0.0	0.0
06/09/2011	p	N. Russell	19:14	19:38	58.02	n	3.35	w	52.0	58.05	n	3.38	w	53.6	4.2	f	nw	6.0	c	o	0.0	0.0
06/09/2011	p	N. Russell	19:38	19:52	58.05	n	3.38	w	53.6	58.05	n	3.41	w	54.0	4.2	r	nw	6.0	c	o	0.0	0.0
06/09/2011	p	N. Russell	19:52	20:29	58.05	n	3.41	w	54.0	58.01	n	3.37	w	44.8	4.2	s	nw	6.0	c	o	0.0	0.0
06/09/2011	p	N. Russell	20:29	21:29	58.01	n	3.37	w	44.8	57.95	n	3.30	w	52.0	4.3	f	nw	7.0	c	o	0.0	0.0

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start postion (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
06/09/2011	p	N. Russell	21:29	21:45	57.95	n	3.30	w	52.0	57.94	n	3.28	w	55.0	4.7	f	nw	7.0	c	o	0.0	0.0
06/09/2011	p	N. Russell	21:45	22:30	57.94	n	3.28	w	55.0	57.94	n	3.23	w	54.0	4.2	r	nw	8.0	c	o	0.0	0.0
06/09/2011	p	N. Russell	22:20	22:52	57.94	n	3.23	w	54.0	57.87	n	3.24	w	52.0	4.0	s	nw	8.0	c	o	0.0	0.0
06/09/2011	p	K. Preston	23:23	00:08	58.00	n	3.31	w	51.0	58.04	n	3.37	w	56.0	4.5	f	nw	8.0	c	o	0.0	0.0
07/09/2011	p	K. Preston	00:08	00:36	58.04	n	3.37	w	56.0	58.04	n	3.41	w	51.0	4.1	r	nw	8.0	c	o	0.0	0.0
07/09/2011	p	K. Preston	00:36	01:06	58.04	n	3.41	w	51.0	58.01	n	3.37	w	44.0	4.3	s	nw	8.0	c	o	0.0	0.0
07/09/2011	p	K. Preston	01:06	02:21	58.01	n	3.37	w	44.0	57.94	n	3.27	w	54.0	4.4	f	nw	8.0	c	o	0.0	0.0
07/09/2011	p	K. Preston	02:21	02:51	57.94	n	3.27	w	54.0	57.94	n	3.22	w	54.0	4.2	r	nw	7.0	c	o	0.0	0.0
07/09/2011	p	K. Preston	02:51	03:25	57.94	n	3.22	w	54.0	57.97	n	3.26	w	53.0	4.2	s	nw	7.0	c	o	0.0	0.0
07/09/2011	p	K. Preston	03:45	04:42	57.99	n	3.29	w	55.0	58.05	n	3.36	w	52.6	4.2	f	nw	7.0	c	o	0.0	0.0
07/09/2011	p	K. Preston	04:42	05:09	58.05	n	3.36	w	52.6	58.05	n	3.40	w	56.2	4.2	r	nw	6.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen, N. Duthie	05:09	05:41	58.05	n	3.40	w	56.2	58.02	n	3.36	w	49.8	4.2	s	nw	6.0	c	o	m	n
07/09/2011	p	K. Preston	05:09	05:41	58.05	n	3.40	w	56.2	58.02	n	3.36	w	49.8	4.2	s	nw	6.0	c	o	0.0	0.0
07/09/2011	v	N. Duthie	05:41	06:15	58.02	n	3.36	w	49.8	57.98	n	3.32	w	51.4	4.2	f	nw	6.0	c	o	m	n
07/09/2011	p	K. Preston	05:41	06:57	58.02	n	3.36	w	49.8	57.94	n	3.26	w	55.3	4.2	f	nw	6.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen	06:15	06:43	57.98	n	3.32	w	51.4	57.96	n	3.28	w	54.8	4.2	f	nw	5.0	c	o	g	n
07/09/2011	v	N. Duthie, Z. Allen	06:43	06:57	57.96	n	3.28	w	54.8	57.94	n	3.26	w	55.3	4.0	f	w	5.0	c	o	g	n
07/09/2011	v	N. Duthie, Z. Allen	06:57	07:20	57.94	n	3.26	w	55.3	57.94	n	3.23	w	57.0	4.3	r	w	5.0	c	o	g	n
07/09/2011	p	K. Preston	06:57	07:20	57.94	n	3.26	w	55.3	57.94	n	3.23	w	57.0	4.3	r	w	5.0	c	o	0.0	0.0
07/09/2011	v	N. Duthie, Z. Allen	07:20	07:53	57.94	n	3.23	w	57.0	57.97	n	3.28	w	55.8	4.1	s	w	5.0	c	o	g	n
07/09/2011	p	K. Preston	07:20	07:53	57.94	n	3.23	w	57.0	57.97	n	3.28	w	55.8	4.1	s	w	5.0	c	o	0.0	0.0
07/09/2011	v	N. Duthie	07:53	08:32	57.97	n	3.28	w	55.8	58.01	n	3.32	w	54.5	4.3	f	w	5.0	c	o	g	n
