Interim Report 2007
for
the ICES/BfN-project:

"Environmentally Sound Fisheries Management in Protected Areas" [EMPAS]

ICES International Council for the Exploration of the Sea

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Contents

1 Introduction

In February 2006, International Council for the Exploration of the Seas (ICES) in collaboration with the German Federal Agency for Nature Conservation (BfN) started the project "Environmentally Sound Fishery Management in Protected Areas [EMPAS]" aimed at developing fisheries management plans of the Natura 2000 sites within the German EEZ of the North Sea and Baltic Sea. The EMPAS project serves as a pilot and guidance project for the development of the necessary management plans for Natura 2000 sites in the German EEZ. (Reports can be downloaded from the EMPAS web-page: http://www.ices.dk/projects/empas.asp).

One of the main targets of the EMPAS project is a conflict analysis between ongoing fishing activities and conservation targets in the marine Natura 2000 sites designated in the German EEZ. To fulfil this task of the EMPAS project fundamental data and information is required: a) habitats and species specific distribution data and conservation objectives for each site, b) fine scale and disaggregated spatial and temporal data describing fleet activity throughout the German EEZ, and c) impact of fishing activities on habitats and species in Natura 2000 sites.

For each of the ten designated German Natura 2000 sites these data and information will allow the following questions to be answered by the EMPAS project:

1) to what extent do specific fishing activities represent a significant threat against reaching the conservation objectives of the NATURA 2000 sites?;
2) for identified conflicts between fisheries and the conservation goals, which management measures would reduce these conflicts to acceptable levels?

The answers will be based on existing data from fisheries and environmental research and, where appropriate, newly collected data, in particular from cooperation with fishers and the fishing industry.

2 EMPAS work and interim results 2007

Short summery:

The WKFMMPA workshop 2007 had two primary goals (ICES, 2007):

1) to review the information that had been collected during the past year, with regard to its adequacy for a full assessment of fishing activities;

2) to review the progress made on specifying the conservation objectives and targets for the Natura 2000 sites, with regard to their suitability to assess potential conflicts between fisheries and nature conservation objectives/targets.

With regard to the path forward, the workshop concluded that the questions the EMPAS project should investigate are:

1) what is the current status of the species and habitats and;

2) given patterns of fishing and knowledge of the impacts of the fishing activities, can the current status be expected to be stable in the longer term for all key species, and possibly improve for the species currently thought to be at risk of loss from the area.

If in the medium or longer term a species to be protected under the Habitats Directive can be expected to decline below the present status level, and impacts of fisheries contribute to the declines (even if they are not the primary cause), then we need to find and introduce management measures to prevent this decline if possible, and minimize it in all cases.

With respect to the structure and function of the habitats, the Habitats Directive requires that a habitat has to persist in the long term. The workshop concluded that with current ecological theory, and knowledge gained from the use of benthic community indicators in assessment and monitoring of environmental quality, it should be possible to find community indicators that could be used in the assessment of habitat quality in the Natura 2000 sites.

The EMPAS project, the process undertaken, and interim results are described in a manuscript submitted 26/10-2007 for publication in the special symposium issue (thematic MPA-issue) of the ICES Journal of Marine Science (Annex 1). Fine scale distributions of fishing effort by fishing gear, 3x3 nautical mile squares, and month in 2006 in the German exclusive economic zone of the North Sea and the Baltic Sea have been estimated from vessel monitoring data (VMS) (Annex 2).

3 EMPAS work plan 2008

The tasks to be fulfilled in the EMPAS project prior to the final workshop 2-4. June 2008 are outlined in Annex 3 and in an EMPAS working document (Annex 4). Successfully fulfilment of these tasks and questions will be dependent on the availability of data and information.

A detailed work plan to improve the availability of data and information for the final EMPAS workshop was presented at a technical EMPAS meeting in Hamburg 11. December 2007 (ICES, 2008). The EMPAS work plan and time table for 2008:

1) An ICES technical data analysing meeting held in ICES, 26-27 February.

2) A BfN workshop entitled: "Impact assessment of bottom trawling on benthic species in MPAs within the German EEZ of the North Sea: A modelling approach", to be held at Isle of Vilm 9-11 April.

3) A BfN workshop entitled: "Effects of fishing activities on marine mammals, seabirds and protected fish species", to be held at Isle of Vilm 5-9 May.

4) The final WKFMMPA workshop in ICES, 2-4 June.

5) A peer review of EMPAS plans/advice and peer review meeting in Halifax during the ICES Annual Science Conference in the end of September.

6) A final EMPAS project report including the results of the EMPAS workshops and the peer review and advices to be submitted to German Federal Environment Ministry (the client).

The ICES meeting (1) and the two BfN workshops (2) and (3) have been planned in order to produce, collect, and forward scientific results of mainly ongoing German research projects to the final WKFMMPA workshop, 2-4 June 2008 (Annex 5).

Selected tasks discussed at the Hamburg meeting 11. December 2007 and actions taken (need to be taken) to fulfil them are outlined under each task presented in Annex 3.

4 References

ICES. 2007. Report of the Workshop on Fisheries Management in Marine Protected Areas (WKFMMPA), 10–12 April 2007. ICES CM 2007/MHC:06. 61 pp + 2 annexes.

ICES. 2008. Report from an EMPAS technical work planning meeting, Hamburg 11. December 2007 (version 11. January 2008). 23pp.

Annex 1: Natura 2000 sites and Fisheries in German Offshore Waters

European MPA Symposium 2007: http://mpasymposium2007.eu/

Manuscript submitted 26/10-2007 for publication in the special symposium issue (thematic MPA-issue) of the ICES Journal of Marine Science.

Natura 2000 sites and Fisheries in German Offshore Waters

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Abstract

In May 2004, Germany nominated ten marine Natura 2000 sites to the European Commission covering 31.5 % of the German exclusive economic zones (EEZs) of the North Sea and the Baltic Sea. The principal objective of Natura 2000 sites is to maintain or achieve a favourable conservation status of habitats and species listed under the EU Birds and Habitats Directives. In the German EEZs of the North Sea and Baltic Sea the habitat types to be protected through this legislation are sandbanks and reefs. The conservation status of the individual habitats and species, its natural variability, and ongoing fishing activities are to be assessed. Fine-scale distributions of fishing efforts calculated from satellite-based vessel monitoring system (VMS) data in 2006 revealed overlap with Natura 2000 sites and hence potential conflicts between fisheries and nature conservation objectives. Preliminary assessments found the main potential conflicts to arise from bottom-contacting fishing gears on benthic habitats and species, and from by-catch of marine mammals and seabirds in static fishing gears. In the EMPAS project, the fishing effort patterns and conflict matrixes will be used in more detailed investigations of the effects of fisheries on habitats and species in and around the Natura 2000 sites. The best available scientific information will be the basis for the developments of management plans and management measures for fisheries in the German offshore Natura 2000 sites.

Keywords: MPA, Natura 2000, fishing effort, impact, management, North Sea, Baltic Sea.

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1. Introduction

The increasing human activities in the marine environment call for integrated assessments of the multiple pressures on the marine environment and for marine spatial planning, as stated in a variety of recent publications (e.g. Eastwood et al., 2007; St. Martin and Hall-Arber, 2007; Marine_Guidelines, 2007). The EU Action Plan on biodiversity entitled "Halting the loss of biodiversity by 2010 - and beyond - Sustaining ecosystem services for human well-being" [Brussels, 22.5.2006 COM(2006) 216 final] states that the halting of damage to ecosystems is a matter of urgency if we are to protect the future of the natural world, on account of both its intrinsic value (recreational and cultural value) and the services it provides (ecosystem services). Two EU Nature Directives have been the driving force for nature conservation and biodiversity protection: The Birds Directive, hereafter BD (79/409/EEC) and the Habitats Directive, hereafter HD (92/43/EEC) (English Nature et al., 2001a,b; Ritterhoff et al., 2004; von Nordheim et al., 2006a,b; Marine_Guidelines, 2007). The principal aim of both the BD and HD is to protect biodiversity on land and in the marine environment in EU Member States and to contribute to the implementation of the Convention on Biological Diversity1. In this context, the HD rules on the achievement and continuation of "favourable conservation status" of natural habitats and species of wild marine fauna and flora of community importance. With the BD and HD it is obligatory for Member States to designate areas in their national waters to protect threatened and declining species and habitats (Marine_Guidelines, 2007). The Special Protected Areas (SPAs) of the BD and the Special Areas of Conservation (SACs) of the HD constitute the elements of the European coherent network of protected areas called Natura 2000. The overall objective of the network is to stop the loss of marine biodiversity and to preserve/restore the structures and functions of the marine ecosystems. According to the EU Action Plan, Member States should complete their Natura 2000 site designations by 2008 and the marine network of well managed marine Natura 2000 sites is to be in place by 2012. The BD and HD/Natura 2000 sites have proven to be effective instruments for the establishment of MPAs in European seas (von Nordheim et al., 2006b; Anon., 2007; De Santo and Jones, 2007, in Press).

In May 2004, Germany as the first EU Member State nominated ten marine Natura 2000 sites to the European Commission covering 31.5 % of its offshore areas of the North Sea and the Baltic Sea (Figure 1a). Article 6(1) of the HD states that the Member States shall establish, if need be, appropriate management plans specifically designed for the Natura 2000 sites2. The management plans shall contain detailed descriptions of the site, the environmental assets, the conservation objectives as well as technical measures of conservation and restoration based on monitoring or scientific data (Czybulka and Bosecke, 2006).

Fisheries exert a particularly strong impact on marine ecosystems. Ecosystem effects of fishing include biomass removal of the target species; bycatch of marine mammals, seabirds, and fish; discarding of by-catch; and mechanical disturbance and damage of benthic communities by bottom trawling (Jennings and Kaiser, 1998; Jennings *et al.*, 2001; Kaiser and Jennings, 2002; Sewell and Hiscock, 2005; Kaiser *et al.*, 2005, 2006; Hiddink *et a*l., 2006, 2007; MAFCONS, 2006; ICES, 2006a, 2007a). The EU Marine Strategy and the EU Common Fishery Policy already require EU Member States to improve their fisheries management through their legislations. To be in compliance with the goals of Natura 2000, additional specific modifications to fisheries management practices are to be added.

In February 2006, International Council for the Exploration of the Seas (ICES) in collaboration with the German Federal Agency for Nature Conservation (BfN) started the project "Environmentally Sound Fishery Management in Protected Areas [EMPAS]" aimed at developing fisheries management plans of the Natura 2000 sites within the German EEZ of the North Sea and Baltic Sea. The EMPAS project serves as a pilot and guidance project for the development of the necessary management plans for Natura 2000 sites in the offshore EU waters. The EMPAS project was initiated in ICES for several reasons: Each EU Member State is responsible for maintaining or, where appropriate restoring habitats

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1 The Convention on Biological Diversity: http://www.cbd.int/convention/default.shtml

2 Habitats Directive: Art 6 – Management
http://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm#art6

and species protected under the Habitats and Birds Directives in marine environments of their EEZ, although the fisheries are regulated under EU Common Fishery Policy. Fishing activities are expected to have major impacts on certain habitats and species in marine Natura 2000 sites. At the start of the EMPAS project no data regarding the fine-scale spatial and temporal distribution of the international fishing effort were accessible from the German EEZ and therefore, no overall data integration could be conducted to evaluate its impacts on protected species and habitats within the Natura 2000 sites. The development of fisheries management plans for Natura 2000 sites need to be based on the best available scientific knowledge.

A specific research programme to identify conflicts with user interests in the Natura 2000 sites designated in the German EEZ has not yet been established. Such a programme is needed and to make progress in its development, fundamental data and information is required for the EMPAS project: a) habitats and species specific conservation objectives for each site, and b) fine scale and disaggregated spatial and temporal data describing fleet activity throughout the German EEZ. For each of the ten designated German Natura 2000 sites these data and information will allow the following questions to be answered by the EMPAS project:

1) to what extent do specific fishing activities represent a significant threat against reaching the conservation objectives of the NATURA 2000 sites?;
2) for identified conflicts between fisheries and the conservation goals, which management measures would reduce these conflicts to acceptable levels?

The answers will be based on existing data from fisheries and environmental research and, where appropriate, newly collected data, in particular from cooperation with fishers and the fishing industry.

"Favourable conservation status" includes population status, productivity, distribution range, health status, and future prospective of the natural habitat types and the species' habitats of concern. "Favourable conservation status" has proven challenging for scientists to interpret consistently and apply objectively (ICES, 2005, 2006a, 2007a,b; STECF, 2006). This paper describes and discusses the process undertaken by the EMPAS project towards the development of fisheries management plans for each Natura 2000 site in German offshore waters.

2. The process undertaken by the EMPAS project

2.1 Workshops

The EMPAS project runs for three years and includes three international workshops in 2006, 2007, and 2008. The project is composed of the following: During the first workshop/year the existing data and information on fishing activities and their effects were investigated (ICES, 2006b, 2007d). The focus of the second workshop/year is the final assessment of fishing activities and area-specific Natura 2000 objectives, as well as the analysis of the likely conflicts between them (ICES, 2007c). The focus of the third and final workshop/year will be the development and reconciliation of the management concept. ICES advice and plans for managing fisheries in each Natura 2000 site in the German EEZ are the intended end-product from EMPAS project.

The participants at the first two workshops were: 1) scientists nominated by their national ICES delegates, 2) scientists with special expertise in marine ecology, and 3) representatives from the fisheries organizations of the Netherlands and Denmark (ICES, 2006b, 2007c). These workshops identified the types of data, information, and analysis which will be important for the development of management plans at the third and final project workshop in April 2008.

The second EMPAS workshop had two primary goals (ICES, 2007c): 1) to review the information that had been collected during the past year, with regard to its adequacy for a full assessment of fishing activities; 2) to review the progress made on specifying the conservation objectives and targets for the Natura 2000 sites, with regard to their suitability to assess potential conflicts between fisheries and nature conservation objectives/targets.

2.2. Conservation Objectives

The Natura 2000 sites containing habitats and species to be protected are the basis for developing management plans, as these plans must ensure that the favourable conservation status of these features are not harmed by any fishing activities within the Natura 2000 sites.

In June 2007, the eight German proposed Sites of Community Importance (pSCI) in the EEZ (Figure 1a) were endorsed by the European Commission and they are now listed as SCIs (SCIs are later to become SACs). Therefore, for these sites, specific national ordinances have not yet been developed. However, as the responsible agency, BfN's principal conservation objectives are in the interim applicable to the protected marine mammals and the marine habitats (Box 1 and Box 2). Both spatial considerations of habitat extent and overall favourable conditions for population productivity and recruitment of the species to be protected are required by the HD (for a discussion, see ICES, 2007c).

Article 1 (e) and (i) of the HD defines the principles of favourable conservation status for habitats and species and explains the criteria which need to be assessed. These criteria for habitats are: (a) natural range and distribution area, (b) specific structure, and (c) function and conservation status of the typical species. For the protected species, these criteria are (a) population dynamics, (b) natural distribution range, and (c) long-term maintenance of sufficiently large habitats (Box 3). The conservation status of a natural habitat will be taken as 'favourable' when: (1) its natural range and areas it covers within that range are stable or increasing, (2) the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and (3) the conservation status of its characteristic species is favourable. The conservation status of a species will be taken as 'favourable' when: (1) population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and (2) the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and (3) there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The HD legally distinguishes two cases in which the conservation status of habitats and species is expected to be assessed. Member states have to monitor and report regularly to the EU Commission according to Art. 11 and 17 of the HD on the conservation status of the habitats and species regardless of whether they are situated inside a Natura 2000 site or outside. If the overall conservation status of a species or habitat in a given biogeographical region is not favourable, the conservation measures must be improved. Additionally, all projects that - individually or in combination with others - are likely to have a significantly adverse effect on the integrity of a designated 'Natura 2000' site in the light of conservation objectives of habitats and species (Art. 6 (2) and (3)), should also be assessed (Box 4).

