Fall of Warness
Wildlife Observations Methodology

- Commercial in Confidence -

Revision	Date	Description	Originated by	Checked by	Approved by
1	-	Fall of Warness Wildlife Observations Methodology	MF		
1	09/02/10	Internal Revision		JN	JN
2	12/02/2011	Changes initially specified verbally & checked retrospectively		CD	JN
3	12/02/2011	Watch rotas for 2011 & 2012 inserted	CB	DC	JN
4	14/02/2013	Watch rota for 2013 inserted	CB	DC	JN

Table of contents

1 SUMMARY

Land-based visual observations will be carried out by observers on a hilltop on the island of Eday, overlooking the Fall of Warness tidal site in Orkney. Watches will be carried out by an experienced observer during daylight hours, ranging between 04:00hrs and 20:00hrs during summertime. The study area will be scanned and the time and location of any marine mammal or seabird sightings will be recorded. Where possible, the geographic location of each marine mammal or seabird group will be recorded using a pre-defined grid. Although marine mammals and seabirds will be identified to species whenever possible, due to the difficulty in differentiating between marine mammal and bird species, especially at distance, additional categories of 'unidentified species' will be included in the species list. Additional information about species sighted will be collected. For marine mammals, group size will be estimated if animals are seen in groups and the location of the centre of the group will be recorded. Prior to this study, the frequency of use of the Fall of Warness by these animals was unknown.

Surveys will encompass all states of tide and times of day (during daylight hours) in a systematic manner to ensure there is appropriate sampling of all environmental states. Tide state will be defined in relation to time since the previous high tide recorded at Kirkwall. Data on several weather variables including precipitation, sea state, cloud cover, and wind speed and direction will also be recorded. Data will be recorded on paper sheets by the observer and then transferred into an Excel spreadsheet.

Data from the land-based study described here will provide information on distribution and 'relative' abundance of animals in and around the study area. To inform the analysis on the reliability of detecting animals from a land-based vantage point, the land-based observations may need to be augmented with boat-based surveys along transect lines placed perpendicular to the coast. This information would then enable variations due to detectability differences to be distinguished from genuine changes in abundance, yielding more robust impact analysis. Monitoring of a site with similar characteristics to the test site, yet undisturbed by the presence of tidal energy devices, may be valuable in relating any changes observed to the tidal devices.

2 STUDY AREA

Due to the size of the study area, which extends down and across the Fall of Warness, it is important that the vantage point selected is of sufficient height to give good visibility across the whole test area. A suitable vantage point, at approximately 50m above sea level, has been identified: this is a point on Ward Hill, on a hillside forming part of Greentoft Farm., located at 59°08.975'N, 002° 47.396'W.

In order to aid accurate recording of sightings, the study area has been subdivided into grid squares, by overlaying a matrix of squares approximately 500m^2 (see Figure 2). [In August 2005, an extra row (labelled -1) was added at the north end of the observation area to accommodate a shift towards the northern-most test berth.]

3 SURVEY EFFORT

This land-based study will record wildlife *sightings* (detailed in section 4) during daily *watches* (section 3.1) by making regular *scans* of the study area (section 3.2) in a consistent manner. The definitions of each of these processes are provided in Figure 1.

Figure 1. Definitions of a watch, scan, and sighting used in this Methodology.

3.1 Watch rota

The watch rota is designed to ensure relatively even temporal coverage across daylight hours and tidal states. The number of hours surveyed is based on 5 working days of 4 hours (20 per week). The adequacy of this sampling rate in providing sufficient power to detect any potential changes will be assessed periodically in the light of data analysis.

Note: the watch rota followed from project initiation until July 2010 was based on observer experience, aiming to sample across the range of daylight hours and tidal states. This has now been standardised as follows, with changes initiated on April 1st, 2011.

