European Research on Cetaceans – 14. Proceedings of the Fourteenth Annual Conference of the European Cetacean Society, Cork, Ireland, 2-5 April 2000, pp.61-65.

ASSOCIATION OF THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) WITH THE WESTERN IRISH SEA FRONT

Caroline R. Weir[1] and Susan H. O'Brien[2]

[1]Seabirds and Cetaceans, Joint Nature Conservation Committee, Dunnet House, 7 Thistle Place, Aberdeen, AB10 1UZ (e-mail: weir_c@jncc.gov.uk)

[2]Present address: Institute of Zoology, Zoological Society of London, Regent's Park, London, NW1 4RY.

INTRODUCTION

On the European continental shelf, seasonal warming of the sea surface in areas of deep water results in stratification of the water column into an upper warm layer and a cooler lower layer. The western Irish Sea front develops as a seasonal oceanographic feature at the interface between thermally stratified water in the deep western Irish Sea and mixed water in the shallow eastern Irish Sea (Simpson & Hunter, 1974). The position of the front extends between the southern end of the Isle of Man and Dublin, Republic of Ireland (Fig. 1), but shifts daily over several kilometres through tidal advection and strong winds.

At the interface of the front, nutrient-rich mixed water combines with warmer, nutrient-impoverished stratified water to result in an enhanced level of primary production, and concentrations of zooplankton, euphausiids, fish eggs and larvae including spratt (*Sprattus sprattus*) and Atlantic herring (*Clupea harengus*). Concentrations of seabirds occur in the area (Begg & Reid, 1997), and an association of cetacean species with frontal systems in the Irish Sea has been suggested for common dolphins (*Delphinus delphis)* at the Celtic Sea front (Goold, 1998), and harbour porpoises (*Phocoena phocoena)* at the Irish Sea and Celtic Sea fronts (Jones, 1984). We report here on the distribution of the harbour porpoise relative to physical water properties in the Irish Sea, August 1998.

METHODOLOGY

Between 1 and 10 August 1998, a dedicated survey to collect oceanographic, seabird and cetacean distribution data was carried out from the M.V. *Loyal Mediator* in the central Irish Sea. The cruise track covered an area between latitudes 53º10'N and 54º15'N, and longitudes 4º20'W and 6º20'W (Fig. 2). An intensive study of the temporal and spatial movements of the front was made on 10 August by running five repeat transects across the front between approximately 53º24'N 5º16'W and 53º34'N 5º36'W. Standard techniques for counting seabirds were used (Webb & Durinck, 1992), and information on cetaceans was collected throughout the survey. An undulating CTD (Conductivity Temperature Density) aquashuttle (*Chelsea Instruments*) was towed behind the vessel to collect data on sea temperature, salinity and chlorophyll concentration (a measure of primary productivity) between the sea surface and approximately 50 m depth. The vessel's position, course and speed were continuously recorded from the Global Positioning System (GPS), and environmental variables such as sea state, wind speed and visibility were recorded every 90 minutes or when a notable change in conditions occurred.

DATA ANALYSIS

Cetacean data collected during the survey are presented as an index of relative abundance. Since the detection rate of porpoises is reduced as sea state increases (Palka, 1995), data collected in a sea state greater than 3 have been excluded from the analysis. Maps were produced using Dmap for Windows (Morton, 1995). Oceanographic data collected with the CTD aquashuttle were analysed using a stratification index (SI) (*pers. comm*. B. Scott) which compares values of salinity, sea temperature and density in the upper ten metres of water with those from depths below 45 metres. Isopycnic water has SI values approaching 0, stratified water has a lower surface density giving SI values greater than 0.5, whilst intermediate values indicate the location of the front.

RESULTS

A total of 1,280 km (384 km^2) survey coverage was achieved during eight days of survey (Fig. 3). The position of the Irish Sea front was easily identified using data collected by the aquashuttle. Mixed water was characterised by low chlorophyll concentrations and uniform temperatures and stratified water by an obvious thermocline, and concentrated chlorophyll. The surface expression and upwelling of the thermocline was apparent by steep horizontal temperature gradients (Fig. 4). Salinity remained relatively unchanged across the front. The southern part of the front shifted considerably over several kilometres during the survey period.

During the survey, a total of 69 sightings were made of 164 harbour porpoises. The highest abundance of porpoises was recorded in the region of the Irish Sea front, with the greatest concentrations observed in the immediate area of the front (Fig. 5). There were only two individuals in stratified water in the north-west region of the study area. A total of 57 sightings (147 individuals) occurred during dedicated crossings of the southern region of the front on 10 August. During the 12 sightings throughout the rest of the Irish Sea, porpoise group size had ranged from one to three individuals and no juveniles had been recorded. In the region of the front on 10 August, group size ranged from one to six animals, and calves were recorded in 50% of the aged groups (Fig. 6).