Marine habitats to be protected: In the German EEZ of the Baltic Sea and North Sea only two habitat types, sandbanks and reefs occur and have been relevant for the designation process of marine Natura 2000 sites. The distribution of reefs and sandbanks in the German EEZ is shown in Figure 1b and 1c and the respective habitat size within the sites is given in Table 1 and 2. Sandbanks and reefs serve several important ecological functions, such as offering protection for rare and threatened species as well as providing breeding nursery feeding and resting habitats. These habitats host important biotope types and communities of marine animal and plant species. The conservation status of habitats is not just related to the physical integrity of the habitat, but also to the conservation status of the characteristic species of animal and plants. In most cases, however, there is a lack of knowledge of the characteristic species of for example fish and seabirds associated with the marine Nature 2000 sites.

Species to be protected: The species listed in Annex II of the Habitat Directive currently represents only a small share of threatened and declining species in the European Sea. For example only anadromous migratory fish species are listed in Annex II (Box 5), but no marine fish species and invertebrates. In the German EEZ three marine mammals (harbour porpoise, grey seal, harbour seal) occur regularly. Due to the stringent criteria of Article 4 (1) of the habitat directive, in the Germany EEZ only harbour porpoise qualified for the specific designation of a single SCI in the North Sea, an

area west of the island of Sylt (*Sylter Outer Reef*). It was designated to protect an essential breeding habitat of harbour porpoises. In the Baltic Sea the *Odra Bank* was selected to protect the most threatened harbour porpoise population of Europe (see below). Nevertheless, all Annex II species including harbour porpoises, which occur in Natura 2000 sites, have to be protected in the same way as in areas exclusively selected for them. Harbour porpoises are also listed in Annex IV of the HD which according to Art. 12 obliged the member states to take the requisite measures to establish a system of strict protection in their natural range.

Little is known about the status of the stocks and even less about the habitat requirements of the protected migrating anadromous fish species (e.g. Annex II of Habitats Directive). Therefore, only preliminary estimations by fisheries experts exist of the population size and ideas about tolerable losses, e.g. due to by-catch mortality. However, given that the conservation status of these species is obviously not favourable, it is recommended by Fricke (2007, in press) that there be no target fisheries for these species. Furthermore, preliminary recommendations for tolerable losses due to by-catch have been developed (Box 5).

The conservation objectives for three selected Natura 2000 sites as an example are described in the following (for more complete descriptions, see Krause *et al.*, 2006):

SCI *Sylter Outer Reef*: The SCI *Sylter Outer Reef*, covering an area of 5314 km^2, is characterized by the best presentation of the habitat type reef mainly along the ancient *Elbe River* (Figure 1a). According to the HD not only the physical integrity of the reefs, Habitat code 1170, are to be protected, but also the associated communities of Flora and Fauna.

SCI *Sylter Outer Reef*.contains the largest continuously documented concentration harbour porpoises in the entire *Eastern German Bight* with regular mother calf sightings indicating, that this area is relevant as a mating area for this species (Figure 1d). The harbour porpoise population in this area has been estimated to comprise 12,000-13,000 individuals. The concentration of harbour porpoises is up to ten times higher than in surrounding waters. Here, the definition of protection objective needs to be based on the evaluation of natural mortality rates and mortality caused by fishing activities and the derived thresholds for maximum fisheries-dependent impact. The evaluation of the natural mortality and fishing mortality will be a difficult task. In most population analysis of commercial fish stocks, the natural mortality are supposed to be constant The by-catch mortality caused by fisheries can only estimated, by monitoring programs, which are mandatory according to EU council regulation 812/2004 (responsible authority BMELV/BFA-FI).

The favourable conservation status of sandbanks is characterized by the presence of large and long living benthic invertebrates. The *Amrum Bank* is another important feature within the SCI *Sylter Outer Reef*. which is a typical sandbank characterised by high biotope and habitat diversity. This habitat is important for long lived mussel species and for endo-benthic fauna adapted to high sediment dynamic.

SCI *Pomeranian Bay with Odra Bank*: The *Odra Bank* is the central morphological structure in the site with an area of 1102 km^2. This structure is a typical large sandbank according to the definition of the HD, Habitat code 1110, and the best example of this habitat type in the entire Baltic Sea. It rises significantly from the bottom of the *Pomeranian Bay* (Figure 1c and Table 2) and serves both as a wintering area for numerous bird species (see below), as a feeding and growth (nursery) area for young fish, and is characterized by a high abundance of snails *(Hydrobia ulvae)* and mussels *(Mytilus edulis, Cerastoderma lamarcki, Mya arenaria, Macoma balthica)* representing an important food resource for fishes and seabirds and habitat for the bottom fauna. Because it extends into shallower water levels, it offers a place of refuge and regeneration before and after oxygen deficiency events, as well as a starting point for the recolonisation of damaged areas (Gosselck *et al.*, 1998). In addition, the *Odra Bank* could retrieve its importance as grazing area for the actual extinct Baltic sturgeon (*Acipenser oxyrinchus*) if its re-establishment under an on-going BfN project will be successful in the future. The site is of particular ecological importance as a nursery and spawning ground for plaice (*Pleuronectes platessa*) and especially for turbot (*Psetta maxima*). Because of its exceptional ecological significance, the entire sandbank, its slopes and the immediate surrounding areas of the *Pomeranian Bay* are proposed as a complex protected site.

The boundaries of the SCI enclose the areas with comparatively very high concentrations (for the Baltic Sea) of harbour porpoises (Figure 1e). The only marine mammal in the *Odra Bank* listed in HD Annex II is the harbour porpoise. These are probably individuals of the harbour porpoise population of the eastern Baltic Sea (Huggenberger *et al.*, 2002), which is considered highly endangered with approximately 600 individuals only. This population is morphologically and genetically distinct from the western Baltic Sea population (Huggenberger *et al.*, 2000; Tiedemann *et al.*, 1996). There seems to be a very limited genetic exchange between the populations presumably caused by spatial separation of the reproduction areas. The *Darss Sill*, which strongly reduces the inflow of marine water masses into the Baltic Sea, is assumed to function as an obstacle that separates the populations.

According to expert opinions a population of marine mammals in a status close to their carrying capacity could tolerate an anthropogenic mortality of 1-2 %. A general accepted reference value suggested by the Agreement on the Conservation of Small Cetaceans of the Baltic and North Sea ASCOBANS3 is an anthropogenic induced mortality of 1.7 %. As a simplification in general 1 % of the mortality is accounted to fisheries mortality and 0.7 % for all other sources of anthropogenic induced mortality (oil- and gas exploration, shipping, seismic and pollution). These levels of additional mortality are only acceptable, for populations, which is close to its carrying capacity (>80% K). As the Baltic Sea population of the harbour porpoise is far away from its carrying capacity, the acceptable anthropogenic mortality is close to 0.

Protection of seabirds: SPA *Pomeranian Bay and* SPA *Eastern German Bight* achieved in September 2005 the national legal status of a nature reserve (IUCN category IV) by the German Government. The conservation objectives for the two German SPAs are contained in §3 of their legal German ordinance (Box 6). They are characterized by large concentrations of migratory waterbirds, including several species listed in Annex I of the Bird Directive (Figure 1f, Table 3 and 4). High abundance of black-throated and red-throated divers, Slavonian and red-necked grebes have been important for especially the designation of the SPA *Pomeranian Bay*. The site is of specific importance for the population of the Slavonian grebe, by harbouring more than 85 % of the individuals of the German population. Therefore there is a specific national responsibility to ensure the protection of this species. Additionally, the site is an important area for hundreds of thousands of sea ducks like common scoters, velvet scoters and long-tailed ducks. The Odra Bank, a topographic feature with water depth below 10 m is of specific ecological significance, with its function as feeding habitat for these species, which feeds on benthic invertebrates.

To define the "favourable conservation status" of the species, it has to be distinguished between species with increasing and declining population trends. According to Wetlands International (2006) several bird species in the area show a declining population trend (e.g. Black throated diver, red necked grebe, Slavonian grebe, great crested grebe, long-tailed duck, little gull). Declining populations are indicating that a species is in an unfavourable status and all Member States have to take measures to stop population reduction (Table 3 and 4).

2.3. Fine-scale distributions of the fisheries

The methods for calculations of the international fishing effort distributions presented in the following are described in Appendix 1.

In the German EEZ, fleets behave differently and partially operate exclusively of each other. Beam trawling is restricted to the North Sea since beam trawling is forbidden in the Baltic Sea. In the North Sea vessels with more than 300 HP are not permitted to trawl inside the so-called "Plaice Box" established to protect nursery areas for flatfish (Sorensen, 2006). Consequently, the distribution areas of large and heavy rigged beam trawlers (TBBL and TBB_hg) are west of the plaice box and comply to a fairly large degree with the delineation of the plaice box (Figure 2a,c). Small beam trawlers fish mainly in the coastal zone east of the Plaice box (Figure 2b). In the North Sea, otter trawl fishing is

3 The ASCOBANS web-page: http://www.ascobans.org/index0101.html

concentrated offshore with a preference for an area north of 55°N ("White Bank"), whereas it is the major fishing activity in the Baltic Sea, both inshore and offshore (Figure 2d). Fishing activities with pelagic otter board trawlers is spatially concentrated in an area north of Rügen Island (Figure 2e). In the North Sea, seiners (SX, Figure 2f) apparently avoid areas of high beam trawl effort. In the Baltic Sea, seiners operate most intensively east of 12° E where otter board trawling effort is relatively low. Offshore gill net fishing is concentrated in two areas in the Baltic, i.e. *Adler Ground* and *the Western Rönnebank* in the *Pomeranian Bay* and *the Kriegers Flak* area (Figure 2h), whereas only minor activity is recognized in the North Sea. Most of the gill net fisheries in the Baltic Sea are performed by vessel smaller than 15 m length without mandatory use of VMS. Therefore further data of aerial surveys and logbook data have to be analysed to study the potential conflicts between gill net fishing activities and the distribution of sea birds and marine mammals.

The designated Natura 2000 sites are affected by fishing activities in different intensity by various gears. For example the SCI Sylter Outer reef is affected by bottom trawls, beam trawlers, whelkers, and potters in very different ways both in terms of demersal trawling activities (Figure 2a,b,c,d) and steaming (Figure 2j) especially between 7° to 7.5° eastern longitude. Fishing for common shrimp (TBB) is concentrated very close inshore and extending into the designated area. Whereas large beam trawlers avoid operating in reef areas (TBBL), small beam trawlers (TBB) utilize relatively evenly all types of bottom habitat within the distance range they work in (Figure 3). Only heavily rigged beam trawlers (TBB_hg) specifically target the reef area (Figure 2c) as well as potters/whelkers (Figure 2i). This indicates that the different reef areas probably inhabit very different types of substrate and communities. In the Baltic Sea there is high intensity of bottom set gillnet fishing in the protected areas of the Pomeranian Bay (Figure 2h). In both the North Sea and the Baltic Sea fishing with small boats are not included in the VMS, therefore, gill net fishing efforts calculated from VMS data and presented in Figure 2h are underestimates. In the Baltic Sea small fishing boats (<15 m) without VMS constitute the majority of the fishing fleet using gill nets.

2.4. Potential conflicts between nature conservation objectives and fishing activities

Developing positive direction or values beyond thresholds for the natural conditions of the habitats and species is critical, but in the marine environment can only be achieved if the effects of past and existing fishing activities on marine ecosystems are taken into account. Principal effects of different fishing gear are known (ICES, 2006a, 2007a,c,d). However, negative impacts on the conservation targets are depending on a number of factors:

- Type of gear
- Temporal and spatial intensity of the fishing activities
- Temporal and spatial distribution of protected species
- Spatial overlap of fishing activities with protected habitats
- The initial level of physical and biological complexity of the protected habitats

Through previous studies, the major fields of interaction between fishing activities and nature conservation objectives have been identified which are within the EMPAS project being evaluated for the designated Natura 2000 sites.

Bottom contacting gears: A consequence of fishing with bottom contacting gears on sandbank and reef habitats is the physical disturbance to the substrate caused by trawling. Effects are the restructuring of the sediments, the removal of large features, the reduction of structure-building organisms followed by a general reduction of habitat complexity and changes in the benthic communities (e.g., ICES, 2002, 2003, MAFCONS, 2007).

For sandbanks, the physical loss or dispersal of sediment due to fishing is not likely to be an important consideration. In contrast, there is evidence that the physical structure of stone and boulder reefs have in the past been adversely affected by towed gears, and the prevention of further physical damage to the habitats and the associated communities will need to be addressed. Bottom trawling increases the mortality of target and non target species, but also of benthic species that are not caught by the net, but

damaged by the passing fishing gear. The impact of demersal trawling on the benthic community increases with body size and fragility of the morphology as well as the decreasing mobility of the benthic organisms. The selective mortality of benthic invertebrates has reduced the abundance of large slow growing species and shifted the benthic communities to dominance of smaller quick growing species with high rates of reproduction in several areas of the North Sea (Jennings *et al.*, 2001; Duplisea *et al.*, 2002).

The HD does not require a restoration of sandbank and reef habitats to a pristine state (whatever that may be) but it requires their long term persistence in a favourable conservation status. For species listed in the Annexes to the Directive, it will be necessary to ensure that current status will be maintain in the longer term. Marine monitor programmes to measure the 'favourable conservation status' have only recently started, but the traditional approach of ICES (in a fisheries context) is to compare the productivity / recruitment of the population with its abundance or biomass (ICES, 2007c). Comparable measures for poorly studied invertebrate populations might include the likelihood of fertilisation as a function of the density of the species. For typical species it will be necessary to identify reasonable indicators of productivity and population status (abundance/biomass) and whether the relationship between those factors is linear, concave or convex. For non-linear relationships, the position of any inflexion point can be used to inform the limit reference point for population size. Future fisheries management plans developed for Natura 2000 sites will need to ensure that anthropogenic caused mortality rates are low enough to maintain these populations.

Bottom set gill net: The fishery with bottom set gillnet is responsible for high by catch rate of seabirds in coastal waters of the Baltic Sea. Highest bycatch rates occur in areas, where fishing grounds and feeding areas of birds overlap. There is no detailed information on bycatch rates of seabirds in the German EEZ of the Baltic Sea yet, but the high spatial and temporal overlap between resting, moulting and wintering birds and fishing activities of bottom set gill net suggests high potential conflicts between fishing activities and nature conservation objectives in these areas. It is estimated that every year more than 10,000 wintering and resting seabirds in the *Pomeranian Bay* get in entangled in bottom set gill net (Erdmann *et al.*, 2005; IfaÖ, 2007, pers. comm.). Probably most affected here are piscivorous (fish feeding) birds like divers, grebes, mergansers, guillemots, cormorants as well as sea ducks and diving ducks feeding on macrozoobenthos at the seafloor. In the area of the southern Baltic sea most affected species are long-tailed ducks, common scoter, black scoter and in some areas eider and scaup (Erdmann, 2006). Highest by-catch rates occur in areas, where fishing grounds and feeding areas of birds overlap. There is no detailed information on by-catch rate of seabirds in the German EEZ of the Baltic Sea yet, but the high spatial and temporal overlap between resting, moulting and wintering birds and fishing activities of bottom set gill net is suggesting high potential conflicts between fishing activities and nature conservation objectives in these areas (Figure 1f and 2h). The Federal Agency for Nature Conservation has initiated a research project to collect data about the fine-scale spatial and temporal distribution of fishing effort and an observer program to study the by-catch mortality of resting and wintering seabirds in the Pomeranian Bay.