To calculate the number of four-hour watches that should be carried out each day in different months, the time between sunrise and sunset is divided by four and rounded to the nearest whole number. This results in 2 different watches for Jan, Feb, Mar, Oct, Nov, and Dec; 3 watches for Apr, and Sep; and 4 watches for May, Jun, Jul, and Aug. These encompass the periods between 0400 and 2000. Table 1 shows watch periods for 2013.. The watch periods are consistent with previous years.

Month	Sunrise	Sunset	Daylight	No. of watches	Watch 1	Watch 2	Watch 3	Watch 4
Jan	08:53	15:49	06:56	2	09:00-13:00	11:00-15:00		
Feb	07:49	17:04	09:15	2	09:00-13:00	12:00-16:00		
Mar	06:31	18:12	11:41	2	08:00-12:00	13:00-17:00		
Apr	05:01	19:25	14:24	3	06:00-10:00	10:00-14:00	14:00-18:00	
May	03:43	20:35	16:52	4	05:00-09:00	09:00-13:00	12:00-16:00	16:00-20:00
Jun	02:59	21:25	18:26	4	04:00-08:00	08:00-12:00	12:00-16:00	16:00-20:00
Jul	03:23	21:11	17:48	4	04:00-08:00	08:00-12:00	12:00-16:00	16:00-20:00
Aug	04:29	20:03	15:34	4	05:00-09:00	09:00-13:00	12:00-16:00	16:00-20:00
Sep	05:39	18:25	12:46	3	06:00-10:00	10:00-14:00	14:00-18:00	
Oct	06:47	17:08	10:21	2	08:00-12:00	13:00-17:00		
Nov	08:02	15:50	07:48	2	09:00-13:00	12:00-16:00		
Dec	08:59	15:14	06:15	2	09:00-13:00	11:00-15:00		

Table 1. Watch periods for 2013.

It is acknowledged that there may be insufficient daylight hours on some occasions for the expected number of watches to be completed. This may require a watch to be reduced to three hours on such odd occasions, in which case a clear note to this effect will be recorded.

Each of the watches has been transcribed into a rota (Tables 2) that is designed to provide relatively uniform coverage across diurnal and tidal cycles. Although it is understood that some watches will not be able to be carried out for reasons such as adverse weather conditions, it is hoped that the rota can be adhered to as far as possible. If a watch is not carried out on a particular day, there is the scope to transfer that rota number to a day on the following weekend.

2013	Month											
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2	1	1	2	3		1	4		2	1	
2	1			3	2		3	1	3	1		2
3	2			2	4	1	2		2	2		1
4	1	2	2	1		3	4		1	1	2	2
5		1	1	3		2	1	3	3		1	1
6		2	2		1	4		2	2		2	2
7	2	1	1		3	1		4		2	1	
8	1	2	2	2	2		3	1		1	2	
9	2			1	4		2	3	1	2		1
10	1			3	1	3	4		3	1		2
11	2	1	1	2		2	1		2	2	1	1
12		2	2	1		4	3	2	1		2	2
13		1	1		3	1		4	3		1	1
14	1	2	2		2	3		1		1	2	
15	2	1	1	3	4		2	3		2	1	
16	1			2	1		4	2	2	1		2
17	2			1	3	2	1		1	2		1
18	1	2	2	3		4	3		3	1	2	2
19		1	1	2		1	2	4	2		1	1
20		2	2		2	3		1	1		2	2
21	2	1	1		4	2		3		2	1	
22	1	2	2	1	1		4	2		1	2	
23	2			3	3		1	4	3	2		1
24	1			2	2	4	3		2	1		2
25	2	1	1	1		1	2		1	2	1	1
26		2	2	3		3	4	1	3		2	2
27		1	1		4	2		3	2		1	1
28	1	2	2		1	4		2		1	2	
29	2		1	2	3		1	4		2	1	
30	1			1	2		3	1	1	1		2
31	2				4		2			2		1

Table 2. Daily watch rota. The watch number refers to the watch times and months given in Table 1.