On 10 August, five consecutive transects were run across the Irish Sea front. No porpoises were sighted during the first transect. A total of 13 animals recorded during the second and third transects were on the mixed side of the front. The majority of porpoises were recorded during the fourth and fifth consecutive transects (n=114). A further twenty individuals were sighted in the south-west area of the frontal region, while steaming towards Dublin after the transects. Of the 114 individuals recorded on the final two transects, 81.4% of these animals were in mixed water or in the region of upwelling, with SI values of less than 0.3. The distribution of harbour porpoises in relation to the front was similar in each transect, and that from the fifth transect is shown in Fig. 7. Porpoises are situated predominantly over mixed water with a homogeneous temperature and chlorophyll concentration. Harbour porpoise sightings were strongly linearly related to stratification index values ($R^2 = 0.505$, $P < 0.0001$) (Fig. 8). Porpoises therefore appeared to be preferentially using the mixed side of the front.

DISCUSSION

The harbour porpoise was shown during the present survey to occur more frequently in the vicinity of the southern Irish Sea front than in other areas of the central Irish Sea. In particular, porpoises favoured the mixed side of the front rather than stratified water. The distribution of greatest porpoise abundance corresponds with previous findings of the distribution in the peak abundance of species of zooplankton (White, 1988), which are consistent with a southward density-driven flow of water along the western side of the Irish Sea. This current of increased productivity, in addition to the Irish Sea front, may explain the distribution of porpoises shown in this study. Harbour porpoises are small, metabolically active animals, and require a daily intake of about 13% of their body weight in food (Evans, 1987). The aggregation of harbour porpoises in the region of the Irish Sea front may therefore be the result of enhanced productivity and availability of food resources within a relatively small, spatial area, making the region an energetically efficient place to forage.

ACKNOWLEDGEMENTS

Although space restricts individual acknowledgements, many thanks are due to all sponsers of the JNCC Seabirds at Sea Phase 5 programme of work. Nigel Harding assisted with computer programs. Ciarán Cronin, Peter Evans, Jim Reid, Rob Robinson, Beth Scott, Mark Tasker and Andy Webb provided comments on earlier drafts. Many thanks to Rowena White for providing help with this paper during and since the Conference. Thanks to Steve Newton, Claire Pollock, Sam Taylor and Andy Webb for collecting data during the survey. Also, thanks are given to the captain and crew onboard M.V. *Loyal Mediator*.

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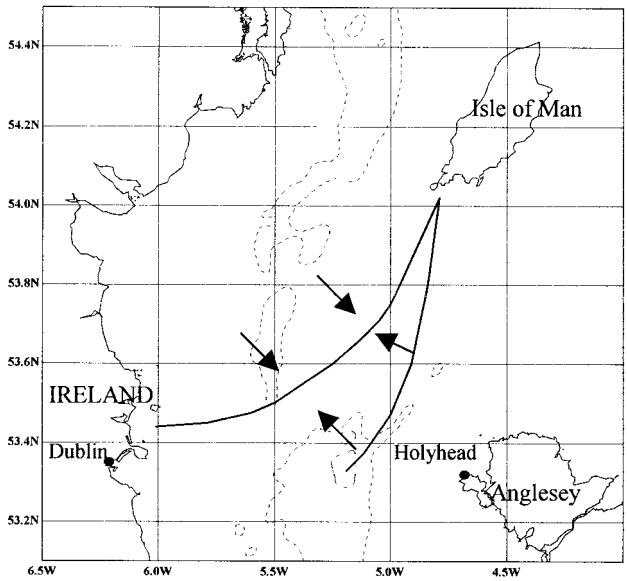


Fig. 1. The survey area showing place names and approximate location of the Irish Sea front
Bathymetry: dot (100m isobath); dotdash (200m isobath)