Bottom set gill net are responsible for high by-catch rates of harbour porpoise in the Baltic Sea. The number of harbour porpoises by-caught in the German gill net fishery has been estimated by Rubsch and Kock (2003) to 57 individuals in the western Baltic Sea and 25 animals in central Baltic Sea. Berggren *et al.* (2002) developed a model to study the impact of anthropogenic mortality on the population of harbour porpoise in the central Baltic Sea. They found that an anthropogenic caused mortality of two animals per year resulted in a negative population trend in this species. By-catch number is prerequsite to estimate by-catch mortality of harbour porpoises in the gill net fishery. As mentioned above the population of harbour porpoise in the Central Baltic Sea is very small (population size estimated to 600 individuals). Irrespective of natural variability the conservation status of this population is not favourable.

3. Future directions

3.1 Interactions between conservation objectives and fleet distributions

Analysis and visualization of fine scale spatio-temporal data and information about fishing activities are essential for stakeholders, the public and managers in order to evaluate the ecological effects and socio-economic consequences of the human activities in the marine areas (this paper; Eastwood *et al.*, 2007; St. Martin and Hall-Arber, 2007). The fine scale distributions of the international fishing effort presented in this paper shows potential conflict/no-conflict zones in relation to the demarcated boundaries of SPAs and SCIs in the German EEZ. The presented fine scale fishing patterns by fishing métiers will be a basis for more detailed investigations of the fisheries and the conflicts with conservation objectives in the German Natura 2000 sites.

The most relevant interactions between fishing activities in the German EEZ and the conservation objectives of the Natura 2000 sites have been identified by the EMPAS project. The future task will be assessments of the level of impact exerted by the identified fishing gears on species and habitats. All types of fishing techniques which have contact with the seabed have potential to cause adverse effects on benthic species and habitats (Kaiser *et al.*, 2005, 2006; ICES, 2006a, 2007a). Recent reviews, meta-analyses, and assessments of the potential for adverse effects of fishing in the North Sea suggest that dredges and beam trawls are the most damaging gears, but that the consequences of their use for benthic habitats depends on the intensity of trawling, the design of the trawl and mesh and the habitat/bottom type and structure (e.g. Hiddink *et al.*, 2006, 2007; ICES, 2006a, 2007a).

Concerning the protected anadromous fish species and marine mammals instruments for an improved by-catch control and further analysis of food competition between those species and fisheries are necessary. The later is also of concern for declining sea bird species. For marine mammals limits of tolerable by-catch rates for harbour porpoises are already given by the International Whaling Commission (IWC) and by the ASCOBANS.

With respect to the structure and function of the habitats, the HD requires the maintenance or if necessary the restoration of the favourable conservation status of habitats and species. With current ecological theory, and knowledge gained from the use of benthic community indicators in assessment and monitoring of environmental quality, it should be possible to find community indicators that could be used in the assessment of habitat quality in the Natura 2000 sites (ICES 2007c). It will be a priority to see if it is possible to use existing information to determine two points. First, do the current benthic communities in the Natura 2000 areas display a conservation status which will persist in the longer term or in states where they are unstable and likely to get worse? Second, even if the current state is stable and particularly if it is already poor, is the rate of impact of fishing activities on these habitats likely to hinder an improvement of its status to more favourable one.

The benefit of using satellite track data like the VMS is a detailed analysis of the fine-scale distribution of fishing effort. However, more detailed information from the VMS or other data collection systems might be necessary for the fine scale analysis. For example in the gillnet fishery in the Baltic Sea, most vessels are below 15 m and therefore not equipped with the VMS systems. One important source for more detailed information are the fishermen, themselves. In the cooperation process with the fishermen, finer scaled information on the spatial and temporal distribution and the impact on species and habitats (e.g. bycatch of seabirds and mammals) will be further investigated and clarified. In the ongoing project, fishermen or their representatives have participated by gathering of their own fishing information from sea charts and plotter tracks from in and around the Natura 2000 sites. In comparison to VMS, which only update positions every 1-2 hours, such data is more precise and may complete the picture of how the areas are used and further improve the ability to clarify if there are conflicts between conservation and fisheries interests.

3.2 Towards management plans for the Natura 2000 sites

The analysis of the critical levels of fisheries impact will as far as possible be carried out in cooperation with fisheries representatives and fishermen to clarify uncertainties, errors and gaps in the available fisheries data. The results of these studies will be important in the development of management plans and co-management solutions.

In areas with negative impact of fishing activities on typical species or communities and/or impacts on habitats it will be necessary to implement measures to reduce the effects to meet the conservation objectives. It will be necessary to explore, on a case-by-case basis, the most efficient way to achieve this reduced mortality and negative impact. Options could include:

- Gear substitution (alternative, ecologically sound fishing gears, e.g. fish traps instead of gillnets in the Baltic Sea)
- Gear modification
- Temporal and spatial zoning concepts within Natura 2000 sites

BfN have recently initiated projects to identify ecologically sound fishing methods in the North Sea and the Baltic Sea to harmonize fishing activities and nature conservation objectives. In the Pomeranian Bay a pilot study has been set up to study the applicability of ecologically sound fish traps as an alternative to gill set nets. Eight fishery enterprises are taking part in this study and will compare fish traps with bottom set gillnets regarding selectivity on target and non-target species, catch efficiency and effects on habitats and species. Initial results are promising, indicating a reduction in bycatch of undersized target species, non target species, and impact on benthic habitats.

If no measures are required there is still a need for a description and determination of the status quo, i.e. the baseline characteristics of the fishery relative to concerned benthic communities/habitats.

The EU Common Fisheries Policy (CFP) already allows for better integration of environmental protection requirements into fisheries management. It therefore contributes directly to the achievement of the objectives of both the BD and HD (Marine_Guidelines, 2007). In the EMPAS project, fishing effort patterns and conflict matrixes will be used in more detailed investigations of the effects of the ongoing fishing activities on habitats and species in and around the Natura 2000 sites. The best available scientific information will be the basis for the development management plans and management measures for fisheries in the German offshore Natura 2000 sites.

Acknowledgements

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Boxes:

Box 1. Principle conservation objectives of the marine habitats 'reefs' and 'sandbanks'

Conservation objectives for the Habitat Type 1170 'Reefs'
… are the conservation and/or recovery of
- the specific ecological functions, the characteristic habitat structure and its extent (area)
- the characteristic morpho-dynamic and general and local currents together with its characteristic and endangered communities and species
- Conservation of the characteristic benthic communities and species within their natural occurrence and abundance, e.g. anemones, tunicates, bryozoas and fishes

Conservation objectives for the Habitat Type 1110 'Sandbanks'
… are the conservation and/or recovery of
- the current ecological quality, habitat structure and surface area of the habitat type
- the characteristic morphological and hydrological dynamics and the typical species and organismic communities in their largely natural population dynamics
- the characteristic benthic communities of habitat 1110 and its characteristic species

Box 2. Principle conservation objectives of the Harbour Porpoises

Conservation objectives for Harbour Porpoises (*Phocoena phocoena*)
… are the conservation and/or recovery of
- the existing stock recognising their natural population dynamics and fluctuations
- their feeding, migration and reproduction habitats with preservation of their functional integrity within the site and the possibility to migrate to other sites outside
- the natural genetic diversity
- the occurrence and abundance in space and time of their food chain

Box 3. Definition of favourable conservation status for habitats and species according to the Habitats Directive (92/43/EEC)

Extractions from the Habitats Directive (92/43/EEC):

Art. 1 (a) conservation means a series of measures required to maintain or restore the natural habitats and the populations of species of wild fauna and flora at a favourable status as defined in (e) and (i);

Habitats:

Art. 1 (e) conservation status of a natural habitat means the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory referred to in Article 2.

The conservation status of a natural habitat will be taken as 'favourable' when:

- its **natural range and areas** it covers within that range are stable or increasing, and
- the **specific structure and functions** which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the **conservation status of its typical species** is favourable as defined in (i);

Species:

Art. 1 (i) conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory referred to in Article 2;

The conservation status will be taken as 'favourable' when:

- **population dynamics** data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the **natural range** of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and there is, and will probably continue to be, a **sufficiently large habitat** to maintain its populations on a long-term basis;

Box 4. The protection level within Special Areas of Conservation (SAC)

The protection level within Special Areas of Conservation (SAC) has been defined according to Article 6 the habitats Directive (Council Directive 92/43/EEC):

1. For special areas of conservation, Member States shall establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans, and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites.
2. Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive.
3. Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.
4. If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.

Box 5. Population size estimation, recommendations for fisheries and tolerable bycatch mortality for anadromous Annex II fish which have to be protected in marine habitats according to the Habitats Directive. NS=North Sea, BS = Baltic Sea. Population data and occurrence according to ANFIOS (Thiel & Winkler, 2007).

	Estimated total population size	Occurence in Natura 2000 sites in the German EEZ	Target fisheries recommended	Tolerable Loss as bycatch (% of population)
Petromyzon marinus	NS: 2000-5000 BS: 20-200		no	NS: 10% BS: 0%
Lampetra fluviatilis	NS: 10.000 BS: 350.000-900.000	SPA Eastern German Bight, Sylt Outer Reef	no	NS: 10% BS: 3%
Acipenser sturio/ oxyrinchus	reintroduction under way	SPA Pommeranian Bay, Odra Bank	no	NS: 0% BS: 0%
Alosa alosa	NS: 250-600 BS: 1-200		no	NS: 0% BS: 0%
Alosa fallax	NS: 3000-15.000 BS: 150-750	Borkum Reef Ground, SPA Eastern German Bight, Sylt Outer Reef, SPA Pommeranian Bay, Odra Bank	no	NS: 10% BS: 0%
Salmo salar	? (stockings)		no	NS: 0% BS: 0%
Coregonus oxyrhynchus	? (stockings)		no	NS: 0%

Box 6. Summary of the conservation objectives in § 3 of the ordinance for the SPAs Pomeranian Bay and Eastern German Bight

. . . are the conservation and/or recovery of

- the qualitative and quantitative composition of bird species and populations, especially of those declining within their bio-geographic region
- the direct and indirect feeding basis of the occurring bird species
- the characteristic features of the area, in particular salinity and geo-and hydro-morphological factors
- contiguous habitats within the site with their specific ecological functions and interactions
- the natural quality of the habitats, in particular their protection from pollution and disturbance

Tables:

Table 1. Relevant species and habitats protected by the Habitats Directive (HD) in SCIs in the German EEZ of the North Sea. "i" = estimated population size; number ranges given after "i" represents the estimated population size range (class); "P" = means the species is present in the area (occurrence verified, but no estimated numbers). An empty cell for a species means that the population size is unknown.

Common name	Scientific name	Borkum Reef Ground	Doggerbank	Sylter Outer Reef
Habitat types, listed in Annex I of the HD 92/43/EEC				
Reefs (Code 1110) [ha]		2277	0	15351
Sandbanks (Code 1170) [ha]		52104	162370	8716
Marine mammals, listed in Annex II of the HD 92/43/EEC				
Grey seal	*Halichoerus grypus*	i = P		i = 11-50
Harbour porpoise	*Phocoena phocoena*	i = 51-100	i = 501-1000	i = 1001-10000
Harbour seal	*Phoca vitulina*	i = 251-500	i = P	i = 1001-10000
Fishes, listed in Annex II of the HD 92/43/EEC				
Twaite shad	*Alosa fallax*	i = P		i = P
River lamprey	*Lampetra fluviatilis*			i = P
Atlantic sturgeon	*Acipenser sturio*			

Table 2. Relevant species and habitats protected by the Habitats Directive (HD) in SCIs in the German EEZ of the Baltic Sea. "i" = estimated population size; number ranges given after "i" represents the estimated population size range (class); "P" = means the species is present in the area (occurrence verified, but no estimated numbers). An empty cell for a species means that the population size is unknown.

Common name	Scientific name	Adler Ground	Fehmarn Belt	Kadet Trench	Pomeranian Bight with Odra Bank	Western Rönne Bank
Habitat types, listed in Annex I of the HD 92/43/EEC						
Reefs (Code 1110) [ha]		11046	5701	2344	0	6531
Sandbanks (Code 1170) [ha]		8657	446	0	47992	0
Marine mammals, listed in Annex II of the HD 92/43/EEC						
Grey seal	*Halichoerus grypus*	i = P				
Harbour porpoise	*Phocoena phocoena*	i > 10	i > 100	i > 10	i = 251-500	i = 11-50
Harbour seal	*Phoca vitulina*		i = P			
Fishes, listed in Annex II of the HD 92/43/EEC						
Twaite shad	*Alosa fallax*				i = P	
River lamprey	*Lampetra fluviatilis*					
Atlantic sturgeon	*Acipenser sturio*				i = P	

Table 3: Individual numbers of relevant bird species protected by the Birds Directive in the SPA Eastern German Bight in the German EEZ of the North Sea according to Sonntag *et al.* (2007). Total German population size from Wahl (2003). Population trends from Wetlands International (2006). STA = stable, INC = increasing. Question mark = uncertain or unknown.

Common name	Scientific name	Total Population (Germany)	SPA Eastern. German Bight	Population trend
Red-throated Diver	*Gavia stellata*	14500	4400	**STA**
Black-throated Diver	*Gavia arctica*	3250	500	**DEC**
Great Crested Grebe	*Podiceps cristatus*	28000		**DEC**
Fulmar	*Fulmarus glacialis*	40200	X	**?**
Gannet	*Sula bassana*	2700	160	**?**
Common Scoter	*Melanitta nigra*	179000	X	**STA**
Little Gull	*Larus minutus*	2100	220	**INC**
Black-headed Gull	*Larus ridibundus*	218157	X	**DEC**
Common Gull	*Larus canus*	85000	11000	**DEC?**
Herring Gull	*Larus argentatus*	115000	35000	*
Lesser Black-backed Gull	*Larus fuscus*	62889	3600	**
Great Black-backed Gull	*Larus marinus*	18500	1300	**INC**
Black-legged Kittiwake	*Rissa tridactyla*	15100	2400	**?**
Sandwich Tern	*Sterna sandvicensis*	4470	200	**STA**
Common Tern	*Sterna hirundo*	6330	100	**STA**
Arctic Tern	*Sterna paradisaea*	2750	800	**?**
Guillemot	*Uria aalge*	33500	2600	**?**
Razorbill	*Alca torda*	8300	X	**?**

**Subspecies: argentatus* INC / *argenteus* DEC
***Subspecies: intermedius* INC / *fuscus* DEC

Table 4: Individual numbers of relevant bird species protected by the Birds Directive in the SPA Pomeranian Bay in the German EEZ of the Baltic Sea according to Sonntag *et al.* (2007). Total German population size from Wahl (2003). Population trends from Wetlands International (2006). STA = stable, INC = increasing. Question mark = uncertain or unknown.