3.2 Survey Methodology – scanning the area

A telescope (Opticron GS 815) set at 20x magnification is used to scan the channel to detect any animals on the surface of the water. If necessary for identification purposes, magnification is increased up to 60x. The equipment will be housed inside a custom built lookout station at the agreed vantage point.

Observing the area by telescope should be carried out in a consistent manner across the pre-defined grid, in a methodical fashion, ensuring the whole study area is covered. For the area closer to land, it may prove more efficient to use binoculars/naked eye for observations. The details of any sightings made (see section 4) should be recorded before moving to the next adjacent cell.

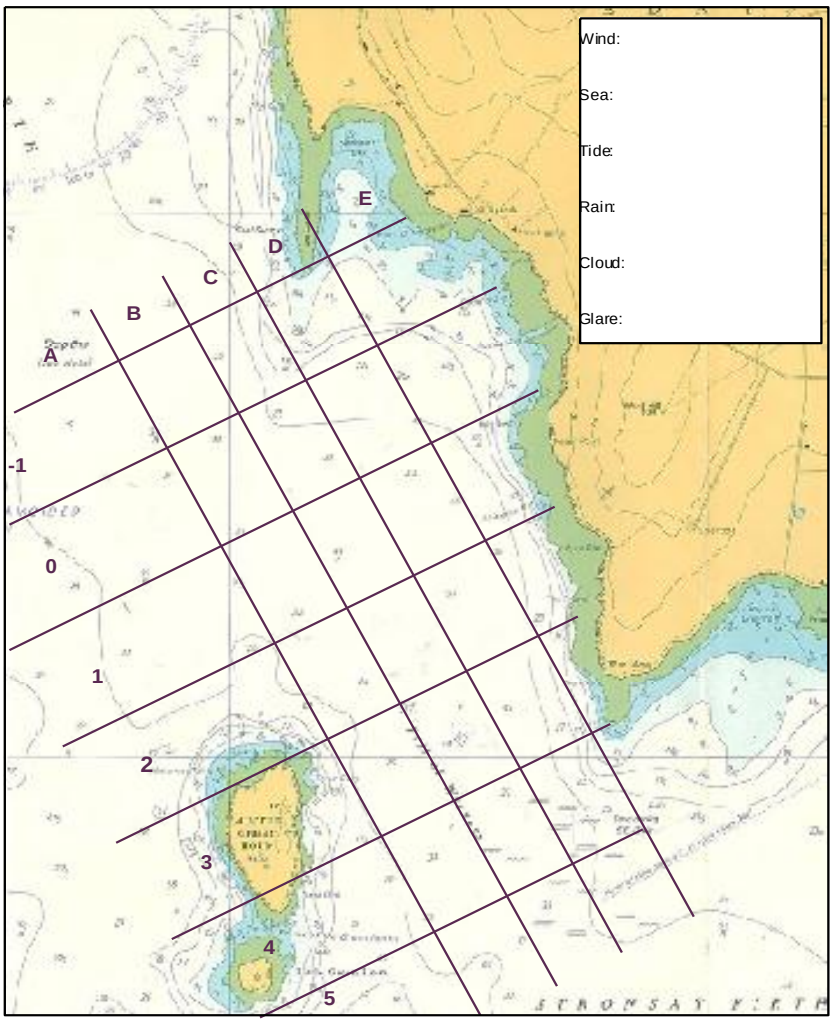

Figure 2: Map of the Fall of Warness tidal site, showing the study area extending from the shoreline to approximately 2km offshore and divided into grid squares of approximately 500m^2.

