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Basin-scale distribution of harbour porpoises in the Baltic Sea provides basis for effective conservation actions

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ABSTRACT

Knowledge on spatial and seasonal distribution of species is crucial when designing protected areas and implementing management actions. The Baltic Proper harbour porpoise (*Phocoena phocoena*) population is critically endangered, and its distribution is virtually unknown. Here, we used passive acoustic monitoring and species distribution models to describe the spatial and seasonal distribution of harbour porpoises in the Baltic Proper. Porpoise click detectors were deployed over a systematic grid of 297 stations in eight countries from April 2011 through July 2013. Generalized additive models were used to describe the monthly probability of detecting porpoise clicks as a function of spatially-referenced covariates and time. During the reproductive season, two main areas of high probability of porpoise detection were identified. One of those areas, situated on and around the offshore banks in the Baltic Proper, is clearly separated from the known distribution range of the Belt Sea population during breeding season, suggesting this is an important breeding ground for the Baltic Proper population. We commend the designation of this area as a marine protected area and recommend Baltic Sea countries to also protect areas in the southern Baltic Sea and the Hanö Bight where additional important harbour porpoise habitats were identified. Further conservation measures should be carried out based on analyses of overlap between harbour porpoise distribution and potentially harmful anthropogenic activities. Our study shows that large-scale systematic monitoring using novel techniques can give important insights on the dis-

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tribution of low-density populations, and that international cooperation is pivotal when studying transnationally migratory species.

1. Introduction

Since its inception as a scientific discipline, two fundamental questions asked in animal ecology and conservation have been how animals are distributed and how many there are (Elton, 1927; Krebs, 1972). Answers to these questions have helped scientists to determine the structure and functioning of populations, communities and ecosystems, and to make suggestions for effective conservation strategies. Determining the spatial and temporal distribution of threatened species or populations is crucial for designing protected areas and management actions. Marine animals may roam vast areas, move mainly below the surface and cross-national boundaries, and are thus notoriously difficult to survey. Highly fragmented, low density populations augment these challenges even further. Hence, many studies focused on marine population ecology and conservation rely on technological and theoretical advances as well as integrated international efforts (Hammond et al., 2002, 2013).

Harbour porpoises (*Phocoena phocoena*) are present in cold to temperate shelf waters throughout the northern hemisphere (Gaskin, 1984). Four subspecies have been identified: two in the Pacific Ocean (*P. p. vomerina* and one un-named subspecies), one in the Black Sea (*P. p. relicta*) and one in the North Atlantic Ocean (*P. p. phocoena*) (Committee on Taxonomy, 2016; Gaskin, 1984; Rosel et al., 1995, 1999). The North Atlantic subspecies is divided into several populations and the existence of a separate Baltic Proper population has recently been investigated in four comprehensive studies testing alternative delimitations of populations using nuclear and mitochondrial DNA (Lah et al., 2016; Wiemann et al., 2010), skull morphometrics (Galatius et al., 2012) and satellite tracking in combination with passive acoustic detections (Sveegaard et al., 2015). These studies all indicate the presence of three separate populations of harbour porpoises in the eastern part of the North Atlantic: one extending into the North Sea, Skagerrak and northern Kattegat; one in southern Kattegat, the Belt Sea and southwestern Baltic Sea; and one in the Baltic Proper (defined as extending from the Darss and Drogden sills in the southwest to the Åland Islands at approximately 60°N in the north, Fig. 1). The existence of a Baltic Proper population of harbour porpoises has considerable implications for the management of the species in this region; hence,

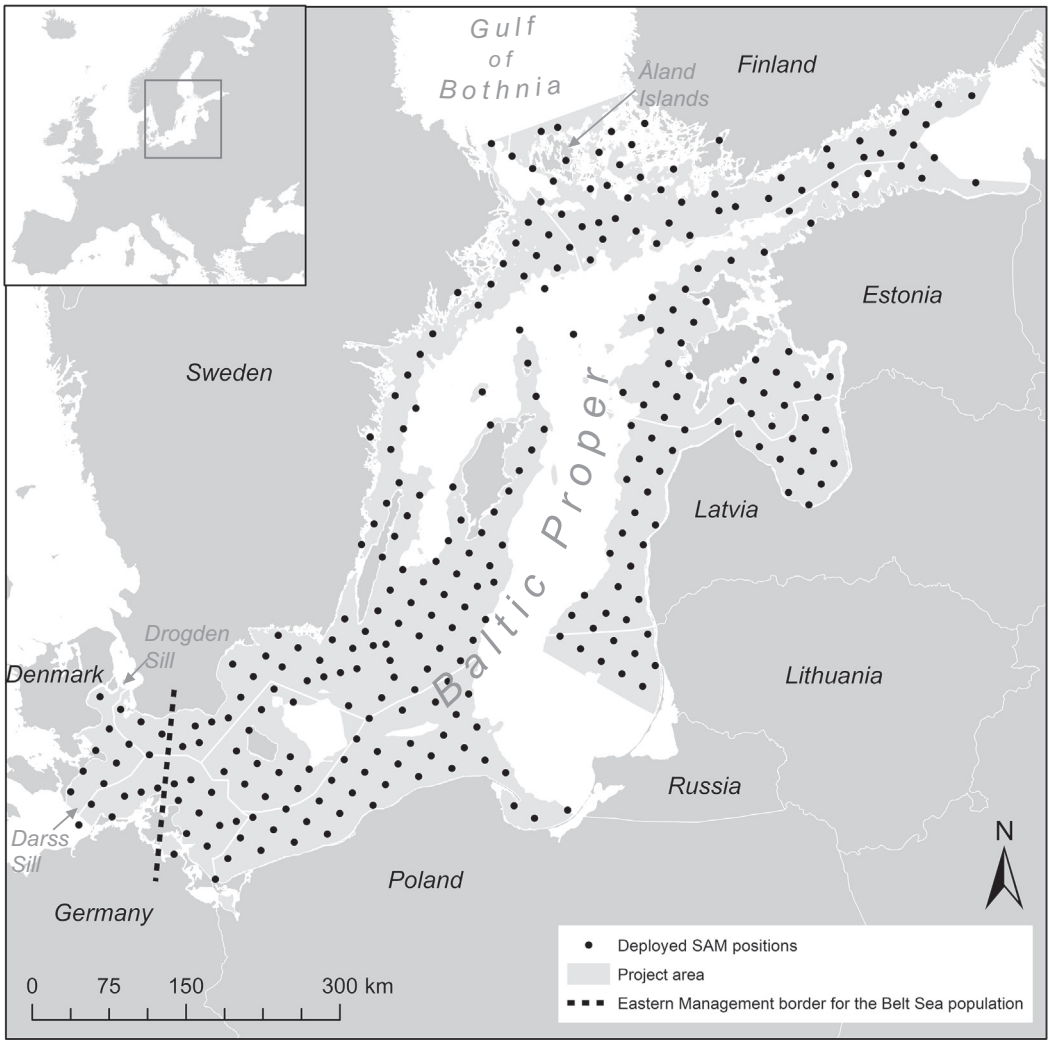

Fig. 1. An overview of the Baltic Sea, with the study area in the 5–80 m depth interval highlighted and the 304 SAMBAH stations shown with black dots. Deeper waters were excluded from data collection and analysis. The dashed line shows the summer (May–September) eastern management border for the Belt Sea harbour porpoise population at 13.5°E, as suggested by Sveegaard et al. (2015).