Common name	Scientific name	Total Population (Germany)	SPA Pomeranian Bay	Population Trend
Red-throated Diver	*Gavia stellata*	14500	750	**STA**
Black-throated Diver	*Gavia arctica*	3250	700	**DEC**
Slavonian grebe	*Podiceps auritus*	575	500	**DEC**
Red-necked Grebe	*Podiceps grisegena*	1000	170	**DEC**
Great Crested Grebe	*Podiceps cristatus*	28000	20	**DEC**
Common eider	*Somateria mollissima*	350000	130	**INC**
Long tailed duck	*Clangula hyemalis*	596000	130000	**DEC**
Common scoter	*Melanitta nigra*	179000	170000	**STA**
Velvet scoter	*Melanitta fusca*	51000	43000	**STA**
Cormorant	*Phalacrocorax carbo*	42500	100	**STA**
Black-headed gull	*Larus ridibundus*	218157	20	**INC**
Little gull	*Larus minutus*	2100	130	**DEC**
Common gull	*Larus canus*	85000	320	**DEC ?**
Herring gull	*Larus argentatus*	115000	1000	*
Lesser Black backed gull	*Larus fuscus*	62889	20	**
Great Black backed gull	*Larus marinus*	18500	150	**INC**
Guillemot	*Uria aalge*	33500	550	**?**
Razorbill	*Alca torda*	8300	110	**?**
Black Guillemot	*Cepphus grylle*	750	200	**?**

**Subspecies: argentatus* INC / *argenteus* DEC
***Subspecies: intermedius* INC / *fuscus* DEC

Legends to figures:

Figure 1a. The ten nominated Natura 2000 sites in the German EEZ. North Sea: 1. SCI Doggerbank; 2. SCI Sylt Outer Reef; 3. SCI Borkum Reef Ground; 4. SPA Eastern German Bight. Baltic Sea: 1. SCI Fehmarn Belt; 2. SCI Kadet Trench; 3. SCI Western Rønne Bank; 4. SCI Adler Ground; 5. SCI Pommeranian Bay with Odra Bank; 6. SPA Pommeranian Bay. Both SPAs are implemented as national nature reserves (IUCN category IV) and they have been designated to the OSPAR/HELCOM MPA network. SCI="Site of Community Interest". The SCIs are to become the SACs when approved by the EC. The Special Protected Areas (SPAs) of the Birds Directive together with the Special Areas of Conservation (SACs) of the Habitats Directive constitute the elements of Natura 2000. For more information see: www.habitatmare.de.

Figure 1b. Occurrence of the Annex I habitat types "Sandbanks which are slightly covered by sea water all the time" (Natura 2000-Code 1110) and "Reefs" (Natura 2000-Code 1170) in the German EEZ in the North Sea and Sites of Community importance (SCIs) under the Habitats Directive.

Figure 1c. Occurrence of the Annex I habitat types "Sandbanks which are slightly covered by sea water all the time" (Natura 2000-Code 1110) and "Reefs" (Natura 2000-Code 1170) in the German EEZ in the Baltic Sea and Sites of Community importance (SCIs) under the Habitats Directive.

Figure 1d. Summer distribution of harbour porpoise and sightings of calves in the German EEZ of the North Sea by aerial surveys in May to August 2002 and 2005 (pooled data).

Figure 1e. Summer distribution of harbour porpoise in the German EEZ of the Baltic Sea by aerial surveys in May to August 2002 and 2003 (pooled data).

Figure 1f. Distribution of all bird species relevant according to the Birds Directive (modified from Garthe 2006). Areas in black indicate areas that were not studied sufficiently and/or were outside the scope. The 12-miles zone is indicated by the dashed line, the border of the German EEZ by the continuous red line. Blue hatches: Special Protection Area (SPA) Pomeranian Bight

Figure 2a. Calculated densities of total fishing time (hours) by large beam trawlers (TBBL) in 2006. Large trawlers (>300 Hp) with demersal gear are not permitted to operate within the Plaice Box, a flatfish nursery area. However, special permits may be issued under certain conditions forcing the vessels to operate like 'normal' beam trawlers.

Figure 2b. Calculated densities of total fishing time (hours) by small beam trawlers (TBB) in 2006.

Figure 2c Calculated densities of total fishing time (hours) by extra heavy beam trawlers (TBB_hg) in 2006.

Figure 2d. Calculated densities of total fishing time (hours) by demersal otter board trawlers (O/P_TB) in 2006. Include single and paired vessel trawling.

Figure 2e. Calculated densities of total fishing time (hours) by pelagic otter board trawlers (O/P_TM) in 2006. Include single and paired vessel trawling.

Figure 2f. Calculated densities of total fishing time (hours) by unspecified seiners (SX) in 2006.

Figure 2g. Calculated densities of total fishing time (hours) by vessels with unspecified fishing gear (TX) in 2006.

Figure 2h. Calculated densities of total fishing time (hours) by gill netters (GN) in 2006.

Figure 2i. Calculated densities of total fishing time (hours) by whelkers/potters (FPO) in 2006.

Figure 2j. Calculated densities of total steaming time (hours) in 2006.

Figure 3. Beam trawling around the Natura 2000 site Sylter Outer Reef (pSCI). A: Trawling densities rescaled from Figures 2a and 2b as hours per day. B: Point mode analysis of beam trawling in relation to sandbanks and reefs.
Grey line= the Plaice box , Blue line=sandbanks, Black line=reef areas. TBB = small beam trawlers, TBBL = large beam trawlers. Due to overlay some values for TBBL are not shown.

Figures:

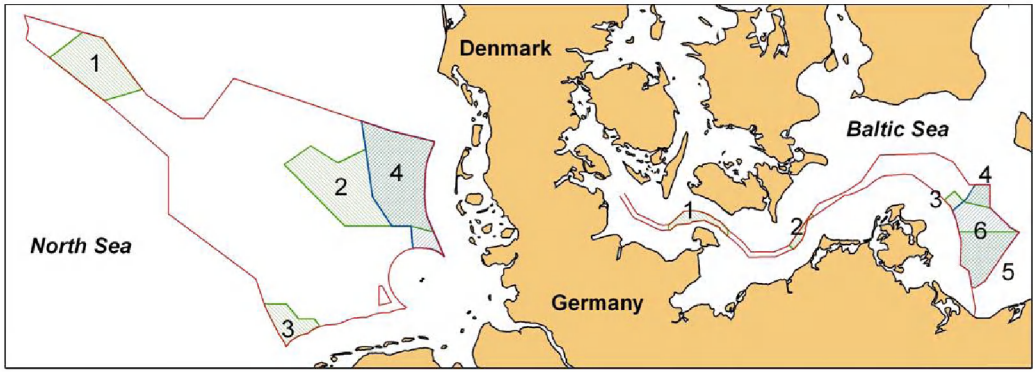
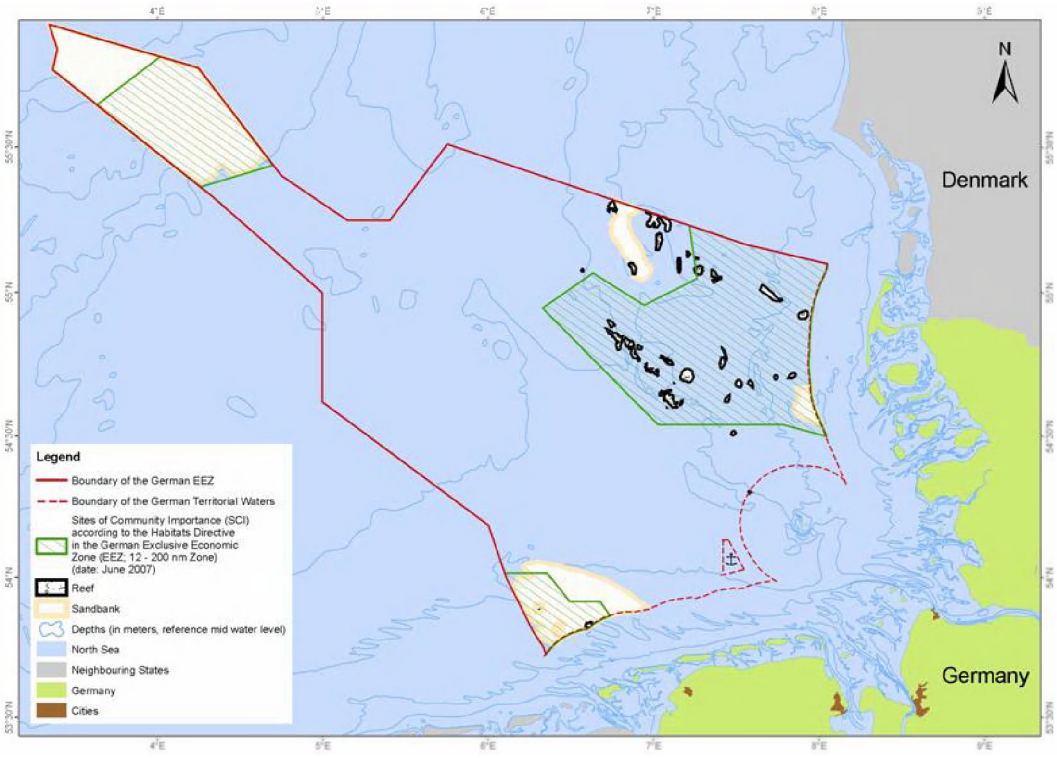


Figure 1a.



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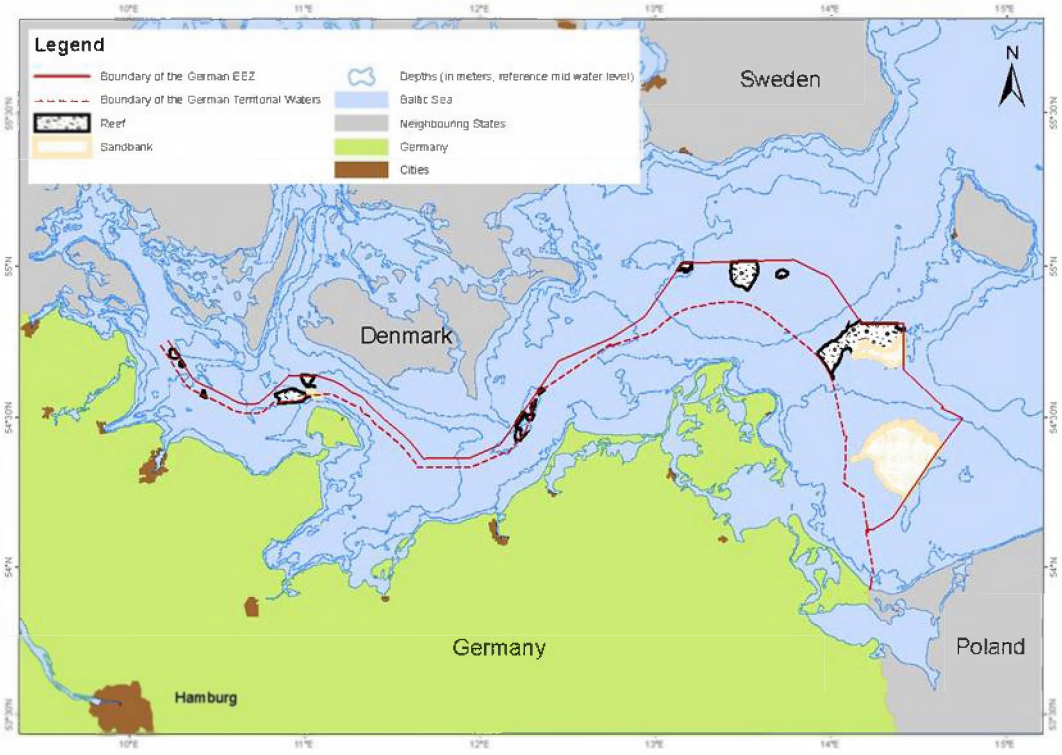

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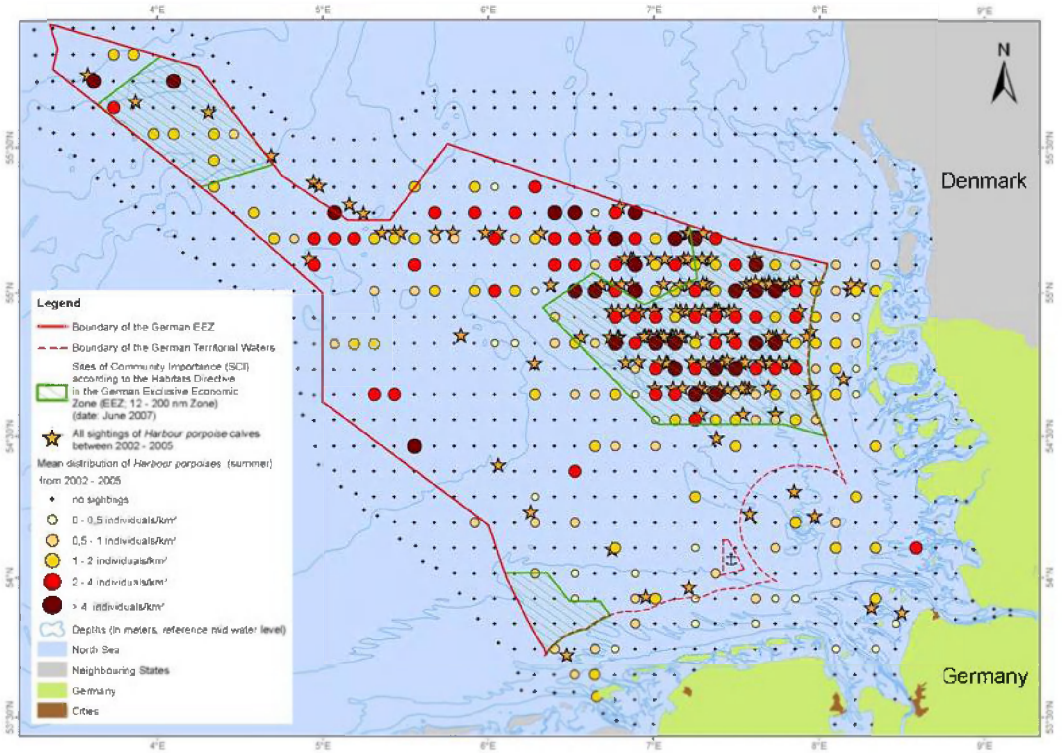

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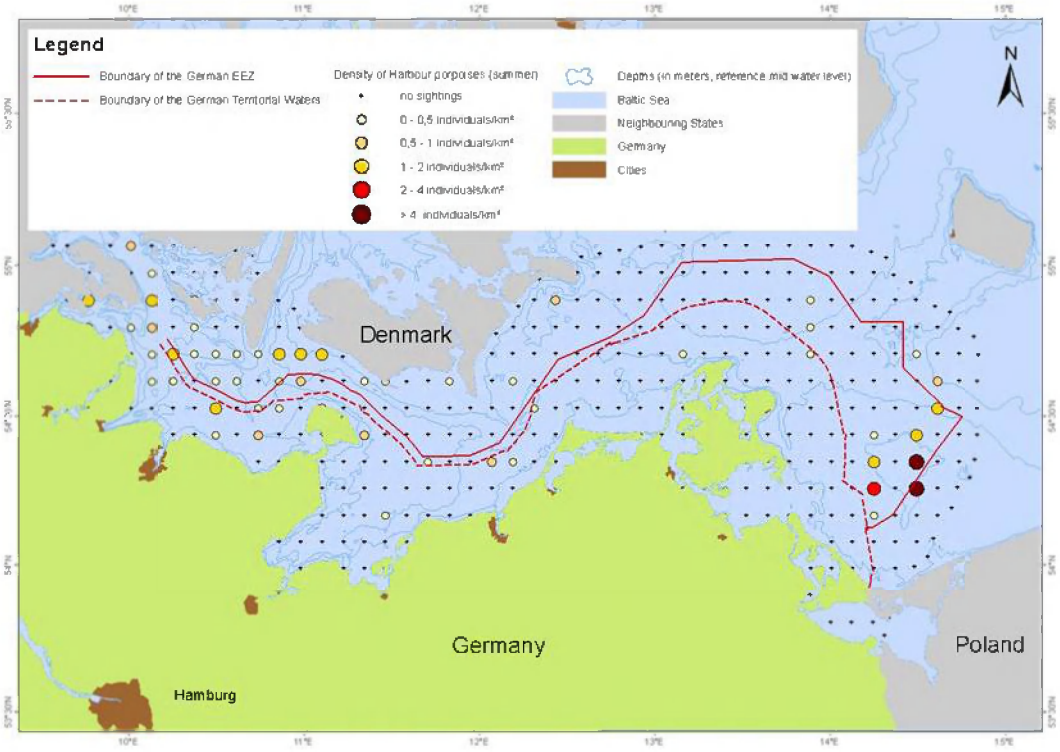

