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Variability and connectivity of plaice populations from the Eastern North Sea to the Western Baltic Sea, and implications for assessment and management ☆

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ABSTRACT

An essential prerequisite of sustainable fisheries is the match between biologically relevant processes and management action. Various populations may however co-occur on fishing grounds, although they might not belong to the same stock, leading to poor performance of stock assessment and management. Plaice in Kattegat and Skagerrak have traditionally been considered as one stock unit. Current understanding indicates that several plaice components may exist in the transition area between the North Sea and the Baltic Sea. A comprehensive review of all available biological knowledge on plaice in this area is performed, including published and unpublished literature together with the analyses of commercial and survey data and historical tagging data. The results suggest that plaice in Skagerrak is closely associated with plaice in the North Sea, although local populations are present in the area. Plaice in Kattegat, the Belts Sea and the Sound can be considered a stock unit, as is plaice in the Baltic Sea. The analyses revealed great heterogeneity in the dynamics and productivity of the various local components, and suggested for specific action to maintain biodiversity.

1. Introduction

An essential prerequisite of sustainable fisheries is the match between biologically relevant processes and management action (Reiss et al., 2009). Management however, is often undertaken at the scale of large hydrographical basins with fixed administrative boundaries, which can often mismatch the putative ecological and/or genetic structure of the marine populations. Even when known and acknowledged (see e.g. review by Reiss et al., 2009), such a mismatch can often not be easily solved. This is partly due to the inertia inherent to fisheries management and its set of conflicting objectives, but partly also because the exact characterization and quantification of the mismatch are a difficult task (ICES, 2011b).

Fish species show complex life cycles that comprise ontogenic habitat segregation. A population can only sustain itself when the habitats are connected and the fish can close the life cycle (Sinclair, 1988). Fish of different populations may mix during feeding while they segregate during the spawning period. Hence, it is important to know if the fish in a certain area belong to a single panmictic population, or belong to different populations (Metcalfe, 2006; Volckaert, 2013). Stock assessment usually builds on catches from a given area, and if different genetic populations are simultaneously present within this area, such a procedure will produce an overall picture of stock dynamics, which might not reflect actual trends within these individual populations (Kell et al., 2009). All individual components should however be maintained and their dynamics monitored to ensure the overall sustainability of the stock.

For some species, such as herring, it has been possible to monitor the relative proportion of each population in an area (e.g. Clausen et al., 2007; Bierman et al., 2010; ICES, 2011b). But in most cases it is not possible, and fish stocks are usually assessed ignoring the underlying structure of sub-populations. This may increase the risk of depletion of local stocks and stock collapse (Hilborn et al., 2003; Kell et al., 2009; Ying et al., 2011).

The European plaice (*Pleuronectes platessa*, Pleuronectidae) is predominantly distributed within the North Sea but extends to adjacent waters. Plaice stock structure comprises different spawning components,

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which separate during spawning and mix during feeding. Juveniles of different spawning components mix also partly on nursery grounds (Hunter et al., 2004; Kell et al., 2004; Hufnagl et al., 2012). In spite of the assumed connectivity between components, plaice abundance is assessed and managed as a suite of ten discrete stock units from the West of Ireland to the Eastern Baltic Sea (ICES, 2010a). Only for the eastern English Channel is the connectivity with both the Western English Channel and the North Sea coarsely accounted for in stock assessment and advice (ICES, 2011a). Noticeably, although several different spawning components are acknowledged, Hoarau et al. (2002, 2004) found only weak genetic differentiation between the North Sea–Irish Sea, Norway, the Baltic and the Bay of Biscay using mt-DNA and microsatellite genetic markers.

On the Eastern side of the North Sea, a single plaice stock has historically been defined in the transition area to the Baltic Sea, in ICES Division IIIa (covering two sub-divisions, Skagerrak (IIIa North) and Kattegat (IIIa South)). This area is characterised by a great heterogeneity of hydrographical conditions, with a very steep salinity gradient and important mainstream currents (Danielssen et al., 1997, Fig. 1). The assessment of this stock by the International Council for the Exploration of the Sea (ICES) has increasingly been deemed as unreliable and the annual advice for future catch opportunities has thus long been given without sound scientific basis (ICES, 2010a). This has important political and socio-economic consequences. Although plaice is not among the highest valued species in the area, it is nevertheless targeted by a coastal fishery along the Danish Northwestern Jutland coast. It enters also a mixed trawl fishery together with cod and *Nephrops*. Thus, the scientific inability to deliver a robust stock assessment in area IIIa is a concern for the sustainability of the stock itself but also for the local fishery that exploits it. In addition, the lack of agreed assessment is an institutional barrier against fisheries ecolabelling, which has created mistrust and frustration among stakeholders. Overall, there is an urgent need to improve the whole governance scheme for this stock.