07/09/2011	p	K. Preston	07:53	09:06	57.97	n	3.28	w	55.8	58.05	n	3.37	w	53.3	4.3	f	w	5.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen	08:32	09:06	58.01	n	3.32	w	54.5	58.05	n	3.37	w	53.3	4.3	f	w	4.0	c	o	g	n

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07/09/2011	v	N. Duthie, Z. Allen	09:06	09:30	58.05	n	3.37	w	53.3	58.05	n	3.40	w	52.8	4.5	r	w	4.0	c	o	g	n
07/09/2011	p	K. Preston	09:06	09:30	58.05	n	3.37	w	53.3	58.05	n	3.40	w	52.8	4.5	r	w	4.0	c	o	0.0	0.0
07/09/2011	v	N. Duthie, Z. Allen	09:30	10:02	58.05	n	3.40	w	52.8	58.02	n	3.36	w	48.0	4.2	s	w	4.0	c	o	g	n
07/09/2011	p	K. Preston	09:30	10:02	58.05	n	3.40	w	52.8	58.02	n	3.36	w	48.0	4.2	s	w	4.0	c	o	0.0	0.0
07/09/2011	v	N. Duthie, Z. Allen	10:02	11:00	58.02	n	3.36	w	48.0	57.96	n	3.29	w	53.2	4.2	f	w	4.0	c	o	g	v
07/09/2011	p	K. Preston	10:02	11:00	58.02	n	3.36	w	48.0	57.96	n	3.29	w	53.2	4.2	f	w	4.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen	11:00	11:19	57.96	n	3.29	w	53.2	57.94	n	3.27	w	54.3	4.2	f	nw	5.0	c	o	m	v
07/09/2011	p	N. Russell	11:00	11:19	57.96	n	3.29	w	53.2	57.94	n	3.27	w	54.3	4.2	f	nw	5.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen, N. Duthie	11:19	11:50	57.94	n	3.27	w	54.3	57.94	n	3.22	w	54.8	4.3	r	w	5.0	c	o	g	v
07/09/2011	p	N. Russell	11:19	11:50	57.94	n	3.27	w	54.3	57.94	n	3.22	w	54.8	4.3	r	w	5.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen, N. Duthie	11:50	12:23	57.94	n	3.22	w	54.8	57.97	n	3.26	w	54.0	4.3	s	w	5.0	c	o	g	v
07/09/2011	p	N. Russell	11:50	12:23	57.94	n	3.22	w	54.8	57.97	n	3.26	w	54.0	4.3	s	w	5.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen	12:23	13:18	57.97	n	3.26	w	54.0	57.03	n	3.33	w	54.6	4.5	f	w	5.0	c	o	g	v
07/09/2011	p	N. Russell	12:23	13:18	57.97	n	3.26	w	54.0	57.03	n	3.33	w	54.6	4.5	f	w	5.0	c	o	0.0	0.0
07/09/2011	v	N. Duthie	13:18	13:40	57.03	n	3.33	w	54.6	58.05	n	3.36	w	52.1	4.0	f	w	6.0	c	o	g	v
07/09/2011	p	N. Russell	13:18	13:40	57.03	n	3.33	w	54.6	58.05	n	3.36	w	52.1	4.0	f	w	6.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen, N. Duthie	13:40	14:13	58.05	n	3.36	w	52.1	58.05	n	3.41	w	51.4	4.3	r	w	5.0	c	o	m	v
07/09/2011	p	N. Russell	13:40	14:13	58.05	n	3.36	w	52.1	58.05	n	3.41	w	51.4	4.3	r	w	5.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen, N. Duthie	14:13	14:49	58.05	n	3.41	w	51.4	58.01	n	3.37	w	44.0	4.4	s	w	5.0	c	o	g	v
07/09/2011	p	N. Russell	14:13	14:49	58.05	n	3.41	w	51.4	58.01	n	3.37	w	44.0	4.4	s	w	5.0	c	o	0.0	0.0
07/09/2011	v	N. Russell	14:49	15:28	58.01	n	3.37	w	44.0	57.97	n	3.31	w	49.0	4.3	f	w	4.0	c	o	g	v
07/09/2011	p	Z. Allen	14:49	15:28	58.01	n	3.37	w	44.0	57.97	n	3.31	w	49.0	4.3	f	w	4.0	c	o	0.0	0.0
07/09/2011	v	N. Russell	15:28	15:48	57.97	n	3.31	w	49.0	57.95	n	3.29	w	52.2	4.2	f	w	5.0	c	o	g	s
07/09/2011	p	N. Duthie	15:28	15:48	57.97	n	3.31	w	49.0	57.95	n	3.29	w	52.2	4.2	f	w	5.0	c	o	0.0	0.0