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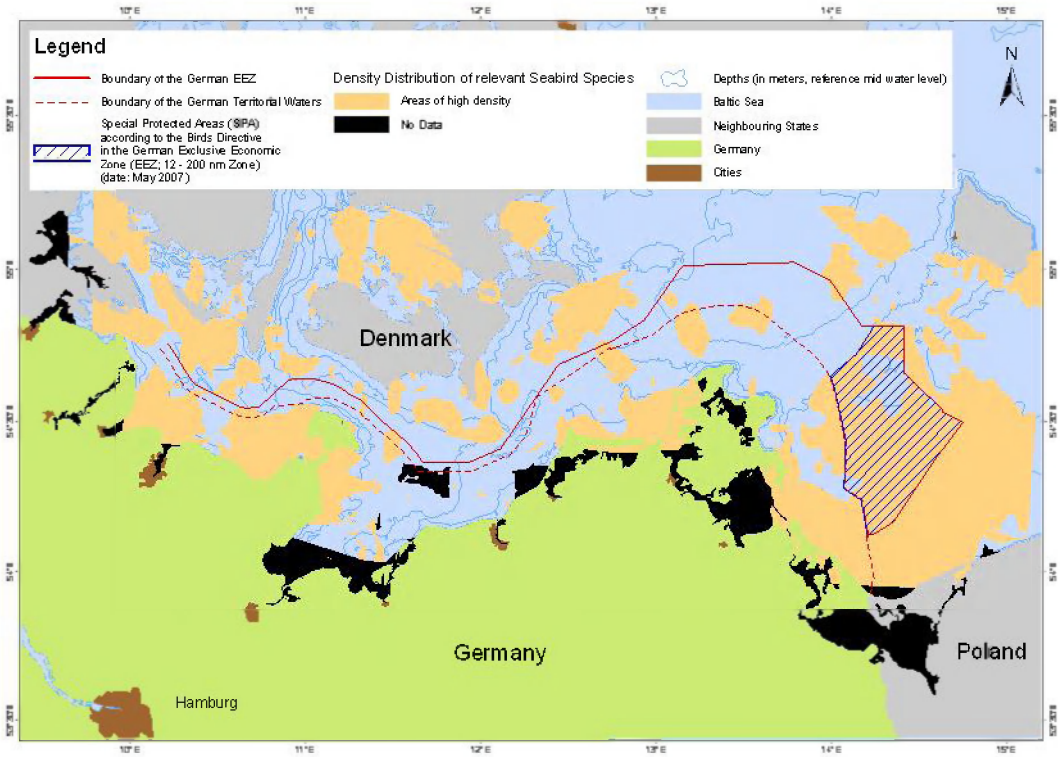


Figure 1f.

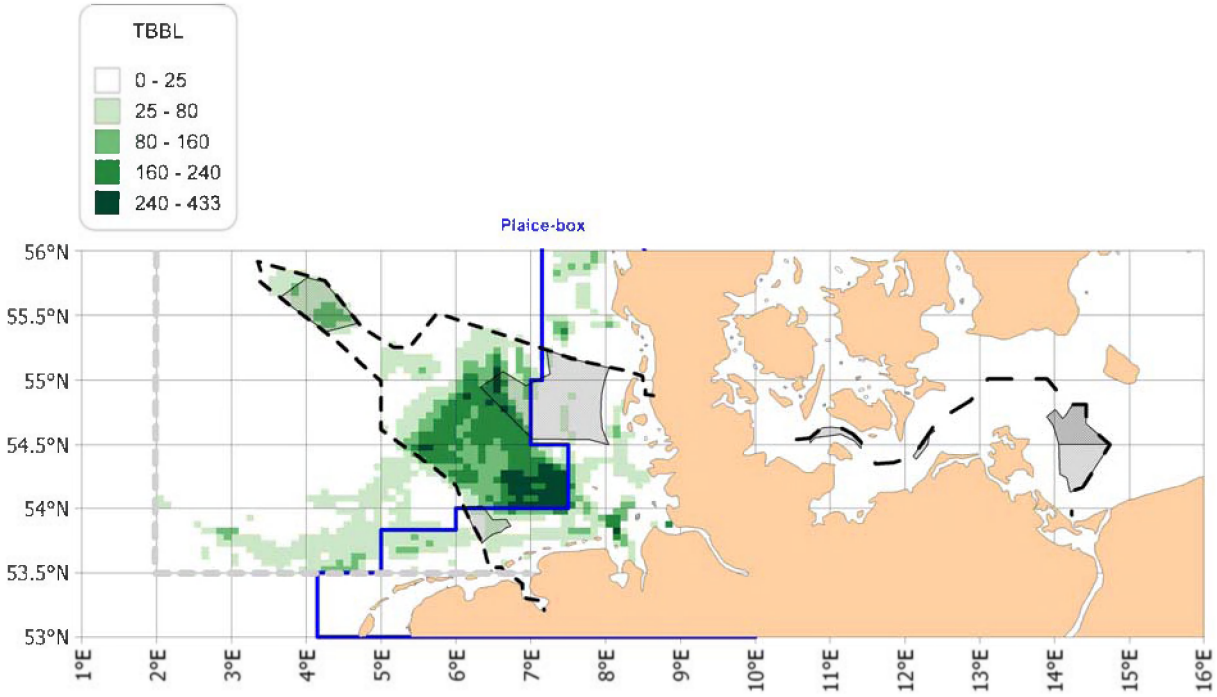
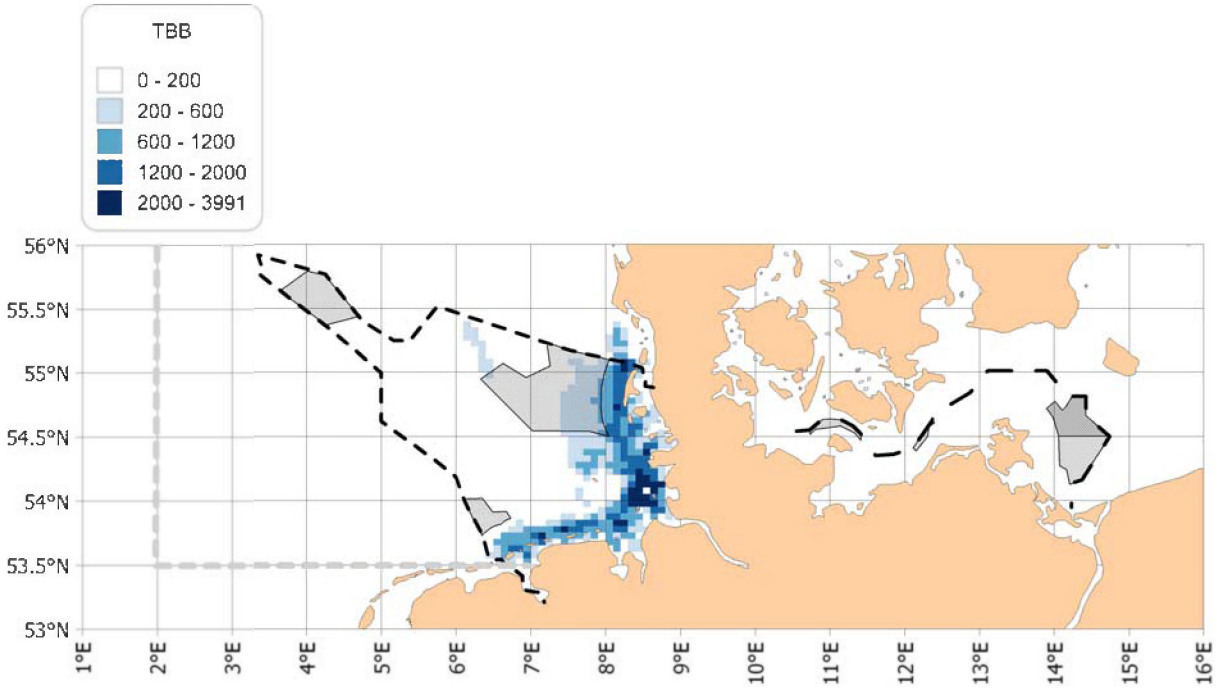


Figure 2a.



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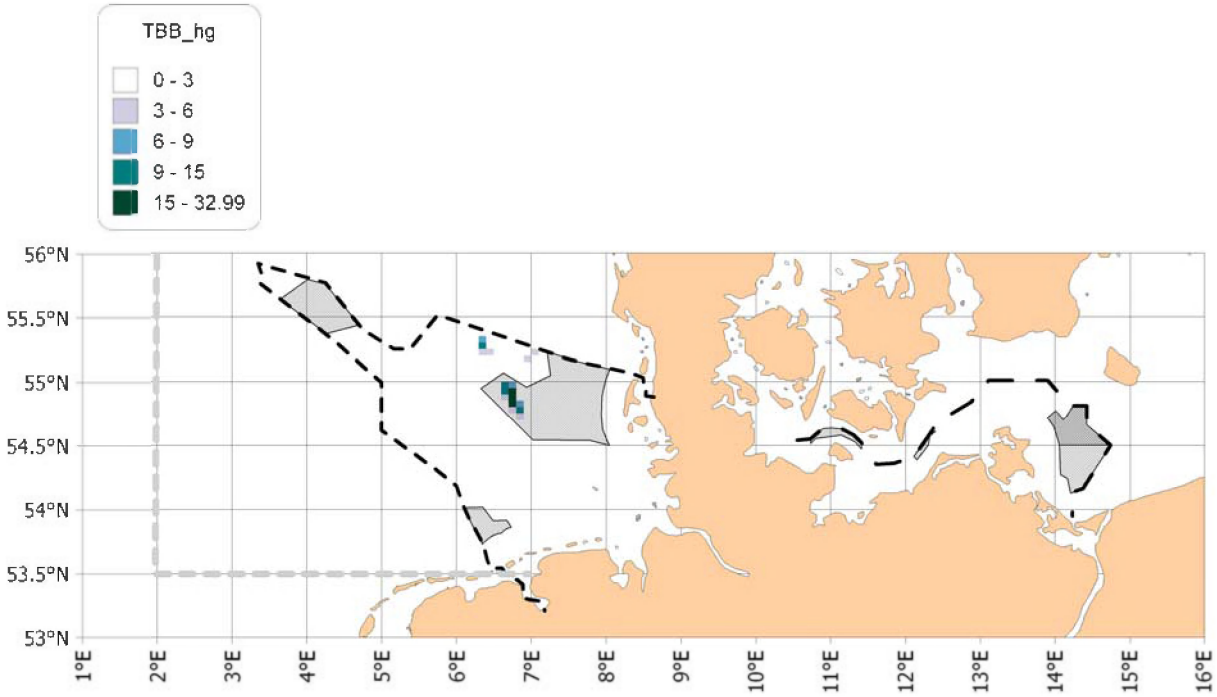

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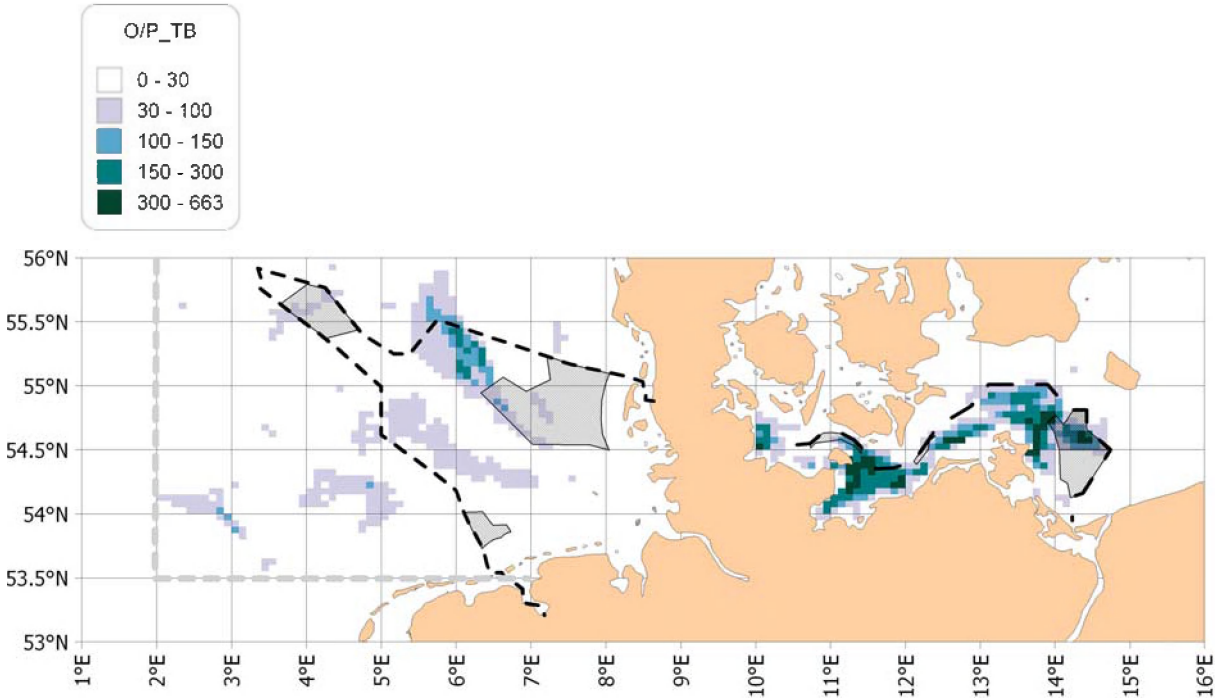

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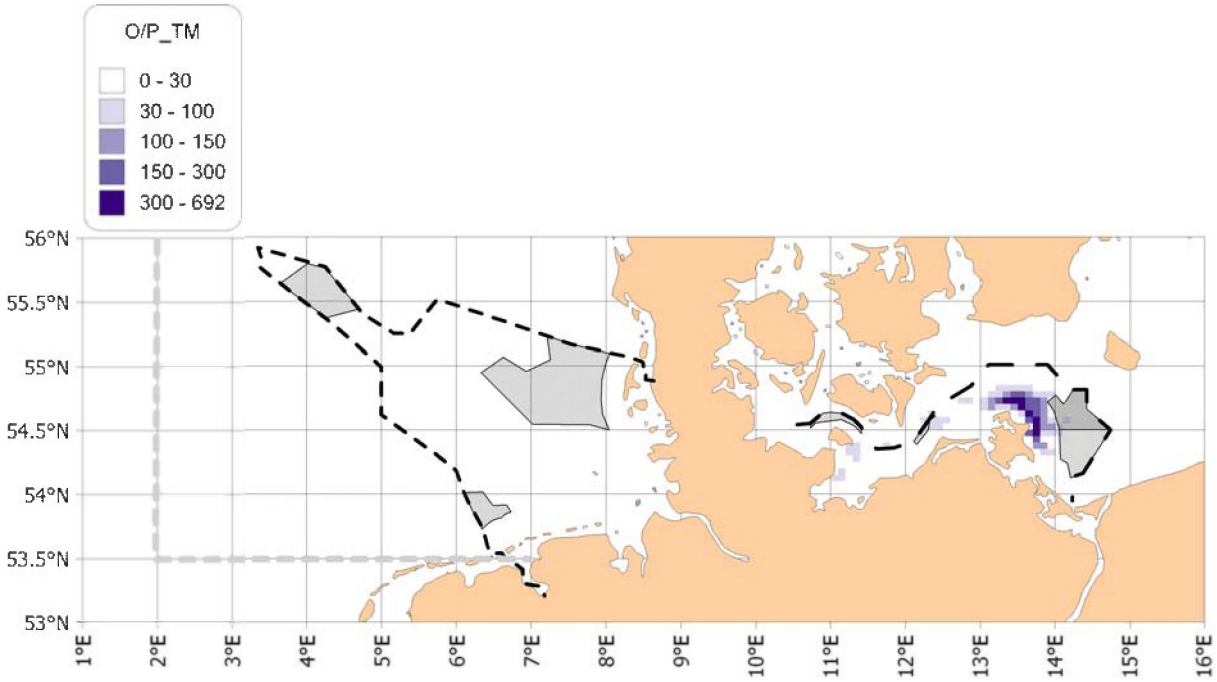

