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On the potential benefits of marine spatial planning for herring spawning conditions—An example from the western Baltic Sea

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ABSTRACT

Fisheries and marine spatial planning (MSP) still have a widely unsettled relationship. This paper reports on the potential benefits of MSP for the management of herring (*Clupea harengus* L.) stocks in the Greifswalder Bodden, a major spawning ground for western Baltic spring-spawning herring. The various pressures that have potential impacts on spawning conditions are identified based on a systematic literature review. Those anthropogenic activities that affect spawning conditions and could underlie MSP regulations are then analysed on the basis of the pressure maps to assess their importance for recruitment success in comparison to other pressures which are not subject to MSP by-laws, e.g. eutrophication. The results confirm that MSP could potentially improve the management of certain fish stocks and help to close existing gaps in European fisheries policy.

1. Introduction

The relationship between marine spatial planning (MSP) and fisheries in Europe has often been tension-fraught since the European Commission began promoting MSP in 2006. From the perspective of the fisheries sector, the initial attention often focused on competition for space and resources (Jentoft and Knol, 2014). Furthermore, MSP has been seen in part as another unwelcome regulation mechanism; this viewpoint has influenced the discussions between the fisheries communities and MSP authorities. In return, responsible MSP agencies often argued that fisheries are outside of their competence because of the Common Fisheries Policy (CFP). While several scientific studies highlighted the strong relation between fisheries and MSP (e.g. Gray et al., 2005; Crowder and Norse, 2008; Berkenhagen et al., 2010; van Deurs et al., 2012; Lamp, 2012), as well as ways in which fisheries could be included in MSP (e.g. Douvere et al., 2007; Fock, 2008; Stelzenmüller et al., 2008), so far fisheries are rarely considered in current marine spatial plans in Europe; exceptions are the Norwegian Integrated Management Plan for the Barents Sea-Lofoten area (Norwegian Ministry of the Environment (NME), 2011) and the English East Inshore and East Offshore Marine Plans (HM Government, 2012).

In contrast to the administrative reality, Worm et al. (2009) and Norse (2010) recommend ecosystem-based spatial planning to benefit marine fisheries. Current fishery management has shortcomings in considering the heterogeneity of fish populations and human uses (Norse, 2010) while MSP has a potential to support sustainable fisheries management by regulating anthropogenic activities. Within the CFP framework, fisheries management can only regulate the fisheries sector. Other variables, e.g. impacts of other anthropogenic activities on spawning conditions, are beyond the reach of the CFP, which has led to some criticism by the fisheries communities (Daw and Gray, 2005).

Numerous studies suggest that various anthropogenic activities have impacts on fish recruitment. For example, DeGroot (1979) reported a severe impact of sand and gravel extraction on sole recruitment, while Richardson (2003) summarised various studies on non-fisheries pressures on the recruitment of marine fish species, such as the impacts of eutrophication, introduction of non-indigenous species, contamination, and noise introduction. Sundby and Nakken (2008) highlighted the impact of climate change on Arcto-Norwegian cod spawning and Grabowski et al. (2012) suggested that even broadcast spawning fish, such as Atlantic cod *Gadus morhua*, may rely on specific spawning habitat types, and concluded that those areas should be protected from anthropogenic disturbance. Recruitment success might also be influenced by anthropogenic noise. Detailed studies on the effects of noise on recruitment are largely missing, but various studies have analysed

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general impacts, e.g. the avoidance of vessels by fish (Olsen, 1971, 1979; Olsen et al., 1983; Ona and Godø, 1990; Gerlotto and Fréon, 1992; De Robertis et al., 2010; De Robertis and Handegard, 2013). The noise emitted from vessels is in the acoustic range detected by fish (Engås et al., 1995; Mitson, 1995), and fish, including herring, react with evasion (Misund et al., 1996; Soria et al., 1996; Vabø et al., 2002; plus reviews in Fréon and Misund, 1999). Furthermore, the general alteration of marine ecosystems and the influence on fish stocks is highlighted by various studies (e.g. Lotze et al., 2006; Worm et al., 2006, 2009).

The present study analyses the potential of MSP to influence the spawning conditions of herring, *Clupea harengus* L., in the Greifswalder Bodden, a major spawning ground for western Baltic spring-spawning herring (WBSS). The paper starts with a short illustration of the study site, covering its environmental and economic characteristics. This is then followed by an explanation of the methodology and an account of the study findings. The paper concludes with a discussion of key issues raised by the exercise and the implications for more sophisticated and place-sensitive approaches to marine management.