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start postion (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
07/09/2011	v	N. Russell, N. Duthie	15:48	16:04	57.95	n	3.29	w	52.2	57.94	n	3.27	w	54.5	4.2	f	w	4.0	c	o	g	v
07/09/2011	p	Z. Allen	15:48	16:04	57.95	n	3.29	w	52.2	57.94	n	3.27	w	54.5	4.2	f	w	4.0	c	o	0.0	0.0
07/09/2011	v	N. Russell, N. Duthie	16:04	16:44	57.94	n	3.27	w	54.5	57.94	n	3.22	w	54.3	4.0	r	w	4.0	c	o	g	v
07/09/2011	p	Z. Allen	16:04	16:44	57.94	n	3.27	w	54.5	57.94	n	3.22	w	54.3	4.0	r	w	4.0	c	o	0.0	0.0
07/09/2011	v	N. Russell, N. Duthie	16:44	17:16	57.94	n	3.22	w	54.3	57.98	n	3.26	w	54.9	4.0	s	w	5.0	c	o	g	s
07/09/2011	p	Z. Allen	16:44	17:16	57.94	n	3.22	w	54.3	57.98	n	3.26	w	54.9	4.0	s	w	5.0	c	o	0.0	0.0
07/09/2011	v	N. Russell	17:16	17:38	57.98	n	3.26	w	54.9	58	n	3.28	w	54.0	4.0	f	w	6.0	c	o	g	v
07/09/2011	p	N. Duthie	17:16	17:38	57.98	n	3.26	w	54.9	58	n	3.28	w	54.0	4.0	f	w	6.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen	17:38	17:53	58.00	n	3.28	w	54.0	58.01	n	3.30	w	56.0	4.2	f	w	6.0	c	o	g	v
07/09/2011	p	N. Duthie	17:38	17:53	58.00	n	3.28	w	54.0	58.01	n	3.30	w	56.0	4.2	f	w	6.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen	17:53	18:32	58.01	n	3.30	w	56.0	58.05	n	3.35	w	54.4	4.3	f	w	7.0	c	o	g	v
07/09/2011	p	N. Russell	17:53	18:32	58.01	n	3.30	w	56.0	58.05	n	3.35	w	54.4	4.3	f	w	7.0	c	o	0.0	0.0
07/09/2011	v	N. Duthie	18:32	19:10	58.05	n	3.35	w	54.4	58.03	n	3.36	w	56.0	4.3	r	w	6.0	c	o	g	n
07/09/2011	p	N. Russell	18:32	19:42	58.05	n	3.35	w	54.4	58	n	3.32	w	54.2	4.3	r	w	6.0	c	o	0.0	0.0
07/09/2011	v	Z. Allen	19:10	19:22	58.03	n	3.36	w	56.0	58.02	n	3.34	w	52.2	4.2	r	w	6.0	c	o	g	n
07/09/2011	p	N. Russell	19:42	19:59	58.00	n	3.32	w	54.2	58	n	3.30	w	54.0	4.2	r	w	6.0	c	o	0.0	0.0
07/09/2011	p	N. Russell	19:59	20:37	58.00	n	3.30	w	54.0	58.04	n	3.35	w	53.0	4.2	s	w	6.0	c	o	0.0	0.0
07/09/2011	p	N. Russell	20:37	20:44	58.04	n	3.35	w	53.6	58.05	n	3.36	w	53.7	4.2	f	w	5.0	c	o	0.0	0.0
07/09/2011	p	N. Russell	20:44	21:09	58.05	n	3.36	w	53.7	58.05	n	3.39	w	53.0	4.4	r	w	5.0	c	o	0.0	0.0
07/09/2011	p	N. Russell	21:09	21:44	58.05	n	3.39	w	53.0	58.02	n	3.35	w	51.0	3.8	s	w	5.0	c	o	0.0	0.0
07/09/2011	p	N. Russell	21:44	22:40	58.02	n	3.35	w	51.0	57.96	n	3.28	w	54.0	4.2	f	w	4.0	c	o	0.0	0.0
07/09/2011	p	N. Russell	22:40	23:02	57.96	n	3.28	w	54.0	57.94	n	3.25	w	54.0	4.2	f	w	5.0	c	o	0.0	0.0
07/09/2011	p	K. Preston	23:02	23:33	57.94	n	3.25	w	54.0	57.95	n	3.21	w	53.0	4.3	r	w	5.0	c	o	0.0	0.0

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07/09/2011	p	K. Preston	23:33	23:59	57.95	n	3.21	w	53.0	57.97	n	3.24	w	52.0	4.2	s	w	5.0	c	o	0.0	0.0
08/09/2011	p	K. Preston	00:00	00:07	57.97	n	3.24	w	52.0	57.98	n	3.25	w	53.0	4.2	s	w	5.0	c	o	0.0	0.0
08/09/2011	p	K. Preston	00:07	01:22	57.98	n	3.25	w	53.0	58.05	n	3.34	w	53.0	4.2	f	w	5.0	c	o	0.0	0.0
08/09/2011	p	K. Preston	01:22	01:50	58.05	n	3.34	w	53.0	58.05	n	3.38	w	51.0	4.2	r	w	5.0	c	o	0.0	0.0
