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Minke whale (*Balaenoptera acutorostrata*) and white-beaked dolphin (*Lagenorhynchus albirostris*) feeding behaviour in Faxaflói, South-west Iceland

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Introduction

Icelandic waters support significant populations of different species of whales, i.e. the minke whale (*Balaenoptera acutorostrata*), the white-beaked dolphin (*Lagenorhynchus albirostris*), the harbour porpoise (*Phocoena phocoena*), the humpback whale (*Megaptera novengliae*), the Orca (*Orcinus orca*) and the blue whale (*Balaenoptera musculus*). Occasionally, also the sperm whale (*Physeter macrocephalus*) is observed in Icelandic waters.

Minke whales(*Balaenoptera acutorostrata*) have a large and cosmopolitan distribution, being found in all the worlds' oceans (Perrin *et al.*,2002). Minke whales are most commonly associated with coastal habitats or ice edge areas (Kasamatsu *et al.*,2002). The occurrence of minke whales is also variable throughout the year as the species make seasonal migrations between polar feeding grounds and lower latitude breeding and calving sites (Perrin *et al.*, 2002). In North Atlantic minke whales, animals are frequently observed feeding in Baffin Bay in the Canadian arctic, Svalbard in the Greenland Sea, the Gulf of St Lawrence, Iceland and Norway (Christensen *et al.*,1990; Vikingsson and Heide- Joergensen, 2004). Minke whales also migrate into the coastal waters of the British Isles.

White-beaked dolphins(*Lagenorhynchus albirostris*) are endemic to the northern North Atlantic, where they occur mainly on the continental shelf and in semi-enclosed waters, notably the Gulf of St. Lawrence and North Sea (Northridge *et al.*, 1997; Kinze *et al.*, 1997; Reeves *et al.*, 1999a). Eastern and western populations are phenotypically distinct (Mikkelsen and Lund, 1994). Estimates of abundance for a number of areas indicate that there are at least tens of thousands of these dolphins, with particularly large numbers in the Barents, Norwegian, and North seas (Hammond *et al.*, 2002). White-beaked dolphins are hunted for food in Newfoundland and Labrador, but no records are kept of numbers killed, and there has been little effort to assess the stock size. White-beaked dolphins have been studied (Rasmussen, 1999; 2006; Magnúsdóttir, 2007) in Icelandic waters but still the information is insufficient to understand their dynamics, habitat use and behaviour. Observations revealed that the dolphins are present in Icelandic coastal waters the whole year around , no evidence of large scale migration trend were noticed. Their seasonal movement seemed to be controlled by the abundance of food (Magnúsdóttir, 2007).

According to Rasmussen (1999) the dolphins seem to forage during the whole day but an increase in the frequency of other types of behaviours in the afternoon is common. Around noon the dolphins are usually travelling, presumably in relation to foraging, but socialize more actively in the afternoon and evening. The white-beaked dolphins are believed to feed mostly on sand eels (*Ammodytes tobianus*) in Faxaflói (Rasmussen, 1999) and they are according to fishermen generally sighted in great numbers at the southwest coast of Iceland during the spawning season of the capelin (*Mallotus villosus*) while it migrates to the spawning grounds. The results gave evidence of preferable feeding ground for white-beaked dolphins within Faxaflói, located approximately 10-12 nm west from Kollafjörður (Magnúsdóttir, 2007).

The third species occurring frequently in Icelandic waters is the Harbour porpoise (*Phocoena phocoena*). It is wildly distributed in coastal waters of the temperate and subarctic Northern Hemisphere. Abundance has declined in many areas as a result of excessive incidental

mortality in fishing operations. Depletion of prey populations, pollution, and other anthropogenic disturbances are believed to have contributed to population declines, but the evidence is less conclusive for these factors than it is for fishery bycatch.

In recent years many studies have attempted to show if correlations exist between the distributions of marine mammals and the surrounding environment. Those activities which have either utilised these species as a resource (Jaquet *et al.,* 1996),or more recently those who have studied the animals for management and conservation (Hooker and Gerber, 2004), have known that marine mammals are not evenly distributed throughout the world oceans, seas and rivers, and that they favor and concentrate in certain areas (Yen *et al.,* 2004). It has been shown that correlations exist between cetacean distributions and physiographic features, such as ocean depth and sea floor slope, as well as hydrographic characteristics which may affect animals directly (Baumgartner, 1997). However, it is believed that these environmental factors mostly effect cetacean distribution secondarily, through their effects on the distribution of cetacean prey (Davis *et al.,* 2002).

Interactions between cetaceans and tour vessels are increasing (Hoyt, 2001). Researchers have observed short-term changes in behaviour, including direct avoidance of the boat vicinity, increase in diving intervals, increase in speed and variations in vocalizations (Kruse, 1991; Corkeron, 1995; Janik andThompson, 1996; Bejer *et al*., 1999; Nowacek *et al*., 2001; Van Parijs and Corkeron, 2001). Assessment of the potential impact of boat traffic therefore requires a fully understanding, first, of the nature of any short-term changes in behaviour and, second, of the longer-term consequences of any reactions.

Objectives

The objective of the study area are to:

to investigate the distribution of minke whales and white-beaked dolphins in association with underlying environmental variables,
to analyse feeding behaviour of minke whales and data collected on associated seabird species,
to recognize individually the minke whales and the white-beaked dolphins photographed.