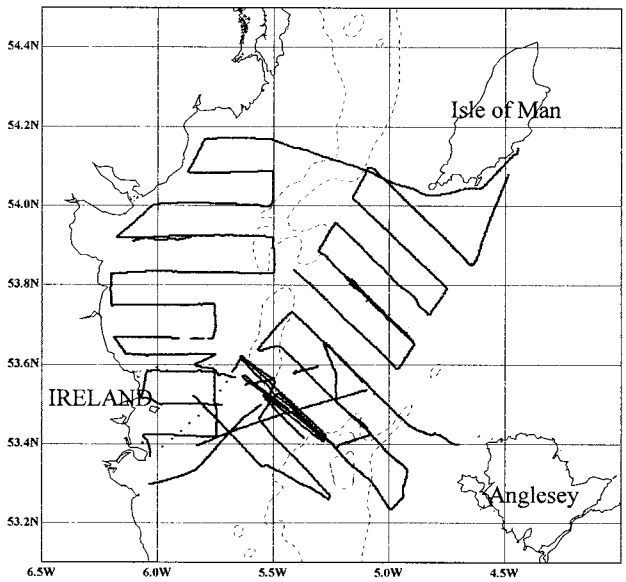
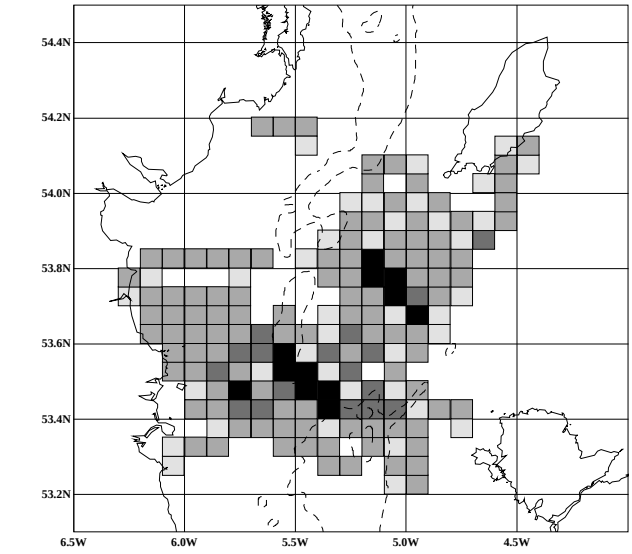


Fig. 2. The cruise track taken during the Irish Sea survey, 1-10 August 1998
Bathymetry: dot (100m isobath); dotdash (200m isobath)



Effort (kms travelled):

Fig. 3. Distribution of survey effort (less than sea state 3) over the survey area
Bathymetry: dot (100m isobath); dotdash (200m isobath)

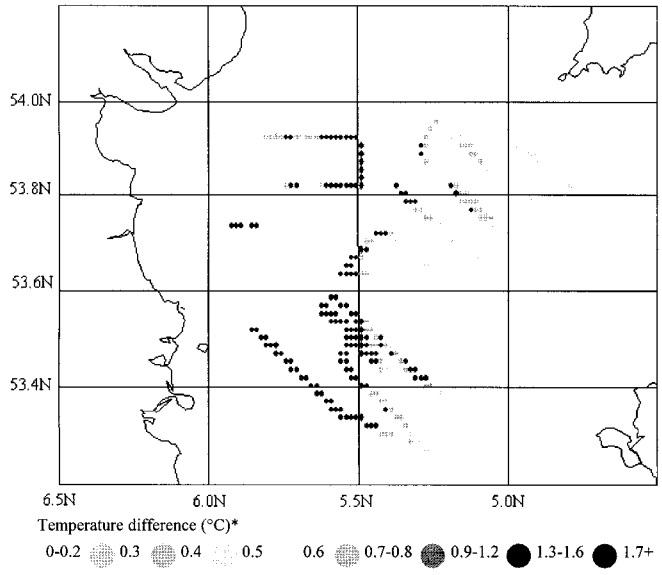


Fig. 4. Distribution of water temperature during survey on 5 August 1998

- Temperature difference represents the difference in average temperature (ºC) between the top 10 m of water and that below 30 m depth

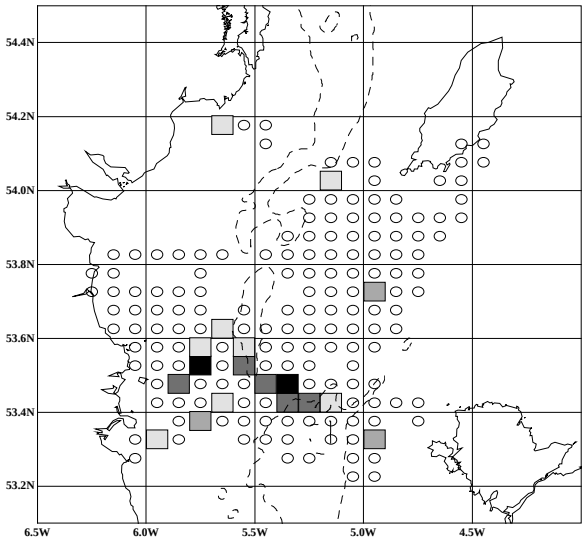


Fig. 5. Abundance of harbour porpoises over the survey area.
Bathymetry: dot (100m isobath); dotdash (200m isobath)