2. Study site

With an area of 510 km^2, Greifswalder Bodden is the largest shallow bay within the south-western Baltic Sea. It is surrounded by the island of Rügen to the north and the mainland to the west and south (Fig. 1). The bay is connected to the Baltic Sea by a narrow and shallow sill and the Strelasund channel. Nutrient-rich riverine waters enter the bay via the Peene outlet and Strelasund channel. Sediments consist mainly of mud, with fractions of sand and clay-gravel mixture. Hydrodynamics are mainly driven by wind, with mixing leading to a generally well-oxygenated water column (Stigge, 1989; Munkes, 2005). However, stratification, especially during the spring and summer seasons, may lead to temporary

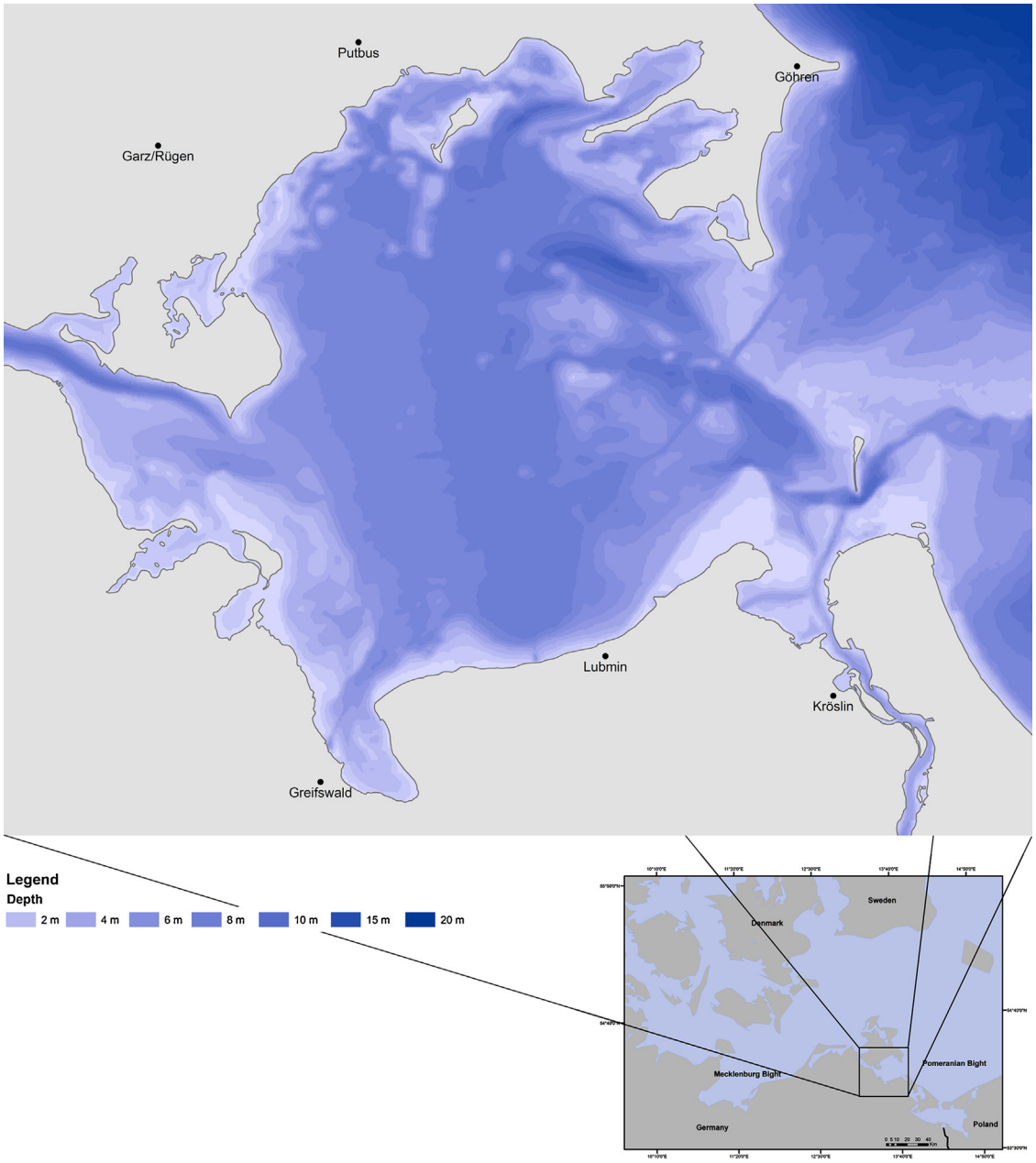

Fig. 1. Case study area 'Greifswalder Bodden'.