THE SOUTHERN OUTER MORAY FIRTH IN NE SCOTLAND AS A POTENTIAL "SAFE AREA" CANDIDATE FOR THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA* L.)

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INTRODUCTION. Throughout its range, the distribution of the harbour porpoise (*Phocoena phocoena* L.) has contracted significantly in the last century, particularly in the North Sea. Reasons for this decline have been primarily attributed to detrimental anthropogenic activities, but the current lack of data on the species has been noted as the foremost reason for the apparent complacency with which the UK and EC governments have regarded it to date.

In areas where shore sightings are known to be prevalent, fine scale data on the distribution and abundance of the species will be fundamental to population estimates, and therefore particularly significant to management plans and conservation policies for the protection of these small cetaceans. In fact, the conservation of ecologically important sites for coastal species such as the harbour porpoise that exclusively use particular habitats makes the monitoring of small inshore populations a necessity.

Along the southern coastline of the outer Moray Firth in NE Scotland (57º40´N, 3º30´W), the harbour porpoise is found in significant numbers during the summer months (Robinson, 2003). The aim of the present study was to determine the general distribution and abundance of the animals using this northern coastal location during the summer months and to identify potential "hotspots" used by the species in these productive inshore waters.

METHODS. Data were collected between May and October 2003 using boat-based surveys along an 82 km stretch of the southern coastline of the outer Moray Firth. The surveys were conducted using a 5.4 m Avon Searider rigid inflatable boat fitted with a 90 hp Johnston Evinrude outboard engine at speeds of 8 to 12 km per hour whilst searching for animals. Trips were made on as many days as possible throughout the study period at sea states of Beaufort 3 or less and during optimal light conditions. If the sea state increased to Beaufort 4 or above or if heavy or continuous rain occurred during the course of a survey, the trip was either stopped temporarily or aborted. Throughout the study, a total survey area of 550 km^2 was systematically covered using 4 parallel transect routes divided further into 3 sub routes falling between the ports of Portknockie and Fraserburgh (fig. 1).

For each boat survey, a *Trip Log* was used to detail the trip information which included the route covered, survey start and finish times, GPS start and finish positions and the sea state / environmental conditions. When animals were sighted, the boat was slowed to minimise disturbance and details of the number of adults and calves sighted, their direction of travel and the behavioural activity of the individuals present recorded. Since multiple encounters could be made during a single survey trip, the recording procedure was repeated for each individual encounter made. Once the required data had been collected, the encounter was terminated and the end time and end GPS positions recorded accordingly. Back on the shore, the details from each encounter were subsequently entered into a spreadsheet from which the GPS coordinates could be plotted onto a scale map using the graph function.

Indices for abundance of animals were determined by sightings rates and expressed as animals per square kilometre. Plots could then accordingly be made by sightings and effort variables over required time scales.

RESULTS. Between the dates of 23 May and 30 September 2003 a total of 44 surveys were carried out on 42 days, producing a total survey effort of 122.87 survey hours and covering a distance of approximately 1,200 km. 77.78% of the surveys were carried out at sea state 2 or less, with a further 20% being undertaken in sea state 3. A total of 131 encounters were recorded on the 42 survey days, producing a cumulative count of 415 animals. Group sizes were found to range from 1 to 17 individuals with a mean of 2.64 ± 1.18 animals (Table 1). Single animals and pairs of animals were recorded most frequently, with single animals accounting for 29.85% of the total encounters recorded. However, the size of groups showed a significant increase (P=0.017) with progression throughout the season, the largest group of 17 animals being recorded in September 2003.

12.68% of all the groups encountered contained calves, accounting for 4.79% of the total cumulative number of animals recorded. During the months of May and June 2003, over 70% of animals were engaged in feeding or foraging activities (Fig. 2). However, this activity dropped to nearly half during the following 3 months, when the animals encountered were more often recorded travelling in typically larger group sizes

Two areas of high usage were identified for the species: Area A, in Aberdour Bay, to the east of the survey area; and Area B, adjacent to Whitehills, in the middle of the survey area (Fig. 3). A total of 71.85% of all encounters made were recorded within these two areas, 41.48% in Area A and 30.37% in Area B. Only 3 encounters were made at depths of 100-metres, the majority of animals being recorded close to the 20-metre depth line. Using ARCGIS 8, potential harbour porpoise "hotspots" were identified in 5 locations: 2 within Aberdour Bay in Area A, and 3 in Area B, adjacent to and to the west of Whitehills.

The relative abundance for animals throughout the entire study area was calculated as 0.75 animals per square kilometre.

DISCUSSION. To date, there have been few fine-scale studies of the harbour porpoise in UK coastal waters and no previously published work for the Moray Firth. The only survey to take this area of Scotland into account was the SCANS survey of 1984, which included a section of the outer Moray Firth along with other regions of northeast Scotland and adjacent areas of the North Sea, classified as Block D. Population estimates for this area are given as 37,144 animals by Hammond *et al.* (1995).