Over the years, a number of initiatives have been taken within ICES to improve the assessment of this stock (e.g. ICES, 2006), but with limited success. A major problem is the difficulty in tracking cohorts in the catch-at-age matrix. This study investigates the potential sources of uncertainty and variability driving this issue. It presents a comprehensive literature review of the biology of plaice in the area, complemented by an analysis of recent commercial catch and survey data and historical tagging data, that may throw light on the stock structure in the transition area. A significant part of the relevant information was found in the grey literature including ICES working group reports and unpublished master theses and laboratory studies. This synthesis allows us to produce a

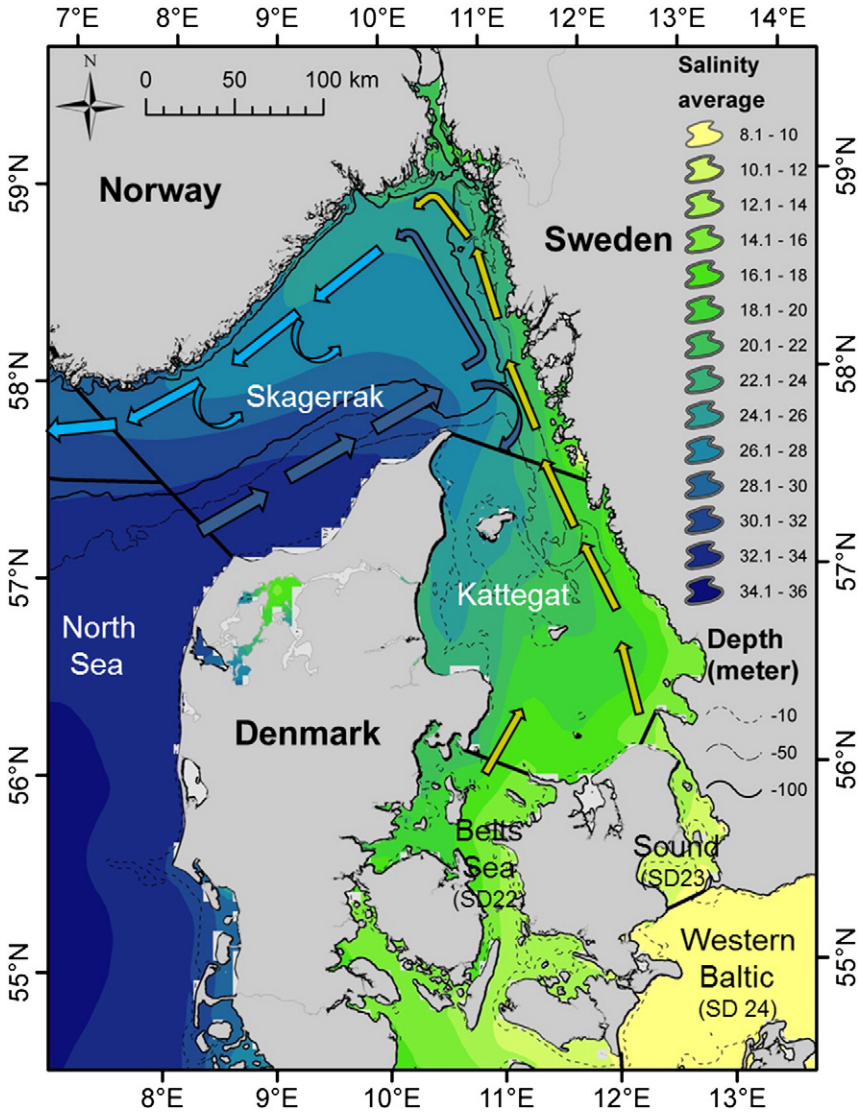

Fig. 1. Hydrographical map of the area with average surface salinity, depth and currents (yellow: Baltic current, dark blue: North jutland current, azure: Skagerrak costal current). Salinity data from DHI. Currents redrawn from Danielssen et al. (1997). The black straight lines delimitate the management areas.