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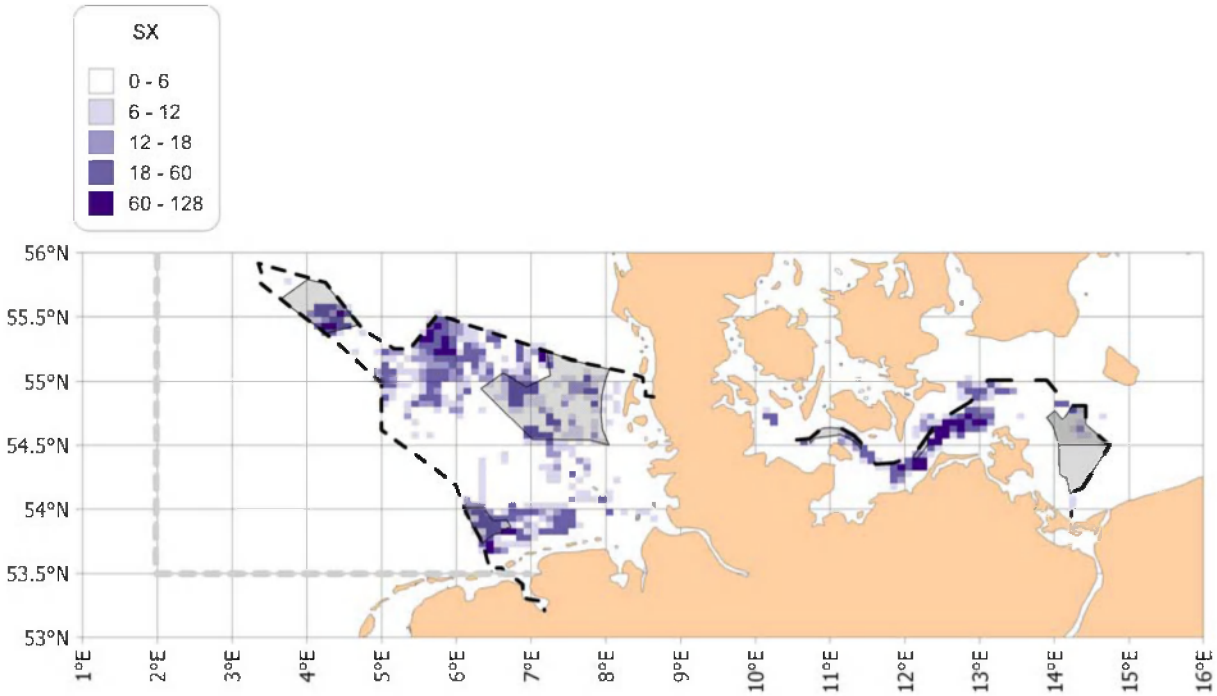


Figure 2f.

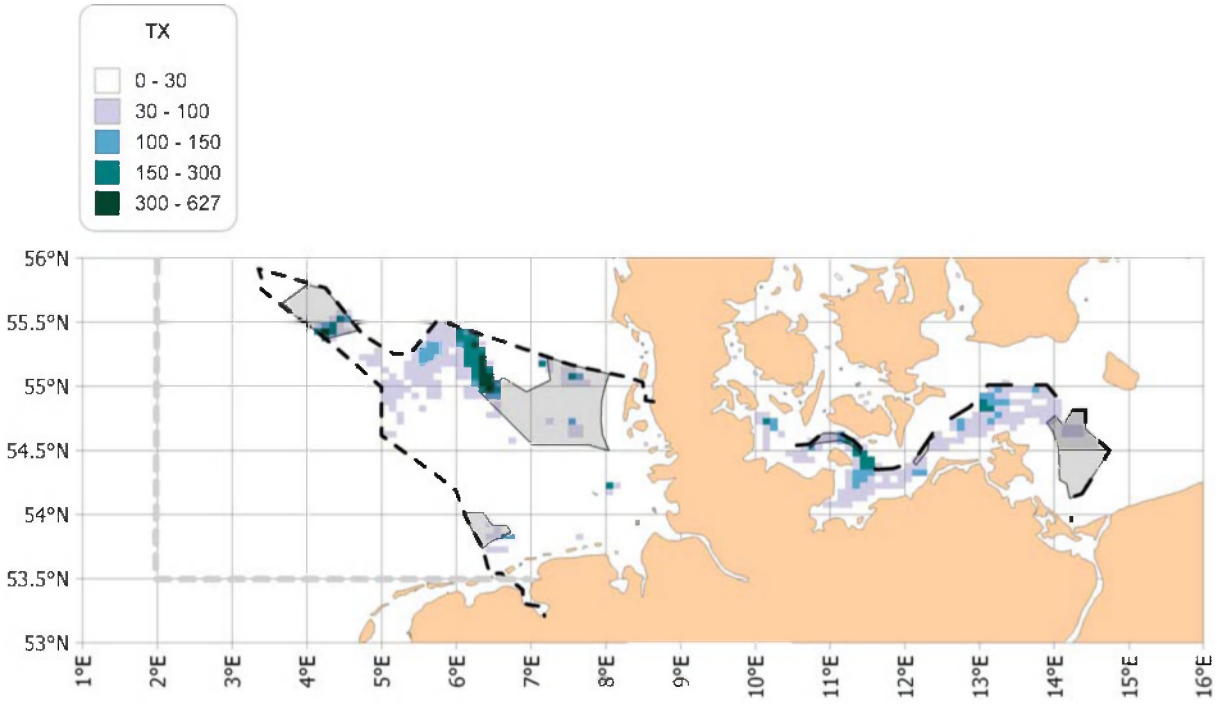


Figure 2g.

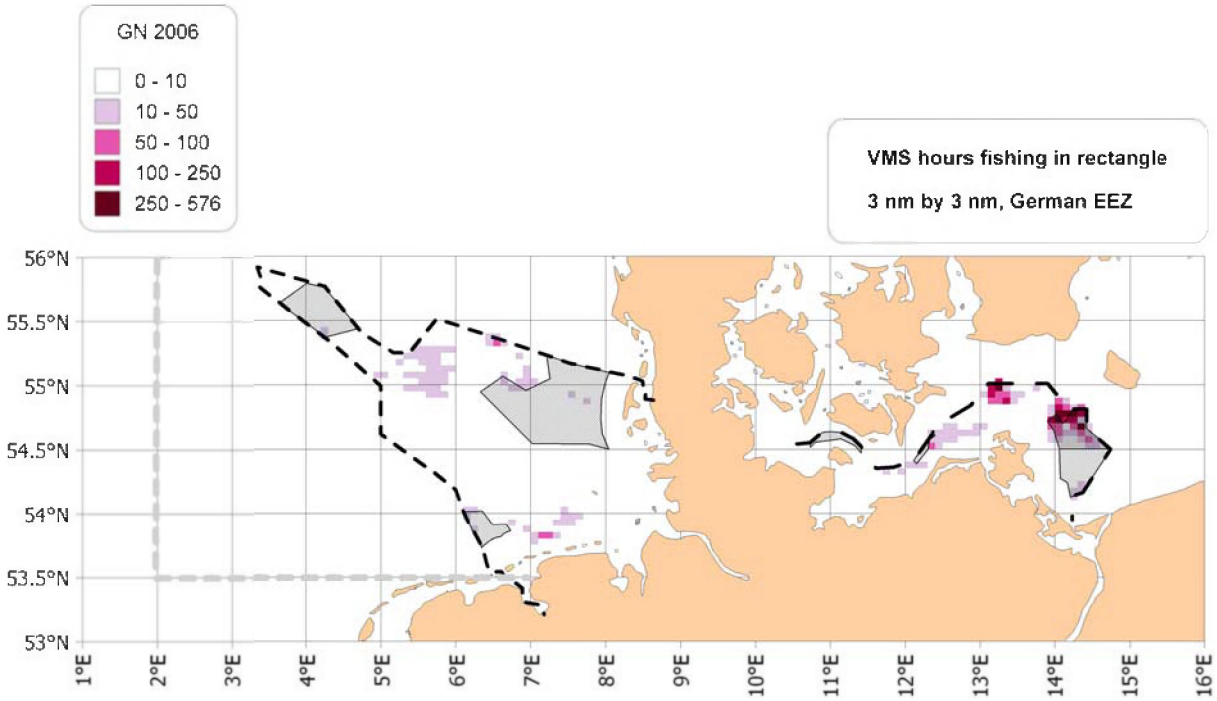


Figure 2h.

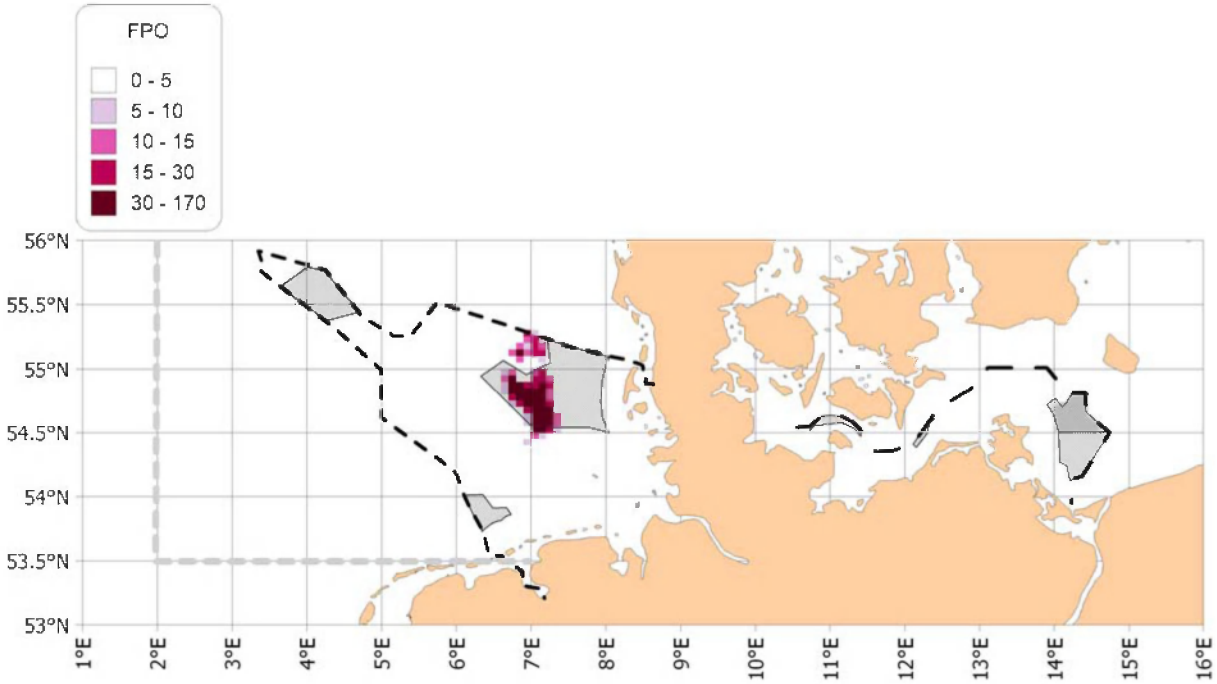


Figure 2i.

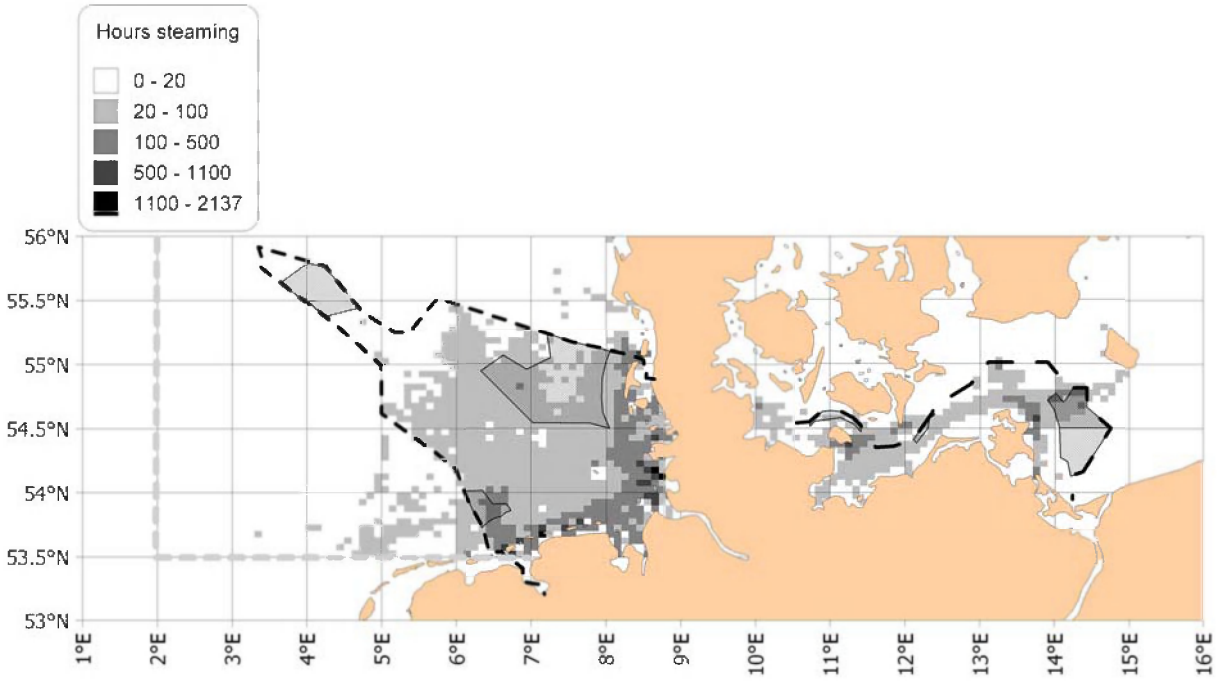


Figure 2j.