08/09/2011	p	K. Preston	01:50	02:22	58.05	n	3.38	w	51.0	58.02	n	3.34	w	52.0	4.1	s	w	5.0	c	o	0.0	0.0
08/09/2011	p	K. Preston	02:22	03:39	58.02	n	3.34	w	52.0	57.95	n	3.25	w	51.0	4.3	f	w	5.0	c	o	0.0	0.0
08/09/2011	p	K. Preston	03:39	04:10	57.95	n	3.25	w	51.0	57.95	n	3.20	w	52.0	4.3	r	w	5.0	c	o	0.0	0.0
08/09/2011	p	K. Preston	04:10	04:42	57.95	n	3.20	w	52.0	57.98	n	3.24	w	53.0	4.1	s	w	5.0	c	o	0.0	0.0
08/09/2011	v	N. Duthie, Z. Allen	05:07	05:59	58.01	n	3.28	w	54.4	58.06	n	3.34	w	54.6	4.4	f	w	6.0	c	o	g	n
08/09/2011	p	K. Preston	05:07	05:59	58.01	n	3.28	w	54.4	58.06	n	3.34	w	54.6	4.4	f	w	6.0	c	o	0.0	0.0
08/09/2011	v	N. Duthie, Z. Allen	05:59	06:22	58.06	n	3.34	w	54.6	58.06	n	3.37	w	53.0	4.1	r	w	6.0	c	o	g	v
08/09/2011	p	K. Preston	05:59	06:22	58.06	n	3.34	w	54.6	58.06	n	3.37	w	53.0	4.1	r	w	6.0	c	o	0.0	0.0
08/09/2011	v	N. Duthie, Z. Allen	06:22	06:53	58.06	n	3.37	w	53.0	58.03	n	3.33	w	55.2	4.5	s	w	6.0	c	o	g	v
08/09/2011	p	K. Preston	06:22	06:53	58.06	n	3.37	w	53.0	58.03	n	3.33	w	55.2	4.5	s	w	6.0	c	o	0.0	0.0
08/09/2011	v	N. Duthie	06:53	07:28	58.03	n	3.33	w	55.2	57.98	n	3.28	w	56.1	4.5	f	w	6.0	c	o	g	v
08/09/2011	p	K. Preston	06:53	07:28	58.03	n	3.33	w	55.2	57.98	n	3.28	w	56.1	4.5	f	w	6.0	c	o	0.0	0.0
08/09/2011	v	K. Preston	07:28	08:01	57.98	n	3.28	w	56.1	57.96	n	3.24	w	54.5	4.3	f	w	6.0	c	o	g	v
08/09/2011	p	Z. Allen	07:28	08:01	57.98	n	3.28	w	56.1	57.96	n	3.24	w	54.5	4.3	f	w	6.0	c	o	0.0	0.0
08/09/2011	v	K. Preston, N.Duthie	08:01	08:11	57.96	n	3.24	w	54.5	57.95	n	3.23	w	53.9	4.2	f	sw	5.0	c	o	g	v
08/09/2011	p	Z. Allen	08:01	08:11	57.96	n	3.24	w	54.5	57.95	n	3.23	w	53.9	4.2	f	sw	5.0	c	o	0.0	0.0
08/09/2011	v	K. Preston, N.Duthie	08:11	08:30	57.95	n	3.23	w	53.9	57.95	n	3.20	w	54.0	4.1	r	sw	6.0	c	o	g	v
08/09/2011	p	Z. Allen	08:11	08:30	57.95	n	3.23	w	53.9	57.95	n	3.20	w	54.0	4.1	r	sw	6.0	c	o	0.0	0.0
08/09/2011	v	K. Preston, N.Duthie	08:30	09:04	57.95	n	3.20	w	54.0	57.98	n	3.25	w	54.9	4.2	s	w	5.0	c	o	g	v
08/09/2011	p	Z. Allen	08:30	09:04	57.95	n	3.20	w	54.0	57.98	n	3.25	w	54.9	4.2	s	w	5.0	c	o	0.0	0.0

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start position (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
08/09/2011	v	K. Preston	09:04	10:10	57.98	n	3.25	w	54.9	58.05	n	3.33	w	55.0	4.2	f	w	5.0	c	o	g	v
08/09/2011	p	N. Duthie	09:04	10:10	57.98	n	3.25	w	54.9	58.05	n	3.33	w	55.0	4.2	f	w	5.0	c	o	0.0	0.0
08/09/2011	v	Z. Allen, K. Preston	10:10	10:21	58.05	n	3.33	w	55.0	58.06	n	3.34	w	54.0	4.0	f	w	5.0	c	o	g	v
08/09/2011	p	N. Duthie	10:10	10:21	58.05	n	3.33	w	55.0	58.06	n	3.34	w	54.0	4.0	f	w	5.0	c	o	0.0	0.0
08/09/2011	v	Z. Allen, K. Preston	10:21	10:45	58.06	n	3.34	w	54.0	58.05	n	3.37	w	53.4	4.2	n	w	5.0	c	o	g	v
08/09/2011	p	N. Duthie	10:21	10:45	58.06	n	3.34	w	54.0	58.05	n	3.37	w	53.4	4.1	n	w	5.0	c	o	0.0	0.0
08/09/2011	v	Z. Allen, K. Preston	10:45	11:18	58.05	n	3.37	w	53.4	58.02	n	3.34	w	53.0	4.1	s	w	4.0	c	o	g	v
