The harbour porpoise (*Phocoena phocoena*) in the North Atlantic: Variability in habitat use, trophic ecology and contaminant exposure

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ABSTRACT

Harbour porpoises inhabit coastal waters, in habitats that are characterized by high diversity and complexity in terms of their bathymetry, substrate, fish communities and point sources of contaminants. The complexity in these habitats influences both the habitat use and feeding ecology of porpoises. Congregations of porpoises feeding primarily on one species are observed in some areas and seasons, while wide movements and diets composed of several species are observed in other areas. Due to these observations, this paper suggests that caution is needed when extrapolating knowledge from one area to another with regard to porpoise habitat use, exposure to contaminants, and interactions with fisheries. Management plans should be site specific and based on local knowledge incorporating porpoise population structure, habitat use, and multiple environmental factors in order to ensure appropriate conservation of this abundant but still vulnerable small cetacean species.

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INTRODUCTION

General assumptions about harbour porpoise ecology and pollution status may be summarised by the following statements:

- harbour porpoises tend to inhabit murky waters, such as are found in bays and estuaries, in areas of coastal upwelling and tidal races (Martin 1990);
- harbour porpoises are fish feeders, and a range of fish species contributes to the diet (*e.g.* Aarefjord *et al.* 1995);
- harbour porpoises are coastal dwellers, feed at high trophic levels and have relatively small body size: these 3 factors combine synergistically to place the species in an ecological situation where it is highly exposed to environmental contaminants (Aguilar and Borrell 1995).

However, when looking behind these general statements we find that there are large variations in harbour porpoise habitats, diet composition and contaminant burdens over relatively small spatial scales. In this introduction to the session on Ecology and Pollution, I will therefore elaborate on the variability observed with regard to habitat use, foraging ecology and exposure to contaminants. I will focus on the Northeast Atlantic, but examples from other areas will also be used, in particular examples from the extensively studied porpoise population in the Bay of Fundy (BoF) and Gulf of Maine (GoM) area.

HABITAT USE AND BEHAVIOUR

Otani *et al.* (1998) explored the diving behaviour of harbour porpoises in Funka Bay, Hokkaido, Japan. They used time-depth recorders and successfully retrieved the instruments from 2 animals. Their animals carried out V-shaped dives assumed to be transit dives. These dives were normally less than 20 m deep and clearly different from U-shaped 70-100 m deep dives assumed to be foraging dives. The depth range of 70-100 m corresponds well to the water depths of Funka Bay (Otani *et al.* 1998). From this study it may be concluded that porpoises dive to less than 20 m when travelling and that they forage at or near the sea floor at depths up to 100 m. However, looking at studies conducted at other areas with a different bathymetry, we find recordings of dives beyond 200 m depths (Westgate *et al.* 1995, Read and Westgate 1998,)

Nine porpoises were tracked in the BoF-GoM area using satellite telemetry (Read and Westgate 1998). The porpoises were captured near Grand Manan in August of 1994 and 1995 and the mean tracking period was 50 days with a maximum of 212 days. These porpoises displayed considerable variability in their movement patterns. Four remained in the BoF while 5 travelled to the GoM. However, they also showed some similarities: many were most frequently located in water depths between 92 m and 183 m (55% of all locations) and fewer (12%) in depths of more than 183 m. When leaving the BoF area, the porpoises followed the 92 m isobath which may represent an important movement corridor for porpoises, at least in this particular area. The estimated home range of GoM porpoises determined using satellite transmitted data was about 50,000 km^2 (Read and Westgate 1998) as compared to 210 km^2 estimated from VHF data (Read and Gaskin 1985). The new information showed that at least some of the GoM-BoF porpoises integrate contaminants from prey over a much larger area than previously thought. This demonstrates that knowledge of habitat use is important for understanding the exposure of porpoises to environmental pollution.