The time required to carry out a single scan of the entire survey area will be designed to maximise the probability of sighting wildlife whilst minimising observer fatigue. This is determined at the start of the fieldwork and maintained throughout the project. A period of 10 minutes should be taken between scans to reduce observer fatigue and to allow data entry to be updated[1]. To avoid potential subliminal observer bias associated with knowledge of operations within the survey area (which may lead to, e.g., over- or under-reporting of animal occurrence/behaviour), it is important that the observer is not made aware of site operations. Although it is clear that operations such as ship movements will be observed and interpreted by the observer, as far as possible, communication to the observer of operations such as device activity (active/not operating) should be avoided.

4 SIGHTINGS

A wildlife 'sighting' is defined as the observation of an individual or group of birds or marine mammals (or other relevant species e.g. basking shark) made during a visual scan of the study area. It is important that consistent methodical scanning (as described above) is maintained throughout: the observer should avoid interrupting a scan to focus directly onto a bird or marine mammal individual or group that has been sighted outside the scan limits (e.g., in peripheral vision, or tracking an animal sighted during a previous scan). If a unique sighting is

[1] This timing may be subject to change on reassessment of the project, if it is felt that it does not provide adequate rest time for the observer.

made outside the scan period then this must be recorded, with details entered in the 'Comments' section at the end of the environment data entry section.

To estimate the geographical location of the animal(s) sighted, the associated grid overlaid on the map is used. When sighting a group of animals, the centre of the group should be aligned with the centre of the field of view. Calibration of the locations defined by the project matrix grid references can be carried out using a boat-based differential GPS system: the boat should be manoeuvred around the study area and the recorded grid square locations compared to the GPS locations. It is anticipated that this should take around a half day and should be carried out near the start of the study.

A group is defined as all animals within approximately 100m of each other. Consequently, animals further apart than this distance will be defined as different groups or individuals. Distance estimation at sea is often challenging and it can be useful to train observers to estimate distance using marks of known range (e.g., marker buoys) or size (e.g., ships and boats). When a group of wildlife is sighted, key information about its location, group size, and behaviour should be recorded. Birds should only be recorded as sightings when on the water or hovering directly above the surface (within a few metres). Birds flying higher than this or birds that are clearly transiting through the study area should not be included as sightings.

An estimate of the number of individuals in each group should be made. For cetaceans, this can be challenging in the field (particularly from land-based observation platforms) because all of the animals within the group are unlikely to be observed at the surface at the same time. When observing a group of cetaceans, group size can be estimated through interpreting the synchrony of surfacings, spatial locations of surfacings relative to each other, and the identification of distinctive individuals (e.g., calves and adult male killer whales). However, a good rule of thumb that is often used to support estimated cetacean numbers is to count the total number of surfacings sighted within the mean dive duration of each species (Appendix 1).

If different observers are used, it is worth undertaking a calibration exercise to indicate any differences in estimates between the observers. This could be done for both group size estimates and location of specific sightings to grid squares, and would inform the analysis by reducing the unknown variability between different observers. Thus, two observers would make independent sighting allocations to grid squares, and group size estimates for the same groups. No communication about estimates should be made between the observers during this calibration. It is estimated that a total of at least 12 comparisons should be made for each animal group (cetaceans, seals, birds).

5 DATA RECORDING

Data is recorded to paper forms directly by the observer and then transcribed into a standard Excel template. The parameters within the template are described in the following sections.

5.1 Effort and Environment data entry

Factors such as sea conditions, light conditions, or precipitation will have an effect on both the probability of sighting animals and the range over which they can be observed. It is therefore important that a regular record of the meteorological and sea conditions is maintained throughout the watch. Furthermore, to accurately interpret the data collected (e.g., sighting rates), it is critical that a robust record of 'observer effort' be provided. If the observer effort changes during the watch (e.g., additional or different observers carry out survey or there is a pause in surveying due to adverse weather), this should also be recorded.