08/09/2011	p	N. Russell	10:45	11:18	58.05	n	3.37	w	53.4	58.02	n	3.34	w	53.0	4.1	s	w	4.0	c	o	0.0	0.0
08/09/2011	v	N. Duthie	11:18	12:17	58.02	n	3.34	w	53.0	58.02	n	3.31	w	55.0	4.1	n	w	4.0	c	o	g	v
08/09/2011	p	N. Russell	11:18	11:25	58.02	n	3.34	w	53.0	58.02	n	3.33	w	53.0	4.1	n	w	4.0	c	o	0.0	0.0
08/09/2011	p	N. Russell	11:30	12:35	58.01	n	3.33	w	52.3	58.04	n	3.33	w	54.5	4.0	n	w	4.0	c	o	0.0	0.0
08/09/2011	v	N. Duthie	12:17	12:35	58.02	n	3.31	w	55.0	58.04	n	3.33	w	54.5	4.1	n	w	4.0	c	o	g	v
08/09/2011	v	Z. Allen, N. Duthie	12:35	13:10	58.04	n	3.33	w	54.5	58.06	n	3.38	w	51.5	4.4	n	w	4.0	c	o	g	v
08/09/2011	p	N. Russell	12:35	13:10	58.04	n	3.33	w	54.5	58.06	n	3.38	w	51.5	4.4	n	w	4.0	c	o	0.0	0.0
08/09/2011	v	Z. Allen, N. Duthie	13:10	13:44	58.06	n	3.38	w	51.5	58.02	n	3.34	w	52.3	4.1	s	w	5.0	c	o	g	v
08/09/2011	p	N. Russell	13:10	13:44	58.06	n	3.38	w	51.5	58.02	n	3.34	w	52.3	4.1	s	w	5.0	c	o	0.0	0.0
08/09/2011	v	Z. Allen	13:44	15:01	58.02	n	3.34	w	52.3	57.98	n	3.24	w	52.9	4.1	f	w	4.0	c	o	g	v
08/09/2011	p	N. Russell	13:44	15:01	58.02	n	3.34	w	52.3	57.98	n	3.24	w	52.9	4.1	f	w	4.0	c	o	0.0	0.0
08/09/2011	v	N. Russell, N. Duthie	15:01	15:24	57.98	n	3.24	w	52.9	57.95	n	3.21	w	53.4	4.3	n	w	4.0	c	o	g	v
08/09/2011	p	Z. Allen	15:01	15:24	57.98	n	3.24	w	52.9	57.95	n	3.21	w	53.4	4.3	n	w	4.0	c	o	0.0	0.0
08/09/2011	v	N. Russell, N. Duthie	15:24	15:58	57.95	n	3.21	w	53.4	57.98	n	3.25	w	54.6	4.3	s	w	5.0	c	o	g	s
08/09/2011	p	Z. Allen	15:24	15:58	57.95	n	3.21	w	53.4	57.98	n	3.25	w	54.6	4.3	s	w	5.0	c	o	0.0	0.0
08/09/2011	v	N. Duthie	15:58	16:29	57.98	n	3.25	w	54.6	58.01	n	3.29	w	52.5	4.2	f	w	4.0	c	o	g	v
08/09/2011	p	Z. Allen	15:58	16:29	57.98	n	3.25	w	54.6	58.01	n	3.29	w	52.5	4.2	f	w	4.0	c	o	0.0	0.0

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start position (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
08/09/2011	v	N. Russell	16:29	16:42	58.01	n	3.29	w	52.5	58.02	n	3.31	w	53.2	4.2	f	w	5.0	c	o	g	v
08/09/2011	p	N. Duthie	16:29	16:42	58.01	n	3.29	w	52.5	58.02	n	3.31	w	53.2	4.2	f	w	5.0	c	o	0.0	0.0
08/09/2011	v	Z. Allen	16:42	17:15	58.02	n	3.31	w	53.2	58.05	n	3.35	w	54.0	4.0	f	w	5.0	c	o	g	v
08/09/2011	p	N. Russell	16:42	17:15	58.02	n	3.31	w	53.2	58.05	n	3.35	w	54.0	4.0	f	w	5.0	c	o	0.0	0.0
08/09/2011	p	N. Russell	17:15	17:57	58.05	n	3.35	w	54.0	58.02	n	3.33	w	53.5	4.5	n	w	5.0	c	o	0.0	0.0
08/09/2011	v	N. Russell, N. Duthie	18:24	19:06	58.02	n	3.27	w	54.7	58.05	n	3.23	w	54.2	4.5	n	w	4.0	c	o	g	n
08/09/2011	p	Z. Allen	18:24	19:06	58.02	n	3.27	w	54.7	58.05	n	3.23	w	54.2	4.5	n	w	4.0	c	o	0.0	0.0
08/09/2011	v	N. Russell, N. Duthie	19:06	19:15	58.05	n	3.23	w	54.2	58.05	n	3.25	w	56.0	4.2	s	w	6.0	c	o	g	n
08/09/2011	p	Z. Allen	19:06	19:15	58.05	n	3.23	w	54.2	58.05	n	3.25	w	56.0	4.2	s	w	6.0	c	o	0.0	0.0
08/09/2011	p	N. Russell	19:15	19:40	58.05	n	3.25	w	56.0	58.03	n	3.30	w	57.1	4.2	s	w	5.0	c	o	0.0	0.0