Despite their predominantly coastal way of life, harbour porpoises may occur far offshore over water depths of some thousand meters. Bjørge and Øien (1995) reported sightings of porpoises midway between mainland Norway and Jan Mayen Island at locations where depths exceed 2000 m. It is not known if these porpoises were foraging over deep waters, or crossing oceanic waters between more shallow coastal foraging grounds. In May 1999 satellite transmitters were attached to 3 porpoises in Varangerfjord, North Norway. Preliminary results indicate that one porpoise utilised offshore shelf waters in the Barents Sea while the other 2 utilised very near shore waters as foraging grounds.

These examples underline the importance of using adequate methods and technology when studying movements and habitat use of harbour porpoises. Further, the examples illustrate the problems associated with extrapolation from one area to another, and with generalising from a small sample size to the population level with regard to behaviour and habitat use in harbour porpoises.

DIET COMPOSITION

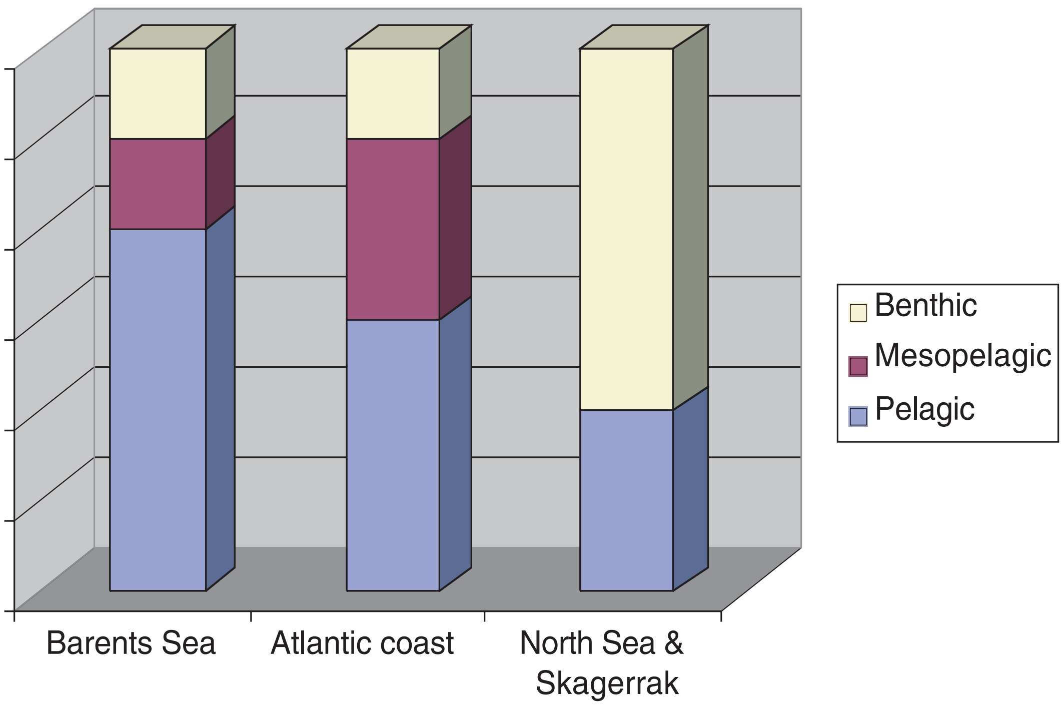
The harbour porpoise is a relatively small endothermic predator with limited energy storage capacity (Gaskin 1982, Yasui and Gaskin 1986, Koopman 1994, 1998). It may be assumed that the porpoises are dependent on foraging throughout the year without prolonged periods of fasting. Changes in relative availability of preferred prey species, or change in nutritive value of available prey may result in switches in diet and foraging grounds. Food depletion or food lower in caloric content may either lead to lower survival or emigration as suggested for harbour porpoises in the central and southern North Sea (Reijnders 1992). Spatial and temporal differences in diet may be expected, and this is demonstrated in Gulf of St. Lawrence and BoF-GoM porpoises. In the summer season porpoises congregate in relatively small areas, *e.g.* in the BoF where they feed almost exclusively on local concentrations of herring (*Clupea harengus*). During autumn the porpoises disperse over the wider Gulf of Maine, and important prey species are herring, silver hake (*Merluccius bilinearis*) and pearlsides (*Maurolicus muelleri*). During the winter season porpoises are assumed to disperse further and forage in coastal waters from New England to North Carolina, and the diet is not well documented (Fontaine *et al.* 1994, Trippel *et al.* 1996, Gannon *et al.* 1998).