The EFFORT and ENVIRONMENT form should be completed immediately at the start of the watch and thereafter if these factors significantly change. Observations should only be carried out in sea states up to Beaufort 4 (inclusive), and should be terminated in the event of significantly reduced sighting conditions (e.g., thick fog or torrential rain). The data should include:

DATE Date of the watch

TIME	Time (GMT) of the environment recording
TIDE STATE	The state of the tide; FLOOD, EBB, or SLACK (within one hour either side of high or low water)
WEATHER	The current weather conditions. Data is limited to FAIR, RAIN, FOG, or SNOW
VISIBILITY	The estimated visibility range (km).
CLOUD COVER	The estimated cloud cover in octaves where 0 represents a clear sky and 8 is overcast
WIND STRENGTH	The current wind strength as described by the Beaufort scale.
WIND DIRECTION	The current wind direction (the direction it comes from) as an approximate compass bearing (N, NE, E, SE, S, SW, W, NW). If there is no wind, enter NA.
SEA STATE	The current sea state as described by the Beaufort scale.
SWELL HEIGHT	The estimated height of the sea swell in metres.
GLARE EXTENT	The extent of sun glare if any is present of the surface. Limited to NONE, SLIGHT, MODERATE, and SEVERE.
COMMENTS	Any additional details about the weather conditions throughout the watch period.

5.2 Marine mammal data entry

The following information should be recorded for every marine mammal sighting made during the scans:

DATE	Date of the watch.
TIME	Time (GMT) of the sighting.
SIGHTING EQUIPMENT	The equipment used to sight the marine mammal(s).
GRID SQUARE	The grid square in which the sighting was made.
SPECIES	The species sighted. As it is often difficult to distinguish birds to species levels, the option is given to enter 'Unidentified '. Further details can be provided in the COMMENTS section.
NUMBER	Estimated number of animals in the group.

Details of the following animal behaviours should also be recorded. Any combination of these can be included.

Behaviour - All

FEEDING	Any sighting where a fish is observed being chased or manipulated at the surface

Behaviour - Cetaceans

AERIAL BEHAVIOUR (excluding REGULAR	Any overt behaviour where all or part of the body clears the water

SURFACINGS)

REGULAR SURFACING	The dorsal portion of the body, excluding the tail flukes, clears the water in a forward roll motion.
BOW RIDING	Any behaviour where the animal(s) are in close proximity to a vessel (<10m)

Behaviour - Seals

STATIONARY	The seal is stationary at the surface with its head above the water surface.
SWIMMING	The seal is making progress at the surface with its head above the water surface.
BOTTLING	The seal is stationary at the surface with its head above the water surface for an extended period. The orientation of the head is perpendicular to the water surface so that the nose is pointing directly upwards.
COMMENTS	Any other relevant information about the sighting should be included here. This may include details such as a record of the age classes of the animals (i.e., if there are any relatively small animals in the group).

5.3 Birds data entry

The following information should be recorded for every seabird sighting made during the scans. Records should be limited to birds that are on the water or that or hovering directly above it (within a few metres), ensuring that the grid square to the location on the water below hovering birds is recorded.

DATE	Date of the watch.
TIME	Time (GMT) of the sighting.
SIGHTING EQUIPMENT	The equipment used to sight the bird(s).
GRID SQUARE	The grid square to which the sighting was allocated.
NUMBER OF SPECIES	As birds often form mixed groups, provide the number of species within each group.
SPECIES	The species sighted. As it is often difficult to distinguish birds to species levels, the option is given to enter 'Unidentified '. Further details can be provided in the COMMENTS section.
NUMBER	Estimated total number of birds (regardless of species) in the group.

Details of the following bird **behaviours** should also be recorded. Any combination of them can be included.

DIVING FROM FLIGHT	One or more birds diving underwater from a hovering or flying position.
DIVING FROM WATER	One or more birds diving underwater from a position on the water surface.
SWIMMING AT SURFACE	The birds are making progress at the surface.

STATIONARY AT SURFACE	The birds are stationary at the surface.
COMMENTS	Any other relevant information about the sighting should be included here. This may include details such as a record of the age or sex classes of the birds (i.e., if there are any relatively small animals in the group or if there are predominantly males or females).