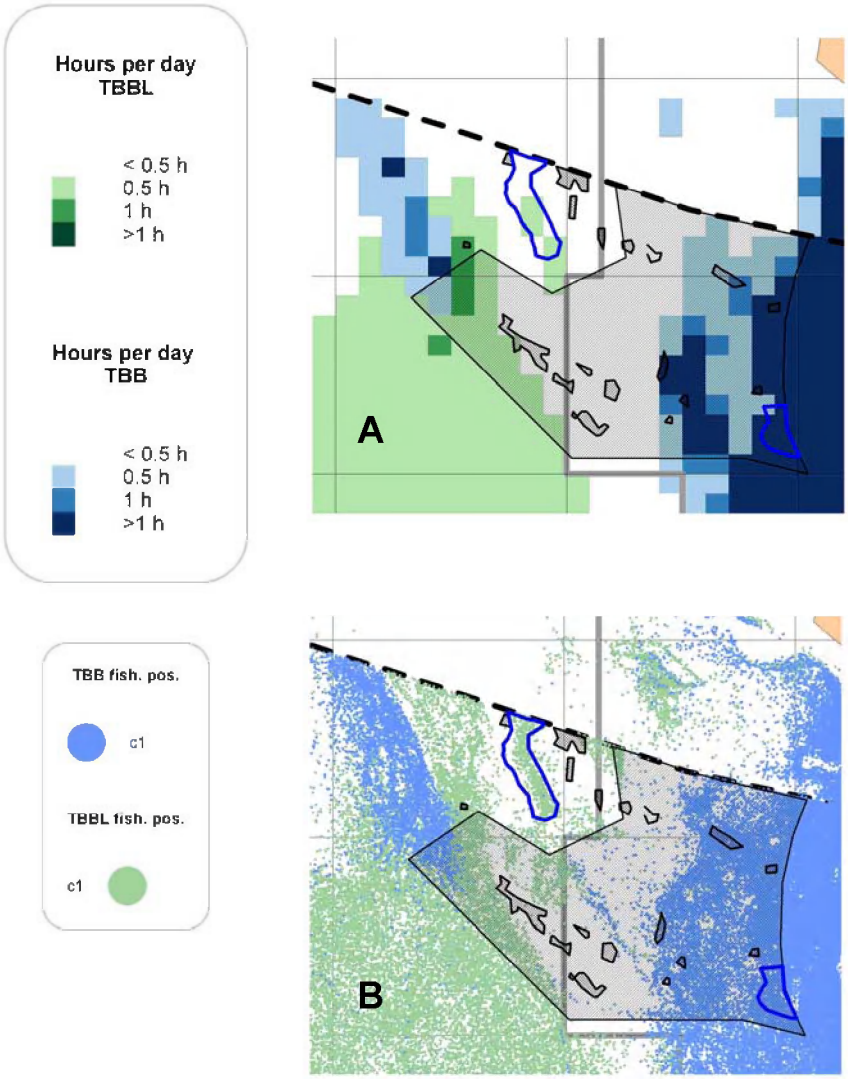

Hours per day
TBBL
< 0.5 h
0.5 h
1 h
>1 h
Hours per day
TBB
< 0.5 h
0.5 h
1 h
>1 h
TBB fish. pos.
c1
TBBL fish. pos.
c1
A
B

Figure 3.

Appendix 1

Estimating high resolution trawl fishing effort from satellite-based vessel monitoring system data

Within European seas, fishing vessels are obliged to operate a satellite-based vessel monitoring system (VMS)(e.g. O'Shea and Thompson, 2006; Nolan, 2006). The EU VMS applies to all larger fishing vessels (from 2005 onwards, to vessels in excess of 15 metres overall length). Until 2003, this regulation was restricted to vessels larger than 24 m. In 2004, minimum overall size was reduced to 18 m and in 2005 to 15 m (EC regulation 2244/2003). In 2006, complete data including vessel code, position, time, speed and direction were distributed to EU member states for their national fleets for all waters, and for foreign vessels operating within the bounds of their national exclusive economic zones (EEZ) (Nolan, 2006).

The benefit of using independent data like the VMS is that it simply shows where fishing vessels operate.

VMS recordings followed different national protocols with regard to time intervals of recording. Most recordings of vessels in German waters were made at about hourly (43.5% of all records) and 2-hour intervals (36 %), but also shorter intervals of 15 minutes were applied to some vessels or fleets (e.g. UK). Single time intervals of > 2.5 hours were regarded as indicating extended periods of recording failure rather than extended periods of operations and thus were reset to 1 h for the respective VMS position.

In case of incomplete records (i.e. some Swedish vessels), missing speed values were replaced by an arbitrary speed of 2.0 knots, a rather conservative estimate. VMS speed records from Polish vessels were considered inaccurate since all values were smaller than 1 knot. These were also replaced by 2.0 knots speed. This procedure was applied to < 1.5 % of all records. Hence fishing activities are probably slightly overestimated with regard to Swedish and Polish contributions (see 'Classification of fleets').

Classification of fleets: Classification of gear types used by vessels was carried out for vessels from Belgium, Denmark, Estonia Germany, Latvia, the Netherlands, Poland, Sweden and UK (Appendix Table 1). Non-German vessels were classified for 2006 according to VMS data and supplementary information provided during an ICES workshop (ICES, 2007c). For each vessel, three different VMS statistics were evaluated: speed frequency distributions to identify mean fishing speed, spatial extent and pattern of fishing operations (see Deng et al., 2005) and speed-time profile during working periods while out of harbour (Rijnsdorp et al., 1998). German vessels were classified according to log-book information on a day-by-day basis.

In the Netherlands two principal fishing métiers that differ markedly in fishing practice and gear characteristics, are usually distinguished: "large vessels" with engine-power of 221 kW or more and "eurocutters", with engine power below 221 kW. Typically the large vessels deploy two 12 m beam trawls and are not allowed to fish inside the 12 nm coastal zone or the "Plaice box" whereas the eurocutters deploy two 4m beam trawls and are allowed to fish inside those areas. For each group a different trawling speed band was determined to distinguish fishing activity from other activities (e.g. trawling): 5-8 knots for the large beam trawlers and 3-6 knots for the small vessels (Piet et al 2007).

The first group of vessels was classified due to a high share and conspicuous peak of speed in the typical trawling speed bands of either 3-5 or 5-7 knots, combined with a relatively large operation area. In the speed-time profile, working periods for trawlers appeared as a coherent low speed band for several hours (Rijnsdorp et al., 1998). German, Dutch, and UK trawlers with a trawling speed of 5-7 knots were classified as large beam trawlers (TBBL) mostly targeting sole and plaice, as compared to other beam trawlers operating at 3-5 knots (TBB, Mills et al., 2007; Rijnsdorp et al., 1998). For the German fleet, the TBB category (Appendix Table 1) was further separated into a fleet fishing for sole and plaice with strong vessels in rather offshore areas´, as opposed to the shrimp-fishing fleet working inshore.

The data models: The VMS data models each contain two steps of interpretation. First, the activity state is identified, i.e. steaming is associated with relatively high speed and fishing related activities with low speed. Determination of fishing activity in VMS data was based on vessel-by-vessel speed profiles. Mean speed values were calculated for all speed values < 8 knots (otter and beam trawlers and unspecified trawlers) and < 5 kn (gill netters, seiners, potters). Then, all positions with a speed value smaller than mean speed +2 knots were considered fishing related positions. This is slightly different from the approach of Rijnsdorp et al. (1998) who took the criterion mean speed ± 2 knots to define fishing activity.

Second, depending on requirements of the interference analysis with either high resolution mapping of habitats or density maps of occurrences for species, two different treatments are applied to quantitatively account for fisheries activities.

Density mode: In density mode, a quantitative measure per area is derived. Each VMS position is considered representative of an area around the measured position due to movements of the vessels unaccounted for by VMS (Mills et al., 2007; Deng et al., 2005). This interpretation is augmented by revision of tracks at high temporal resolution. A track of a vessel with VMS recordings at 12 minute intervals resolved arbitrarily to 2 h intervals reveals that a much wider area is actually covered by fishing activities than was indicated by the coarser VMS signal (Appendix Figure 1).

Quantitative properties of every fishing position are determined with respect to aerial extent and time spent fishing. Given the uncertainty about activity between two subsequent VMS records, mean vessel-by-vessel values were assigned to each fishing position with respect to speed and movement, i.e. changes in direction. For changes of direction, proportions were determined for forward moves, i.e. no change (0°), right side / starboard (90°), left side / port side (270°) and backwards direction (180°). Based on the directional proportions, each fishing position was substituted by four possible subsequent positions. The positions were calculated from the mean fishing speed (see above) multiplied by the time interval and by the directional proportion in the respective direction superimposed on the main direction between the current and the next position (Appendix Figure 2). Time effort was reallocated accordingly. For each of the four potential new positions effort was reallocated by means of preceding time interval multiplied by the directional proportion.

Effort data were aggregated in aerial units of 1/100 ICES rectangle approximating 3*3 nm. This is augmented by the distribution of interval distances showing that > 60 % of distance data were located within a range of 3 nm.

Point mode: In point mode, fishing positions are mapped at high resolution to visualize small scale distribution of activity in relation to habitat delineations. An example is given in Figure 3.

Appendix Table 1.

Classification of the fleets was carried according to international standards4 and for vessels from Belgium, Denmark, Estonia Germany, Latvia, the Netherlands, Poland, Sweden and UK.

TBBL:	German, Dutch, and UK trawlers with a trawling speed of 5-7 knots were classified as large beam trawlers (TBBL) mostly targeting sole and plaice, as compared to other beam trawlers operating at 3-5 knots (TBB, Mills et al., 2007; Rijnsdorp et al., 1998).
TBB:	For the German fleet, the TBB category was further separated into a fleet fishing for sole and plaice with strong vessels in rather offshore areas´, as opposed to the shrimp-fishing fleet working inshore.
TBB_hg:	Vessels being observed to have operated on stony grounds in the 4th quarter of 2006 with heavy gear and an average trawling speed about 4 to 5 knots were classified as extra heavy beam trawlers (TBBHG).
TX:	A separation between TBBL and TBB fleets can not be derived from VMS for foreign vessels which then were classified as TX, trawling at 3-5 knots speed. Swedish vessels not operating on the Dogger Bank were classified as TX. Also, vessels for which no supplementary information was available were classified as TX. Remaining vessels were checked for short periods of trawling and if such were present, vessels were classified as TX.
O/P_TB:	Demersal otter board trawlers include single and paired vessel trawling. Paired operations are only recognized for the German fleet and not distinguished from single operated trawls.
O/P_TM:	Pelagic otter board trawlers include single and paired vessel trawling. Paired operations are only recognized for the German fleet and not distinguished from single operated trawls.
SX:	Those vessels operating at low speed but in an extended area (0.1 – 1 degree in latitude or longitude) and often with arch-shaped tracks at low speed were classified as unspecified seiners (SX). Seiners with a normal working period of 2.5 h often showed only one low speed value amongst intermediate values and very rarely zero speed. Vessels with only a small share of speed in the trawling speed band and vessels with increasing shares towards zero speed were analysed separately. Here, vessels with a distinct narrow bird foot-shaped aerial VMS pattern at low speed (returning to the same position from several surrounding points) were classified as Danish seiners (SDN).
GN:	Vessels operating in a very narrow area (< 0.1 degree in latitude or longitude) at low and often zero speed were classified gill netters (GN). Working periods of gill netters are indicated by sequences of zero speed combined with intermediate and travelling speed.
FPO:	The two known potters were indicated as FPO

4 Classification acc. to *Int. Standard Statistical Classification of Fishing Gear* except for TBBL and TBB_hg, see text (ftp://ftp.fao.org/FI/DOCUMENT/cwp/handbook/annex/AnnexM1fishinggear.pdf)

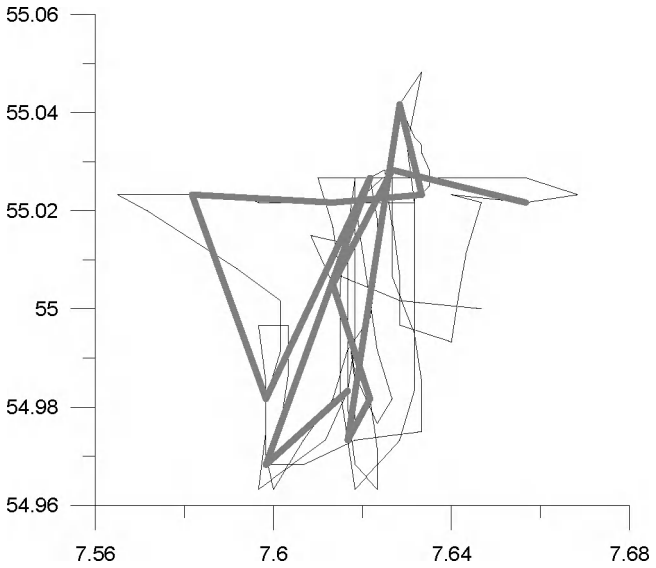
Legends to Appendix figures:

Appendix Figure 1.

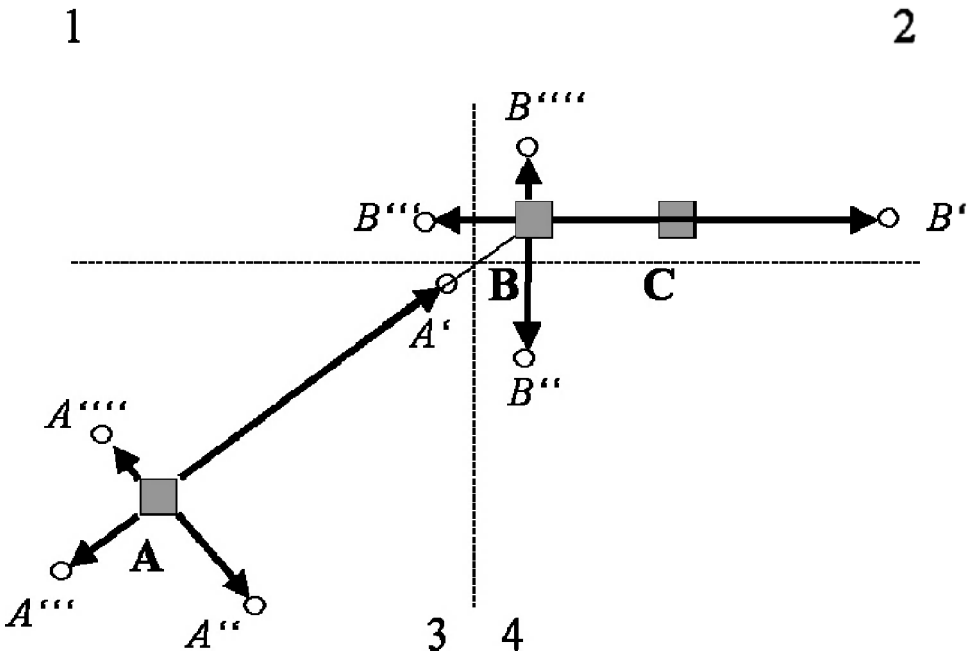
Effect of temporal resolution of VMS data on aerial extension of fishing activities. A 24 h sequence for a single vessel in the North Sea is shown. Original VMS recording at 12 min intervals (thin lines) compared to commonly available 2 h interval resolution (bold grey line).

Appendix Figure 2.

The VMS data model: The distances between three subsequent VMS fishing positions A, B and C, i.e. $\overline{AB}$ and $\overline{BC}$ are shorter than would have been expected from the product of fishing speed times time interval, indicating that unaccounted movements have occurred. Thus, the VMS data model replaces A and B by four new positions each, A'-A"" and B'-B"". The lengths $\overline{AA'}$ etc. are calculated from vessel specific mean speed and vessel specific portions of movement in respective directions A' etc. The effort allocated to A' is calculated from vessel specific portion of movements in direction A' times the preceding time interval, respectively. In this example, the 'raw data'-interpretation would be that fishing activities only take place in sectors 3 and 2. The VMS data model indicates that fishing activities also take place in sectors 1 and 4, indicated by B"' and B". Note that due to model implications B' lies beyond C.



Appendix Figure 1.



Appendix Figure 2.

Annex 2: Fine scale distributions of fishing efforts

Fine scale distributions of the total international fishing effort by fishing gear, 3x3 nautical mile squares, and month in 2006 in the German exclusive economic zone of the North Sea and the Baltic Sea have been estimated from all available international log-book information and vessel monitoring data (VMS). The methods used for estimating the international fishing efforts are described in the manuscript in Annex 1.

The fishing effort data presented in the following maps has been provided to the EMPAS project by Heino Fock, German Federal Research Centre for Fisheries (BFA-Fi), Institute for Sea Fisheries, Palmaille 9, D-22767, Hamburg.

German North Sea:

Maps of distributions of the total international fishing effort by fishing gear, 3x3 nautical mile squares, and month in 2006 in the German exclusive economic zone of the North Sea are given in Figure 1a-g.

German Baltic Sea:

Maps of distributions of the total international fishing effort by fishing gear, 3x3 nautical mile squares, and month in 2006 in the German exclusive economic zone of the Baltic Sea are given in Figure 2a-g.