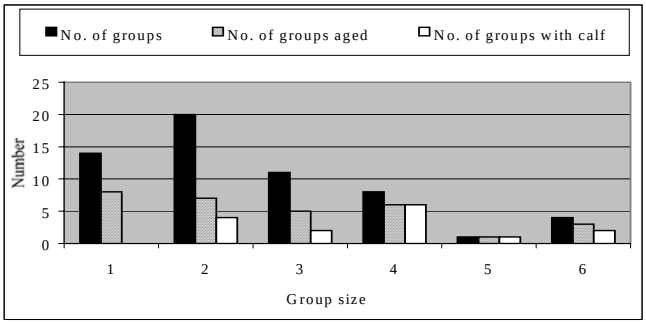


Fig. 6. Group size and composition in the region of the Irish Sea front on 10 August 1998

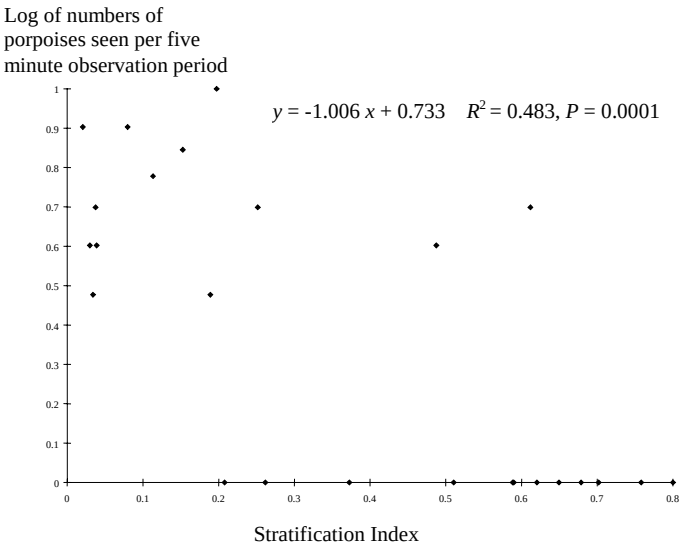


Fig. 8. Regression of number of porpoises recorded against stratification index for transect five

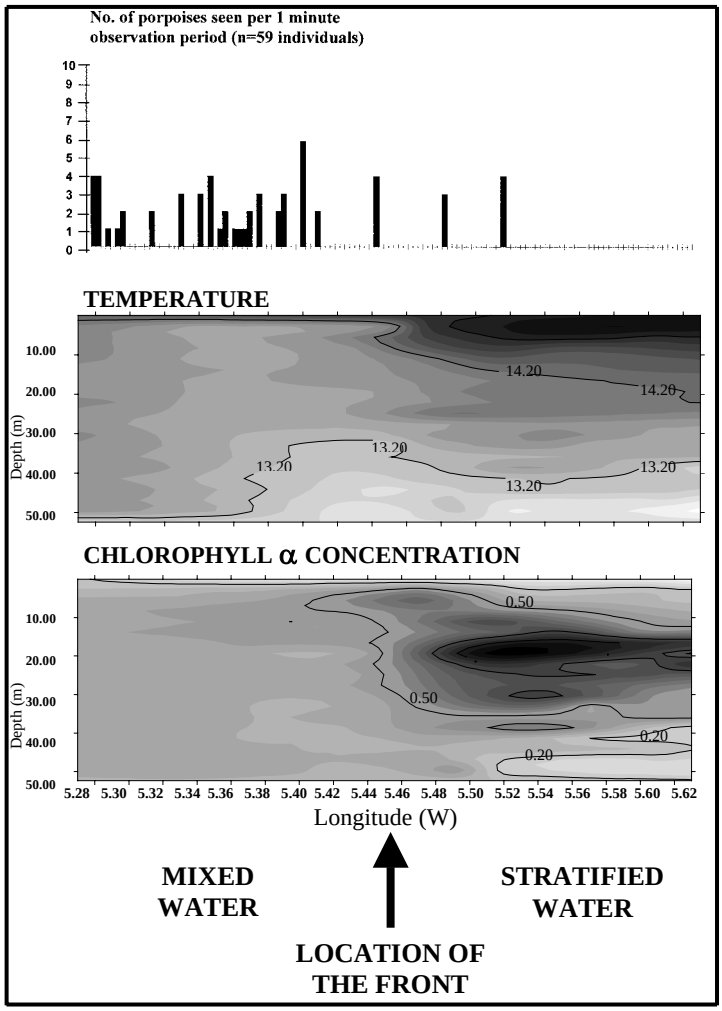


Fig. 7. The number of harbour porpoises recorded over temperature and chlorophyll α profiles, during transect five across the Irish Sea front, August 1998