5.4 Shipping data entry

The following information should be recorded for every vessel sighted during the scans.

DATE	Date of the watch.
TIME	Time (GMT) of the vessel sighting.
SIGHTING EQUIPMENT	The equipment used to sight the vessel(s).
GRID SQUARE	The grid square in which the sighting was made.
VESSEL NAME	The name or registration number of the vessel, if visible.
VESSEL TYPE	The type of vessel. Data is limited to FERRY, FISHING VESSEL, KAYAK, LARGE COMMERCIAL VESSEL, POWERBOAT (<10M), POWERBOAT (>10M), TIDAL ENERGY DEVICE, and YACHT. If a different type of vessel is sighted, record the closest match and provide further details in the COMMENTS section.
ROUTE	A standard diagram of vessel routes through the test site has been developed.
COMMENTS	Any other relevant information about the vessel should be included here. This may include details such as the activity of the vessel (e.g., fishing).

6 ESTIMATING THE RANGE DETECTION FUNCTION

An important caveat associated with studying the distribution of animals from a fixed location is that the probability of sighting an animal, or group of animals, decreases as an unknown function with distance from the observer. It is important therefore, to highlight that data from the land-based observations described in this Methodologies will only provide information on the distribution and 'relative' abundance of animals in and around the study area. This issue of detectability with range is also particularly important in a study such as this one where tidal devices may be moored several kilometres from shore; the power to detect changes will inherently be lower at greater ranges without knowledge of the detection probabilities.

To inform the analysis on detectability, it may be useful to augment the land-based observations with boat-based surveys along transect lines placed perpendicular to the coast. This would provide sound information about the detectability rates for a range of distances from the observation point. The information collected from the boat would allow the observer-based numbers recorded from the observation point to be calibrated and would inform the analysis about the detectability of the animals at various distances from the observation point. This information would then potentially enable detectability and any genuine changes in abundance to be distinguished.

Without prior knowledge about animal densities in the survey area, it is challenging to determine survey frequency. However, to obtain as much information as possible, it is suggested using transect lines as close together as practicality and/or cost allows and to survey these lines as often as practicable; monthly surveys along survey tracks are likely to provide a suitable initial design. Augmentation of the land-based survey design by boat would lead to an analysis which combines both detectability and abundance aspects of the impact assessment, leading to more defensible impact assessment results.

When undertaking calibration surveys, the transect lines should be covered at a constant speed. For each sighting made during the surveys, the same information that is recorded from land should be noted. In addition, the boat position at the time of the sighting (LAT LONG), and the range (metres) and grid square of the sighting should be recorded. A datasheet could potentially be provided if this augmented survey approach is pursued.

7 CONTROL SITE

Baseline monitoring of a different site with similar characteristics to the test site, yet relatively undisturbed, has been suggested, and may be valuable in determining if potential changes observed in the tidal test site are restricted to, or can be ascribed to the impact of devices.

It would indeed be very useful from an analytical perspective to have a reliable control site, whose characteristics were sufficiently similar to the test site as to make a Before-After-Control-Impact (BACI) analysis meaningful. However, the reality of finding another such site, experiencing the same range of variables, within a dynamic and changing environment, makes this difficult to recommend at a generic level. It is likely that large numbers of 'control' sites would need to be sampled in order to provide sufficiently robust data on which to make assessments of potential impacts that may be ascribed solely to the presence and operation on tidal energy devices.

Other possible sources of comparative data might include either extending the survey area beyond the extent of the immediate testing area, or utilising population statistics.

One way or the other, it is important to be wary of incorrectly assigning any decline of a species to the presence of tidal devices, since there are numerous other variables to which such a decline could potentially be ascribed, and the potential use of a 'control' site needs to be further discussed in the light of such lack of clarity.