08/09/2011	p	N. Russell	19:40	20:52	58.03	n	3.30	w	57.1	57.98	n	3.42	w	44.6	4.3	f	w	5.0	c	o	0.0	0.0
08/09/2011	p	N. Russell	20:52	21:55	57.98	n	3.42	w	44.6	57.94	n	3.53	w	57.1	4.2	f	w	4.0	c	o	0.0	0.0
08/09/2011	p	N. Russell	21:55	22:33	57.94	n	3.53	w	57.1	57.91	n	3.53	w	57.8	4.1	n	w	3.0	c	o	0.0	0.0
08/09/2011	p	N. Russell	22:33	23:01	57.91	n	3.53	w	57.8	57.93	n	3.46	w	43.0	4.7	s	s	2.0	s	o	0.0	0.0
08/09/2011	p	K. Preston	23:01	23:59	57.93	n	3.46	w	43.0	57.97	n	3.35	w	53.8	4.3	f	s	2.0	s	o	0.0	0.0
09/09/2011	p	K. Preston	00:00	01:21	57.97	n	3.35	w	53.8	58.02	n	3.22	w	49.7	4.3	f	s	2.0	s	o	0.0	0.0
09/09/2011	p	K. Preston	01:21	01:50	58.02	n	3.22	w	49.7	58.05	n	3.22	w	55.0	4.3	n	s	3.0	s	o	0.0	0.0
09/09/2011	p	K. Preston	01:50	02:25	58.05	n	3.22	w	55.0	58.03	n	3.27	w	54.0	4.3	s	s	3.0	s	o	0.0	0.0
09/09/2011	p	K. Preston	02:25	04:41	58.03	n	3.28	w	54.0	57.94	n	3.53	w	56.3	4.3	f	s	3.0	s	o	0.0	0.0
09/09/2011	p	K. Preston	04:41	05:17	57.94	n	3.53	w	56.3	57.9	n	3.52	w	56.2	4.3	n	s	3.0	s	o	0.0	0.0
09/09/2011	v	Z. Allen, N. Duthie	05:10	05:17	57.91	n	3.53	w	56.0	57.9	n	3.52	w	56.2	4.3	n	s	3.0	s	o	m	n
09/09/2011	v	Z. Allen, N. Duthie	05:17	05:50	57.90	n	3.52	w	56.2	57.92	n	3.46	w	54.2	4.3	s	s	3.0	s	o	m	n
09/09/2011	p	K. Preston	05:17	05:50	57.90	n	3.52	w	56.2	57.92	n	3.46	w	54.2	4.3	s	s	3.0	s	o	0.0	0.0
09/09/2011	v	N. Duthie	05:50	06:50	57.92	n	3.46	w	54.2	57.96	n	3.36	w	49.7	4.3	f	s	3.0	s	o	m	n

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longitude (decimal degrees)	Start position - east/ west	Depth of water at start postion (m)	End Latitude (decimal degrees)	End position - north/ south	End longitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
09/09/2011	p	K. Preston	05:50	06:50	57.92	n	3.46	w	54.2	57.96	n	3.36	w	49.7	4.3	f	s	3.0	s	o	0.0	0.0
09/09/2011	v	Z. Allen	06:50	08:05	57.96	n	3.36	w	49.7	58.01	n	3.21	w	51.2	4.3	f	s	3.0	s	o	m	n
09/09/2011	p	K. Preston	06:50	08:05	57.96	n	3.36	w	49.7	58.01	n	3.21	w	51.2	4.3	f	s	3.0	s	o	0.0	0.0
09/09/2011	v	Z. Allen, K. Preston	08:05	08:45	58.01	n	3.21	w	51.2	58.03	n	3.24	w	54.0	4.0	r	s	3.0	s	o	m	n
09/09/2011	p	N. Duthie	08:05	08:45	58.01	n	3.21	w	51.2	58.03	n	3.24	w	54.0	4.0	r	s	3.0	s	o	0.0	0.0
09/09/2011	v	Z. Allen, K. Preston	08:45	09:09	58.03	n	3.24	w	54.0	58.02	n	3.28	w	56.0	4.0	s	s	3.0	s	o	m	n
09/09/2011	p	N. Duthie	08:45	09:09	58.03	n	3.24	w	54.0	58.02	n	3.28	w	56.0	4.0	s	s	3.0	s	o	0.0	0.0
09/09/2011	v	K. Preston	09:09	10:45	58.02	n	3.28	w	56.0	57.95	n	3.45	w	49.1	4.2	f	s	3.0	s	o	m	n
09/09/2011	p	N. Duthie	09:09	10:45	58.02	n	3.28	w	56.0	57.95	n	3.45	w	49.1	4.2	f	s	3.0	s	o	0.0	0.0
09/09/2011	v	N. Russell	10:45	11:26	57.95	n	3.45	w	49.1	57.92	n	3.52	w	59.0	4.3	f	s	3.0	s	o	m	n
09/09/2011	p	Z. Allen	10:45	11:26	57.95	n	3.45	w	49.1	57.92	n	3.52	w	59.0	4.3	f	s	3.0	s	o	0.0	0.0
