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## Multidisciplinary mapping of fish habitats in the Sound, Denmark for maritime spatial planning

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### Summary

The emergence of a conflict in the Danish part of Øresund involving environmental groups, local fishers and sand extraction activities led to a project in which nursery, feeding and spawning habitats of commercially important demersal fish species in the area were mapped. Apart from intensive angling, most fishing in the Sound is carried out by small-scale gillnetting with vessels <12 meters. No high-resolution spatial data (e.g. vessel monitoring system data) exists for these fisheries. Habitat mapping was therefore based on ecological knowledge gathered through interviews with fishers, coupled with existing sediment maps and low resolution fish survey data. Resulting maps reveal that fish habitat mapping in data poor areas is possible to a degree where reliable broad scale maps can be produced. Maps of both fishing grounds and the habitats that represent the ecological foundation of the fisheries are essential in informing spatial planning processes, i.e. constituting a solid baseline for constructive dialogue and discussion between authorities and affected stakeholders when planning activities at sea.

### Introduction

Øresund, the narrow sound separating Denmark and Sweden, is a sea area that is used for commercial and recreational purposes by a wide range of commercial sectors as well as citizens of the large cities and towns on both coasts. Øresund is unique in the sense that trawling has been prohibited there as a shipping safety measure since the early 1930's. Fish populations of Øresund are in a comparatively healthy state and benthic habitats have not been exposed to physical impacts from mobile, bottom-contacting gears for many decades (Svedäng 2010). Recreational fishing and angling within and along the shores of Øresund is intensive and the commercial fishery in Øresund consists mainly of gillnetters fishing from vessels that are under 5-11 meters in length. Main target species are cod, eel, sole, plaice, lumpsucker, garfish, herring, flounder, turbot and others. Parts of Øresund have recently received much attention in Danish media due to protests from fishers, divers and NGOs over sand extraction activities in areas considered to be important fish habitats. In order to improve the understanding of the distribution of Øresund's fish habitats and provide a foundation for more informed spatial planning of maritime activities in the area, a fish habitat mapping study was commissioned by the Danish government.

### Materials and Methods

Due to the low resolution of existing Øresund fish survey data and the absence of VMS data for fishing vessels smaller than 12 m, the only viable approach to mapping of fish habitats was to glean the ecological knowledge of fishermen through semi-structured, open ended interviews, inspired by approaches used in Canada (Neis et al. 1999; Murray et al. 2008) and Sweden (Gunnartz et al. 2011), and to analyze the information in combination with existing habitat and sediment maps and survey data. Interviews and mapping sessions were conducted using paper nautical charts to identify, as specific as possible, areas where demersal fish species are caught, where the species grow up and where they spawn. 13 gillnetters, 1 pound net fisherman, 2 highly experienced sea anglers and 2 experienced angling tour skippers were

interviewed. Resulting hand drawn maps were digitized in ArcGIS. More general information (e.g. depth intervals and substrate descriptions) was translated and mapped in ArcGIS based on existing data regarding bathymetry, sediment composition and existing maps of the seafloor in the area. Data layers were combined with existing survey data collected from sources such as DTU Aqua fish survey data and nearshore visual fish surveys conducted by scientists at the Natural History Museum of Denmark. Mapped habitats were discussed and consolidated through workshops including experts and experienced representatives from the fishing and angling communities.

## Results and Discussion

Broad-scale habitat maps were produced for 7 focal fish species, characterized by having direct association with benthic features during their life cycle: cod, lumpsucker, eel, plaice, sole, turbot and brill. The 7 maps were subsequently combined to indicate habitat overlap among species and thus where detrimental impacts to habitats would affect the highest number of species. Maps indicate that commercial fish species utilise most of Øresunds habitats at least once throughout their life cycles. In a narrow sea such as Øresund, there are therefore very few areas that, during a given year, do not serve as fish habitat for at least one of the examined species at one time or another. Areas to the north of Copenhagen are home to a higher number of species than in southern areas, partly due to a gradual reduction in salinity that limits the southward distribution of species such as sole and brill. Another explanation may be that the northern part of the sound contains a larger diversity in habitat types and a higher topographical complexity that in turn provide for a wider range of biological niches for fish throughout their life cycles. The results show that it is possible to map fish habitats in data poor areas using ecological knowledge of fishers in combination with existing data. Data collected through interviews is inherently subjective, but the collation of all information and comparison with mapped general information revealed patterns that confirmed much of what interviewees had stated.

Fish habitat mapping can rarely be carried out at a level of spatial and temporal detail and confidence that can eliminate the need for constructive involvement and dialogue with stakeholders within maritime spatial planning processes. However, maps based on available data and the ecological knowledge of fishers may serve as a very strong foundation for engagement with stakeholders and can be pivotal in minimizing conflicts between the fishery and other sectors. In addition to facilitating the implementation of the EU's Maritime Spatial Planning Directive, fish habitat mapping is instrumental in identifying sites that are key to the functioning of marine ecosystems and is therefore also important for the implementation the Marine Strategy Framework Directive as well as the Common Fisheries Policy.

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