APPENDIX 1: Cetacean species frequently sighted around Orkney

Harbour porpoise

The harbour porpoise is the smallest cetacean found off the coast of the UK. It has a small, rotund body, blunt head, no beak, and a small triangular dorsal fin. Adults are approximately 1.4-1.6m in length. Mean dive duration: 20 sec.

White beaked dolphin

The white beaked dolphin is a stout dolphin, about 2.5-2.7m in length; it has a short, often white beak, and black back and a pale grey to white area behind the dorsal fin that extends to a blaze on the flanks. This forms a diagnostic "saddle" on the back. Mean dive duration: 20 sec.

White sided dolphin

This bulky dolphin can be confused with the white beaked dolphin and often forms mixed groups with this species. It reaches around 3m in length and cab be distinguished from the white beaked dolphin by its all-black back and elongated yellow-ochre band on its flanks. Mean dive duration: 20 sec.

Risso's dolphin

The Risso's dolphin is a large, robust dolphin around 3.5m in length. They have a blunt, rounded head, and a slight melon with no beak. It is distinctively grey in colour, often with numerous white scars on the flanks. Mean dive duration: 20 sec.

Killer whale

Killer whales are large, reaching around 9m in length. Males have a very tall, triangular and erect dorsal fin. Immatures and adult females have a smaller sickle- shaped fin. They have a conical shaped black head with a distinctive white oval patch behind the eye, and a grey saddle behind the dorsal fin. Mean dive duration: 40 sec.

Pilot whale

Pilot whales reach approximately 6m in length and have a bulbous, square head. The fairly low, long- based dorsal fin is situated forward of the centre of the back. It is sickel shaped and becomes flag shaped in older animals. The body is black or dark grey in colour. Mean dive duration: 70 sec.

Minke whale

The minke whale is the smallest of the baleen whales in the UK. Growing to a length of 7-8.5m, it can be distinguished by a white diagonal band on the flipper, a small, pointed triangular head, and the lack of a conspicuous blow. Mean dive duration: 60 sec.

APPENDIX 2: Seabird species frequently sighted around Orkney

Auks

Razorbill

Guillemot

Black guillemot

Puffin

Little auk

Ducks, swans, and geese

Mute swan

Whooper swan

Common scoter

Eider

Goldeneye

Long tailed duck

Mallard

Pochard

Scaup

Shellduck

Red breasted merganser

Tufted duck

Wigeon

Greylag goose

Pink footed goose

White fronted goose

Terns

Arctic tern

Common tern

Sandwich tern

Cormorants and shags

Cormorant

Shag

Divers

Black throated diver

Red throated diver

Great northern diver

Skuas

Arctic skua

Pomarine skua

Great skua

Long tailed skua

Gulls

Black headed gull

Common gull

Herring gull

Great black backed gull Lesser black backed gull Kittiwake

Other

Gannet

Fulmar

Storm petrel

Manx shearwater

APPENDIX 3: Identifying seals at sea

Harbour seal

HEADS IN WATER: Harbour seals have a dished shaped forehead (they have relatively distinct foreheads. Their eyes are very much on the front of the face, close to the nose. In terms of overall head shape, an oval drawn around the head (when viewed face on) would need to be squashed from top to bottom.

MARKINGS: Harbour seals are usually fairly uniformly spotted.

BODY SIZE: Harbour seals are the smaller of the two species with adults measuring around 1.3-1.7 m long.

Grey seal

HEADS IN WATER: Grey seals have relatively flat noses and their eyes are located midway between the nose and the back of the head. Unlike harbour seals, grey seals have 'double chins'. In terms of overall head shape, an oval drawn around the head (when viewed face on) would need to be squashed from side to side.

MARKINGS: Female grey seals have contrasting pale bellies and darker grey backs, with large irregularly shaped spots and blotches. Male grey seals have darker, more uniform, coats than females.

BODY SIZE: Grey seals are the larger of the two species with adults measuring around 1.8-2.1 m long