09/09/2011	v	N. Russell, Z. Allen	11:26	12:09	57.92	n	3.52	w	59.0	57.9	n	3.51	w	57.0	4.3	r	se	2.0	s	o	m	n
09/09/2011	p	N. Duthie	11:26	12:09	57.92	n	3.52	w	59.0	57.9	n	3.51	w	57.0	4.3	r	se	2.0	s	o	0.0	0.0
09/09/2011	v	N. Russell, Z. Allen	12:09	12:40	57.90	n	3.51	w	57.0	57.92	n	3.45	w	55.8	4.4	s	e	3.0	s	o	m	n
09/09/2011	p	N. Duthie	12:09	12:40	57.90	n	3.51	w	57.0	57.92	n	3.45	w	55.8	4.4	s	e	3.0	s	o	0.0	0.0
09/09/2011	v	Z. Allen	12:40	14:05	57.92	n	3.45	w	55.8	57.97	n	3.30	w	54.0	4.2	f	e	3.0	s	o	m	n
09/09/2011	p	N. Russell	12:40	14:05	57.92	n	3.45	w	55.8	57.97	n	3.30	w	54.0	4.2	f	e	3.0	s	o	0.0	0.0
09/09/2011	v	N. Duthie	14:05	14:46	57.97	n	3.30	w	54.0	58	n	3.22	w	51.2	4.3	f	e	3.0	s	o	m	n
09/09/2011	p	N. Russell	14:05	14:46	57.97	n	3.30	w	54.0	58	n	3.22	w	51.2	4.3	f	e	3.0	s	o	0.0	0.0
09/09/2011	v	Z. Allen, N. Duthie	14:46	14:59	58.00	n	3.22	w	51.2	58.01	n	3.20	w	49.7	4.2	f	e	4.0	c	o	m	n
09/09/2011	p	N. Russell	14:46	14:59	58.00	n	3.22	w	51.2	58.01	n	3.20	w	49.7	4.2	f	e	4.0	c	o	0.0	0.0
09/09/2011	v	Z. Allen, N. Duthie	14:59	15:35	58.01	n	3.20	w	49.7	58.03	n	3.21	w	49.2	4.1	r	e	4.0	c	o	m	n
09/09/2011	p	N. Russell	14:59	15:35	58.01	n	3.20	w	49.7	58.03	n	3.21	w	49.2	4.1	r	e	4.0	c	o	0.0	0.0

Date	Visual watch or PAM?	Observer's / operator's name(s)	Time of start of watch (UTC)	Time of end of watch (UTC)	Start Latitude (decimal degrees)	Start position - north/ south	Start Longtitude (decimal degrees)	Start position - east/ west	Depth of water at start postion (m)	End Latitude (decimal degrees)	End position - north/ south	End longtitude (decimal degrees)	End position - east/ west	Depth of water at end position (m)	Speed of vessel (knots)	Source activity	Wind direction	Wind force (Beaufort)	Sea state	Swell	Visibility (visual watch only)	Sunglare (visual watch only)
09/09/2011	v	Z. Allen, N. Duthie	15:35	16:09	58.03	n	3.21	w	49.2	58.01	n	3.27	w	53.5	4.4	s	e	4.0	c	o	p	n
09/09/2011	p	N. Russell	15:35	16:09	58.03	n	3.21	w	49.2	58.01	n	3.27	w	53.5	4.4	s	e	4.0	c	o	0.0	0.0
09/09/2011	v	Z. Allen	16:09	16:28	58.01	n	3.27	w	53.5	58	n	3.31	w	53.0	4.3	f	se	4.0	c	o	p	n
09/09/2011	p	N. Russell	16:09	16:46	58.01	n	3.27	w	53.5	57.99	n	3.34	w	50.6	4.3	f	se	4.0	c	o	0.0	0.0
09/09/2011	v	N. Duthie	16:28	17:19	58.00	n	3.31	w	53.0	57.96	n	3.40	w	47.6	4.2	f	se	4.0	c	o	m	n
09/09/2011	p	Z. Allen	16:46	17:19	57.99	n	3.34	w	50.6	57.96	n	3.40	w	47.6	4.2	f	se	4.0	c	o	0.0	0.0
09/09/2011	v	N. Duthie, N. Russell	17:19	18:22	57.96	n	3.40	w	47.6	57.92	n	3.51	w	49.0	4.2	f	se	4.0	c	o	m	n
09/09/2011	p	Z. Allen	17:19	18:22	57.96	n	3.40	w	47.6	57.92	n	3.51	w	49.0	4.2	f	se	4.0	c	o	0.0	0.0
09/09/2011	p	N. Russell	18:22	19:02	57.92	n	3.51	w	49.0	57.92	n	3.46	w	48.0	4.3	n	se	4.0	c	o	0.0	0.0

Sightings Forms