Methods

This study will rely on the use of two boats. Whale watching offers an excellent opportunity for scientific research. Whale watching vessels, in fact, may be used to collect useful data having the advantage of high rates of sightings (Robbins and Mattila, 2000) due to the tendency to survey same areas known being visited by cetaceans. Other advantages have been reported by Robbins (2000) and include the possibility to detect, in the short term, specific and unusual events such as intra and/or inter-specific interactions. Moreover whale watching data provide, in the long term, the opportunity to gain information about individuals and to assess the relative abundance of a population (Cecchetti, 2006).

Two boats (Elding and Hafsúlan both approx 30 m long) will be used as platforms from which minke whales and white-beaked dolphins will be observed (6 m above sea level).
Faxaflói Bay supports an important population of minke whales during the summer period and partially during the winter time, and also a population of white-beaked dolphins moving along the coast all year round.

Photo-identification techniques will be to identify individual whales and dolphins frequenting the study site, following the procedure as described by Parra and Corkeron (2001). The animals will be photographed using a digital camera (Nikon D80) with a 70-300 mm zoom lens

(f=4-5.6) at high shutter speeds. Photographs will be taken as perpendicular as possible to the animal's body axis, to capture it dorsal fin, recognize as the best distinctive feature for whales photo-identification. All the photographs taken during the study will be classified in term of their quality, considering focus, contrast between dorsal fin and background, and its size relative to the frame. Only photographs deemed good or excellent will be use to catalogue individuals for each species. Minke whales and white-beaked dolphins showed distinct features suitable for individual identification such as notch patterns on the fin, global fin shape, pigmentation and distinct scratches (Rasmussen, 2006; Mayr and Ritter, 2005; Dorsey *et al*., 1980).

The pattern in which whales come to the surface, respire, and dive again varies with behaviour and activity level. These patterns are useful in characterising and discerning different behaviours and may be observable whilst those underwater are not (Dorsey *et al*, 1989). The ventilation rates will be study between two distinct behavioural states: wide range behaviour, such as travelling, and narrow range behaviour such as feeding (Jahoda *et al*., 2003). From these samples, various ventilation characteristics were calculated and statistically assessed: mean surfacing interval; dive duration; time between blows in a surfacing; surface duration; and the number of blows per surfacing. All ventilation characteristics are significantly different across the range of behaviours (Curnier, 2005). Thus, breathing patterns therefore serve as good indicators of behaviour.

Relatively little as been published about on the foraging association of the minke whale with coastal seabirds. During the season 2007 (from May until September 2007) minke whales occurring along the coast of Reykjavik in the south west of Iceland have been recorded foraging in the presence of seabirds, such as black backed gulls(*Larus argentatus*), gannets (*Sula bassana*), fulmars (*Fulmarus glacialis*), puffins (*Puffinus puffinus*), artic terns(*Sterna artica*) and kittiwakes (*Rissa tridactyla*), which form dense feeding rafts at the water's surface.

The idea is to use the birds data to determine the number of encounter in which birds were present, the relative proportion of each birds species by month and the associated behaviour of the whales.

In addiction, we want to investigate the tendency of minke whales to specialize in particular feeding technique: feeding with birds or aggregating prey using lunging and bubble blowing (Tetley, 2004), verifying also if this choice is individual-specific.

The following environmental variables will be evaluated in relation to whale distribution and behaviour: bathymetry (depth, slope and aspect), sediment type, water temperature and primary productivity. Previous studies have found that minke whales are most frequently encountered in areas of (1) shallow depth, (2) steep slope, (3) northerly facing aspect and (4) sandy gravel sediment type (Cecchetti, 2006; Tetley, 2004). This information will be gathered from bathymetrical maps and from local researchers dealing with plankton.

A previously decided survey route is followed. The boat reaches the whale watching ground and the crew starts looking for whales using reticle binoculars (Fujinon 7x50) and naked eyes. Especially flocks of feeding birds are carefully observed because the probability is higher to spot feeding minke whales in between. The guide is situated on the top of the roof of the captain's cabin using his naked eyes to spot feeding seabirds and whales. The sighting ends when the captain decides to continue the tour or when the whale is no more visible. In case of more than one whale in the

survey area only the closest one has been monitored; the closest group of dolphins has been followed.
Throughout the observation periods four forms are completed to record:

1) environmental data (sea state, wind direction, wind force, outside temperature, visibility, swell height, cloud coverage and precipitation); the fish finder is checked on board when possible.

2) behavioural data, categorized into four main behavioural states: feeding foraging, socializing, travelling, milling; species, relative number of animal and associated wildlife is noted. This is achieved dividing the survey time in 15 min blocks, at the start of which any whale activity is recorded on the form (with the help of a digital recorder to record the behaviours displayed in real time by the animals).

3) boat traffic data: type of boats present during the sightings, distance from the animal or the pod, type of approach, behaviour when first sighted, behaviour end encounter, GPS positions.

4) breathing rates data: using a stop-watch mean surfacing interval, dive duration, time between blows in surfacing, surface duration and n° blows per surfacing are noted. The desired sampling period is 25 min.

During the all sighting photos of sighted individuals are taken. Occasionally sequences of photographs are taken of feeding behaviour, surfacing pattern and seabirds in the vicinity of the encountered whales.

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