In the present study area, representing just 1.14% of the SCANS Block D area, a cumulative total of 415 animals were recorded from just 44 surveys carried out from May to September over a survey area of approximately 1,200 km. In comparison, Pierpoint (2001) logged 254 animals during survey work in southwest Wales over a distance of 1,287 km, whilst Leopold *et al.* (1992) recorded 251 animals over 270 km in southwest Ireland. In addition, Weir *et al.* (2001) compiled sightings from the west and north coast of Scotland over 19 years, between 1979 and 1998, and recorded only 1,318 animals from 650 sightings. These initial figures would suggest that the coastline of the outer southern Moray Firth might represent a significant coastal habitat for this species during the summer months.

This is further supported by the estimation of abundance made for the present study area. The calculated figure of 0.752 animals per square km compares well with other data from around the country. For example, Hammond *et al.* quote a figure for block D in SCANS of 0.363 animals per km, less then half of the estimate made in the present study. The estimates made by Pierpoint range from 0.14 to 0.72 animals per km in southwest Wales. The SCANS survey for the Celtic sea (Block A) provided estimations of 0.57 animals per km, although Leopold *et al.* (1992) found a density of 0.77 per km for a smaller, coastal area. Block F, the central North Sea, is the area that had the highest density in the SCANS survey of 0.776 animals per km. Interestingly, this figure is only slightly above that determined for the present study area.

Virtually all the encounters recorded in the study area occurred either on or near the bathymetric slopes where nutrient upwellings are most likely to occur (Harding-Hill, 1993). Harbour porpoise have been noted to use such upwellings previously (Pierpoint, 1993), where they can often be observed feeding alongside minke whales (*Balaenoptera acutorostrata* Lacépède) (pers. obs.). The porpoises were rarely recorded close to the shoreline and were never observed in the presence of bottlenose dolphins, which typically use the rocky areas and bays close in to the shore (Eisfeld, 2003).

Two main areas were identified as potential "hot-spots", defined as zones of critical habitat supporting aggregations of animals by Pierpoint (2001): one adjacent to Whitehills harbour, and the other within the confines of the more secluded Aberdour Bay. These two areas contained between them 71.85% of all sightings. Both hot-spot areas appear to be clustered along the 20-metre shelf line. Apart from this, the two areas appear to have little in common. Whilst Zone A lies adjacent to a busy marina, Zone B is a quiet bay with little boat traffic. However, since both areas are found adjacent to areas where upwellings may occur, the clumped distribution of animals at these two sites is likely to be related to the presence of prey; the water mixing in these areas resulting in high levels of primary production near the surface (Tynan, 1997). Further studies using newly available techniques such as remote sensing might be useful to correlate such biotic and oceanographic factors with the presence and/or absence of these animals in this location.

Whilst two potential sites of high usage were identified in the present investigation, further study would be desirable to establish whether or not these sites also provide important calving / nursery areas for porpoises. The results suggest that the coastline of the southern outer Moray Firth constitutes a potential "safe area" candidate for the species. To this end, the preliminary study provides a useful foundation supporting further investigation of this population, and additional studies may prove crucial to the designation of protected areas for harbour porpoise populations not only in this area of the North Sea, but in other coastal destinations throughout the UK as a whole.

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Table 1. Showing the mean and range of harbour porpoise group sizes by month from May to Sep 2003.

Survey month	Total no. of encounters	Mean group size encountered	Range		No. single animals encountered
			Min	Max	
May	14	1.79 ± 0.89	1	4	6
Jun	4	1.00 ± 0.00	1	1	4
Jul	45	3.29 ± 2.92	1	13	15
Aug	36	3.47 ± 1.89	1	9	6
Sep	32	3.66 ± 3.17	1	17	7
Total Period	131	2.64 ± 1.18	1	17	38