Sighting number	Date	Time at start of encounter (UTC)	Time at end of encounter (UTC)	Were animals detected visually and/ or acoustically?	How were the animals first detected?	Observer's/ operator's name	Position - decimal degrees latitude	Position - north/ south	Position - decimal degrees longitude	Position - east/ west	Water depth (metres)	Species or species group	Description (visual sighting only)	Bearing to animal	Range of animal (metres)	Total number	Number of adults (visual sightings only)	Number of calves (visual sightings only)	Behaviour (visual sightings only)	Direction of travel (relative to ship)	Direction of travel (compass points)	Airgun/ source activity when animals first detected	Airgun/ source activity when animals last detected	Closest distance of animals from airguns/ source (m)	Time of closest approach (UTC)	What action was taken?
1	31/08/2011	1	1	v	v	K. Preston	57.90	n	2.58	w	65	Harbour Porpoise	small triangular fin, rolling surface motion	70	400	2	2	0	milling	v	var	n	n	400	13:55	n
2	31/08/2011	1	1	v	i	Mustafa, N. Russell, Z. Allen, N.Duthie	57.89	n	2.39	w	50	Harbour Porpoise	small triangular fin, rolling surface motion	80	80	5	5	0	transiting	c	n	n	n	80	15:36	n
3	31/08/2011	1	1	v	i	N. Duthie	57.90	n	2.46	w	55	Grey Seal	roman nose, vertical nostrils	90	100	1	1	0	Surfacing	x	0	n	n	100	16:05	n
4	31/08/2011	1	1	v	i	N. Duthie	57.92	n	2.78	w	88.1	Northern Minke Whale	small baleen whale	200	270	1	1	0	slow swimming	v	var	n	n	270	18:33	n
5	31/08/2011	1	1	v	i	Z. Allen	57.92	n	2.96	w	100	Unidentified Dolphin sp.	Flash of silver	210	100	1	1	0	breaching	0	0	n	n	100	19:13	n
6	31/08/2011	1	1	v	i	D. Carrot	57.93	n	2.91	w	87	Northern Minke Whale	small whale	60	600	1	1	0	slow swimming	0	0	n	n	150	19:35	n
7	01/09/2011	0	0	v	i	D. Carrot	58.01	n	3.35	w	46.95	Northern Minke Whale	small baleen whale	50	100	1	1	0	slow swimming	o	ne	n	n	100	08:35	n
8	01/09/2011	0	0	v	i	D. Carrot	58.01	n	3.36	w	46.95	Grey Seal	Dog-like snout	85	120	1	1	0	Surfacing	0	0	n	n	120	10:08	n
9	01/09/2011	1	1	v	v	N. Duthie	58.06	n	3.35	w	51.8	Northern Minke Whale	small baleen whale	270	300	1	1	0	travelling	s	sw	n	n	300	17:51	n

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10	01/09/2011	0.8	0.8	v	v	D. Carrot, Z. Allen, N. Duthie	58.00	n	3.51	w	49	Northern Minke Whale	pointed rostum, falcate dorsal, small baleen whale.	90	200	1	1	0	travelling	o	ne	n	n	200	19:25	n
11	02/09/2011	0.7	0.7	v	v	N. Duthie	57.97	n	3.43	w	45.5	Harbour Porpoise	small triangular fin, rolling surface motion	20	600	1	1	0	Porpoising	a	0	f	f	600	17:37	n
12	05/09/2011	0.4	0.4	v	v	N. Duthie	57.94	n	3.41	w	49	Harbour Seal		210	200	1	1	0	Surfacing	o	nw	f	f	200	10:25	n
13	06/09/2011	0.4	0.4	v	v	K. Preston	58.05	n	3.41	w	51.9	Northern Minke Whale	small baleen whale, no blow, fin showing same time as back	90	300	1	1	0	transiting	x	sw	r	r	300	10:50	n
14	06/09/2011	0.5	0.5	v	v	N. Duthie	57.95	n	3.30	w	52.2	Unidentified Whale sp.	bushy blow	170	800	1	0	0	blow	a	nw	f	f	800	12:30	n