The diet may vary between neighbouring areas within a season. A total of 247 porpoises taken as bycatch in Norwegian and adjacent coastal waters showed regional differences. The porpoises were primarily taken during May-July of 1988, however some animals were stranded or taken as bycatch by other fisheries throughout the year. At the Norwegian Barents Sea coast, capelin (*Mallotus villosus*), herring, saithe (*Pollachius virens*), haddock (*Melanogrammus aeglefinus*), blue whiting (*Micromesistius poutassou*) and greater argentine (*Argentina silus*) were the most frequently occurring prey species. On the Alantic coast of Mid-Norway, herring, saithe, blue whiting, poor cod (*Trisopterus minutus*), argentine and pearlsides occurred most frequently, as did herring, gobiids, ammotydids, sprat (*Sprattus sprattus*), whiting and cod (*Gadus morhua*) in North Sea and Skagerrak waters (Aarefjord *et al.* 1995). These differences in diet show a shift from pelagic prey species in the deeper northern waters to more benthic prey species in the relatively shallow North Sea and Skagerrak waters (Fig. 1). The mesopelagic species normally occur in deep waters and may become available to the porpoises during the preys' nocturnal vertical migrations. The lesson to be learned by these observations is that in addition to the migration and distribution of potential prey species, the local bathymetry may also impact the diet composition of harbour porpoises.

EXPOSURE TO POLLUTION

The harbour porpoise is exposed to chemical pollution primarily through food ingestion, and they feed at high trophic levels (Pauly *et al.* 1998). Of particular concern to the health of

Fig. 1: *Relative occurrence of pelagic, mesopelagic and benthic species among the 6 most frequently occurring prey species (see text) in harbour porpoises by-caught in the Barents Sea, the Atlantic coast of Mid-Norway and the Danish North Sea and Skagerrak. Based on data from Aarefjord et al. (1995).*



porpoises are the fat-soluble organochlorines (OCs) that accumulate through the food webs to reach relatively high concentrations in top predators. In porpoises, gradients of OC levels and changes in relative concentrations of major compounds are observed over short distances, *e.g.* from Newfoundland to BoF-GoM (Westgate *et al.* 1997), and along the Norwegian coast (Kleivane *et al.* 1995).

The production and application of some of the classical OC's is now banned in the North Atlantic region. The ratio between DDT and PCB seems to have changed in recent years. The highest levels of DDT were invariably found in porpoises before 1975. However, these compounds are very persistent in the environment, and the PCB levels remain high and represent a standing health hazard for marine top predators such as porpoises (Aguilar and Borrell 1995, Jepson *et al.* 1999, Reijnders *et al.* 1999). New groups of compounds (*e.g.* the brominated flame retardants), which may have similar effects as the classical OCs, are at present entering the marine biota at an increasing rate.

Mercury is also of concern with regard to porpoises. Siebert *et al.* (1999) found that concentrations of mercury and methylmercury were higher in the German North Sea porpoises than the German Baltic Sea porpoises, and that high concentrations of mercury were correlated with higher prevalence of parasitic infections and certain pathological conditions such as pneumonia.

CONCLUSIONS

The harbour porpoise is mainly coastal in its distribution. However, information on habitat use, diet and exposure to contaminants may not readily be extrapolated from one area to another. The coastal environment may vary tremendously over short distances in bathymetry, availability of prey and contaminant levels. Point sources of pollutants may cause local but dramatic effects, and such effects may add to bycatch mortality of porpoises in coastal gill net fisheries which are demonstrated to be significant in may areas throughout the range of the species. In addition, depletion of favoured, nutritive rich prey species through, for example, overfishing, introduces extra environmental stress. Taking into account the evolving information on discrete population and sub-population structures in harbour porpoises, management plans should be based on local knowledge and multiple environmental factors in order to ensure appropriate conservation of this abundant but still vulnerable small cetacean species.

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