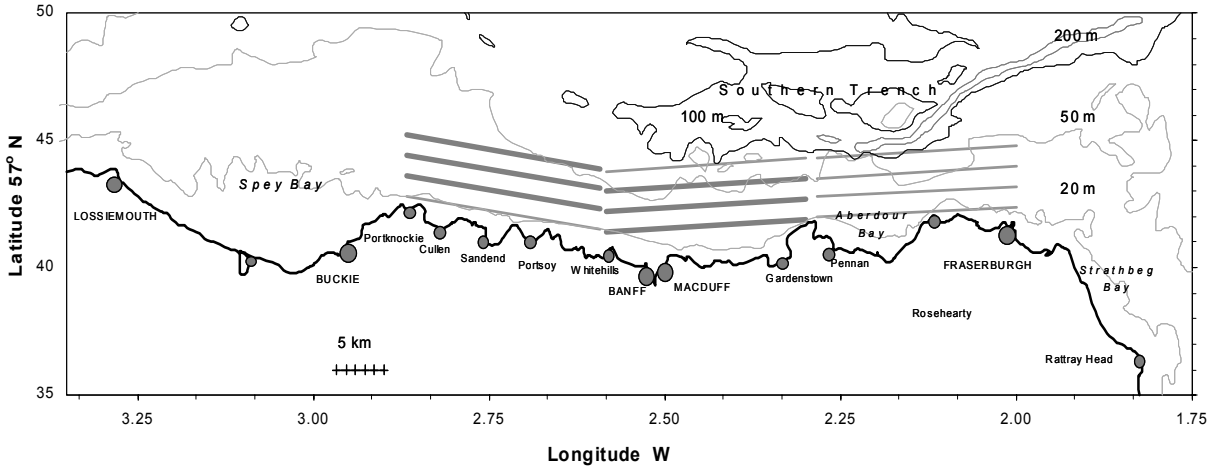


Figure 1. Map showing the coastline of the southern outer Moray Firth and the line transect survey routes undertaken in the present study between the ports of Portknockie and Fraserburgh. The transects were divided into 4 longitudinal routes, each approximately 45 minutes apart in latitude (depicted by parallel lines running adjacent to the shoreline, above) broken into 3 respective sub routes.

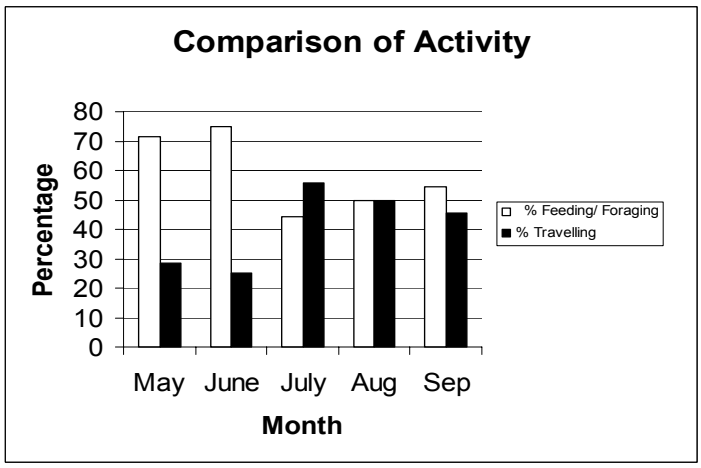
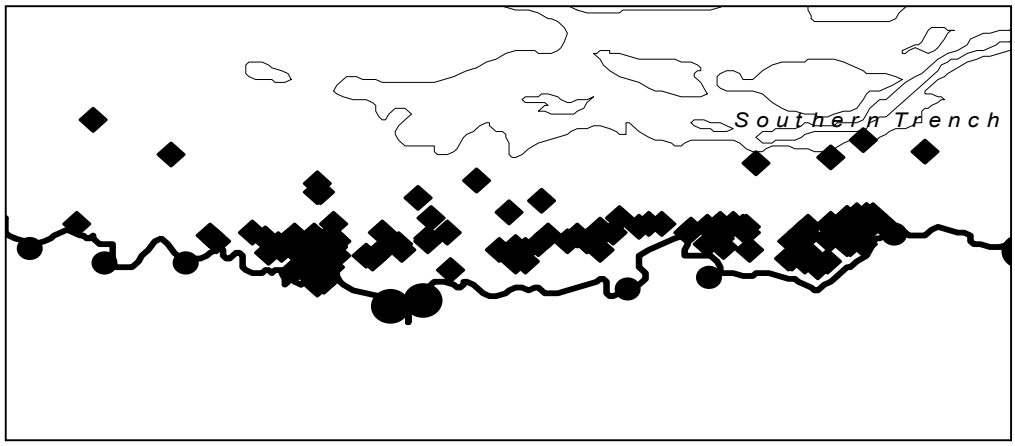


Figure 2. Histogram showing the activity of harbour porpoise groups recorded during encounters from May to September 2003.

(i)



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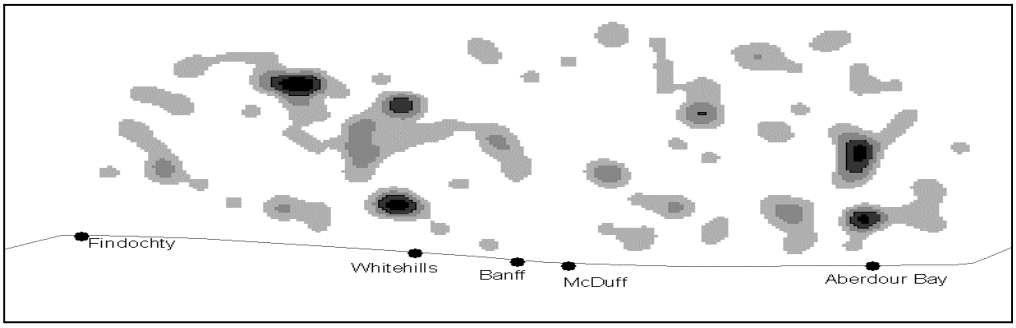

Figure 3. Distribution maps for the harbour porpoise showing: (i) sightings plotted by individual encounter (n=134); and (ii) abundance throughout the study area in the form of a density map (not to actual scale with map 3a).