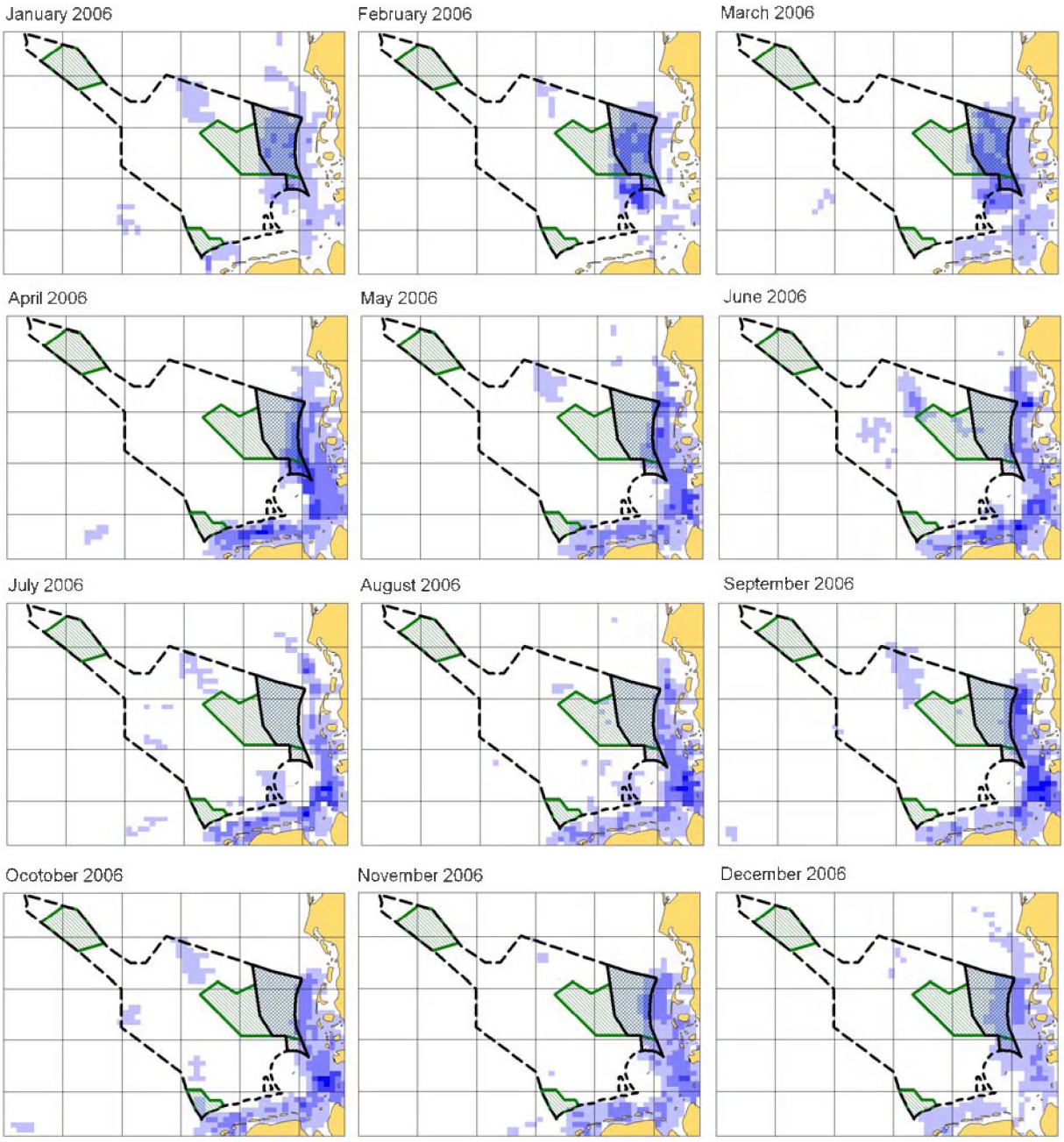


Figure 1a.
Calculated fishing time (hours) of small beam trawls (TBB) by 3x3 nmile squares and month.

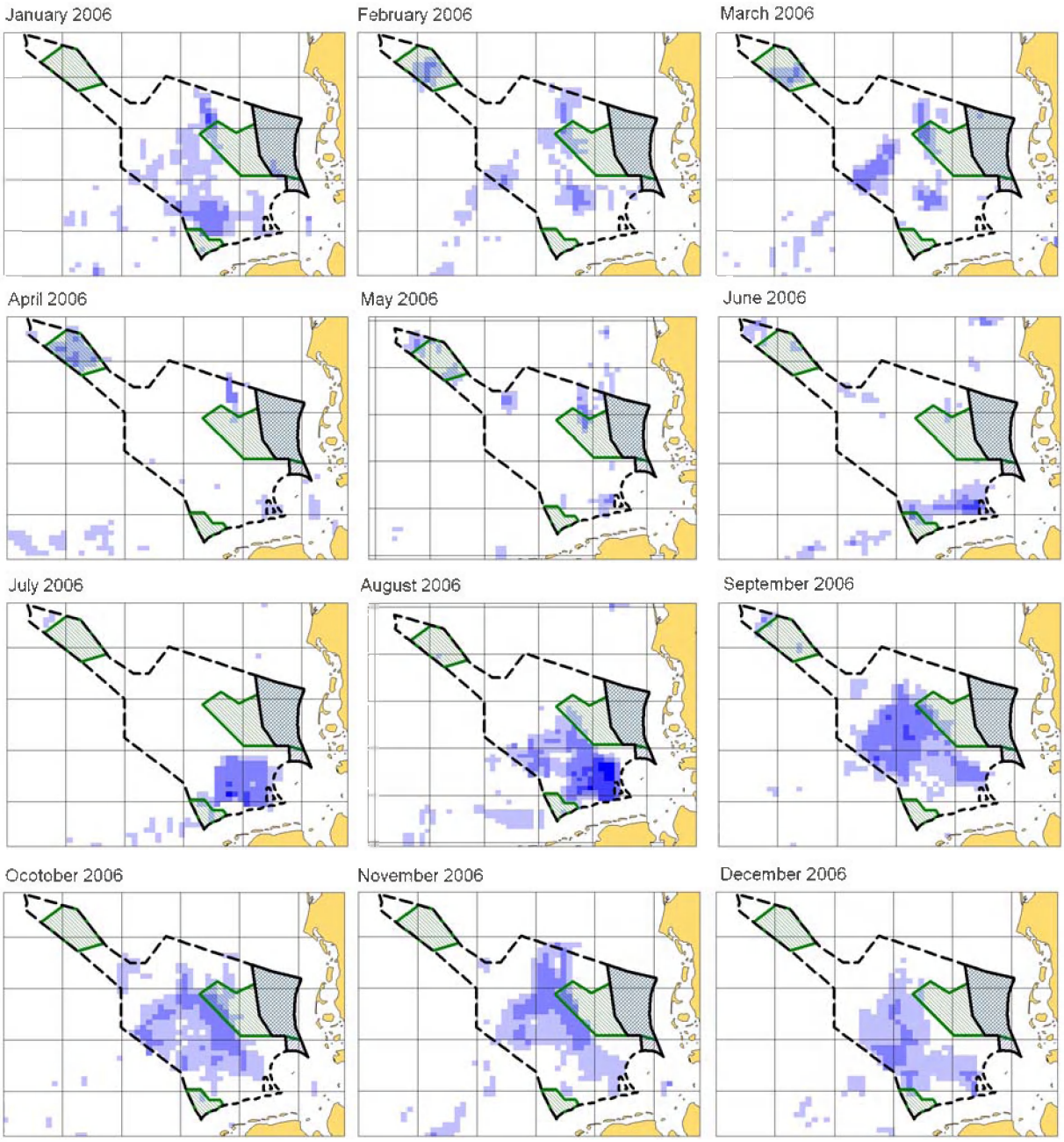


Figure 1b.
Calculated fishing time (hours) of large beam trawls (TBBL) by 3x3 nmile squares and month.

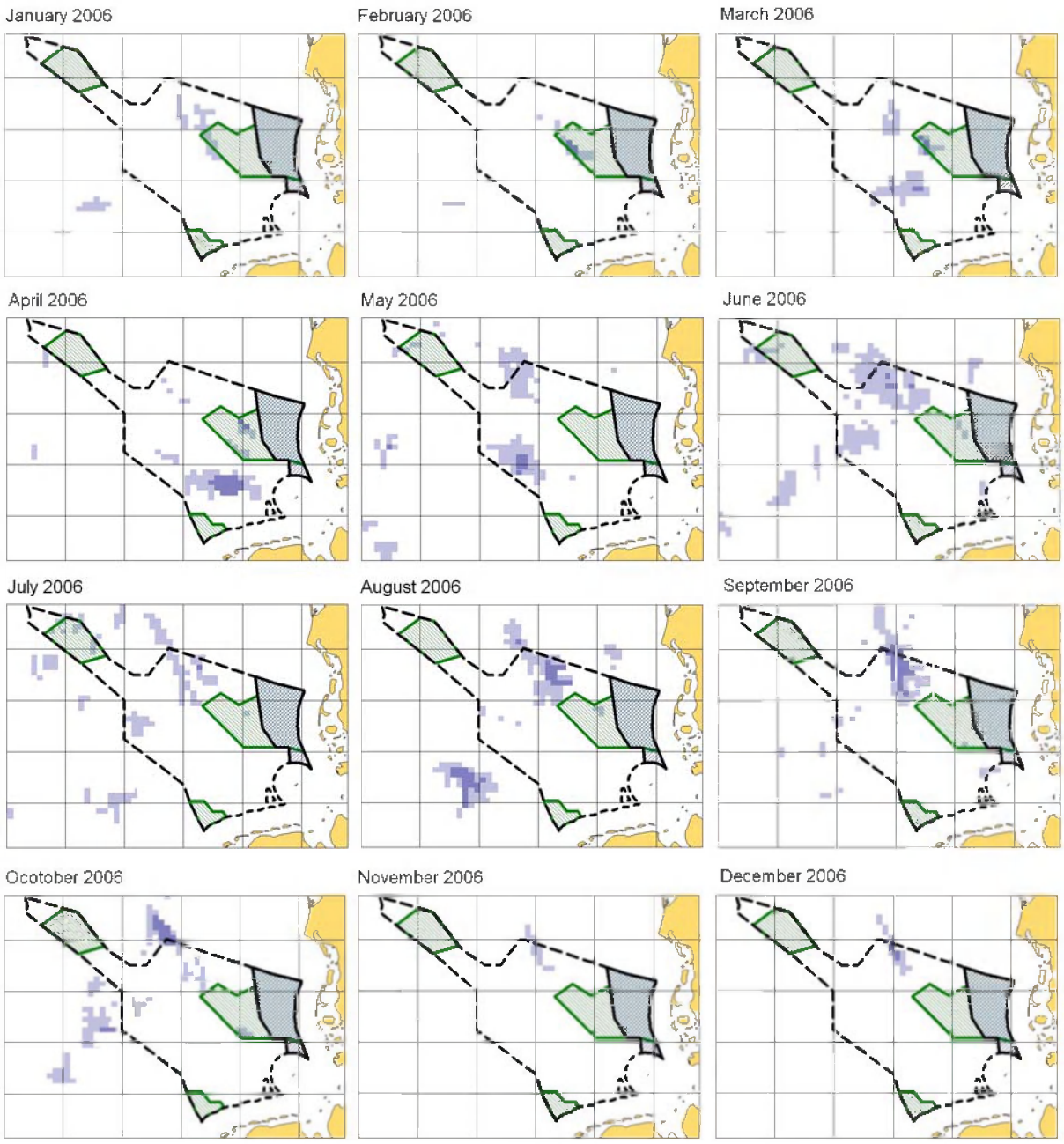


Figure 1c.
Calculated fishing time (hours) of bottom otter trawls (OTB) by 3x3 nmile squares and month.

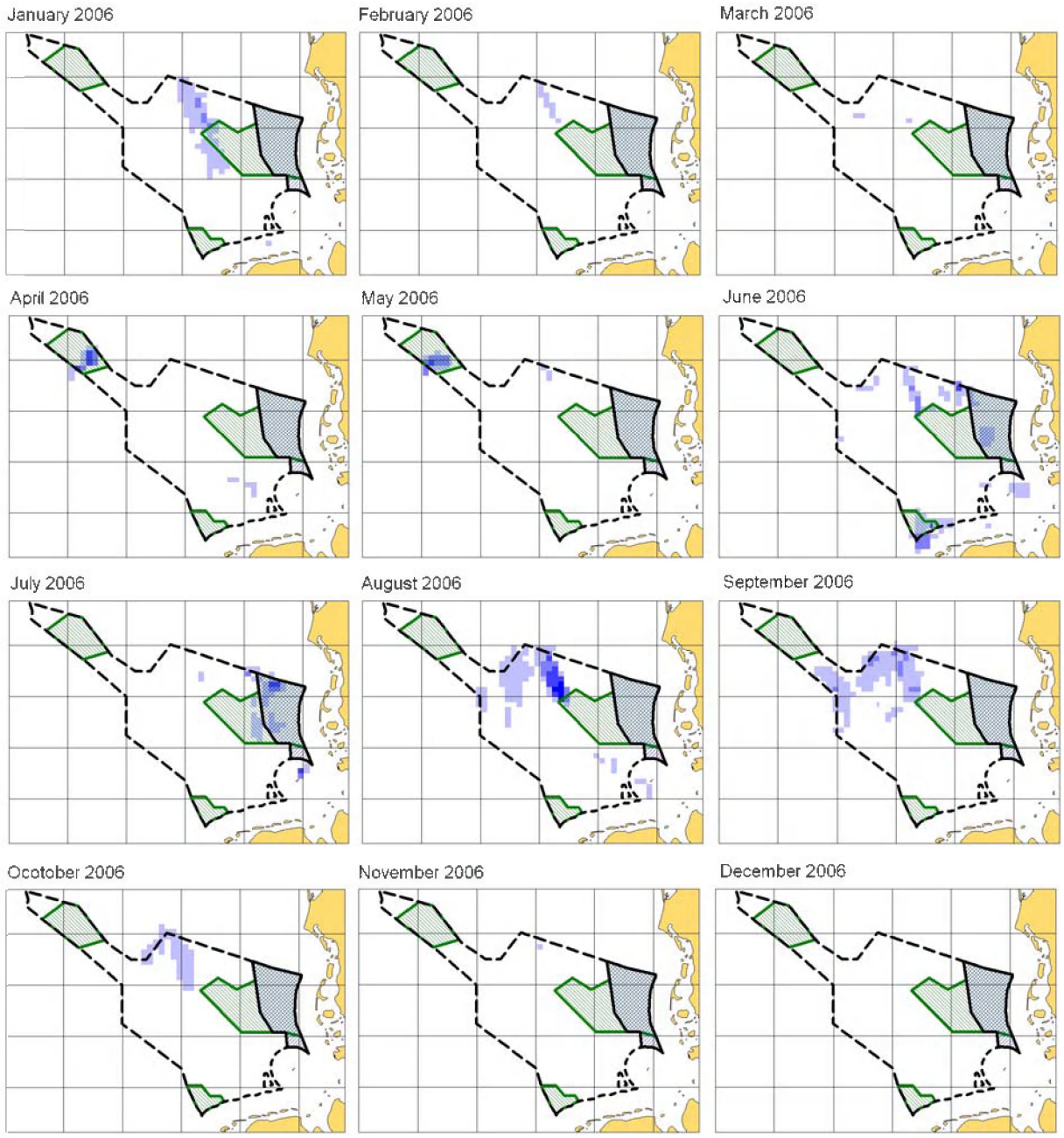


Figure 1d.
Calculated fishing time (hours) of unspecified trawls (TX) by 3x3 nmile squares and month.

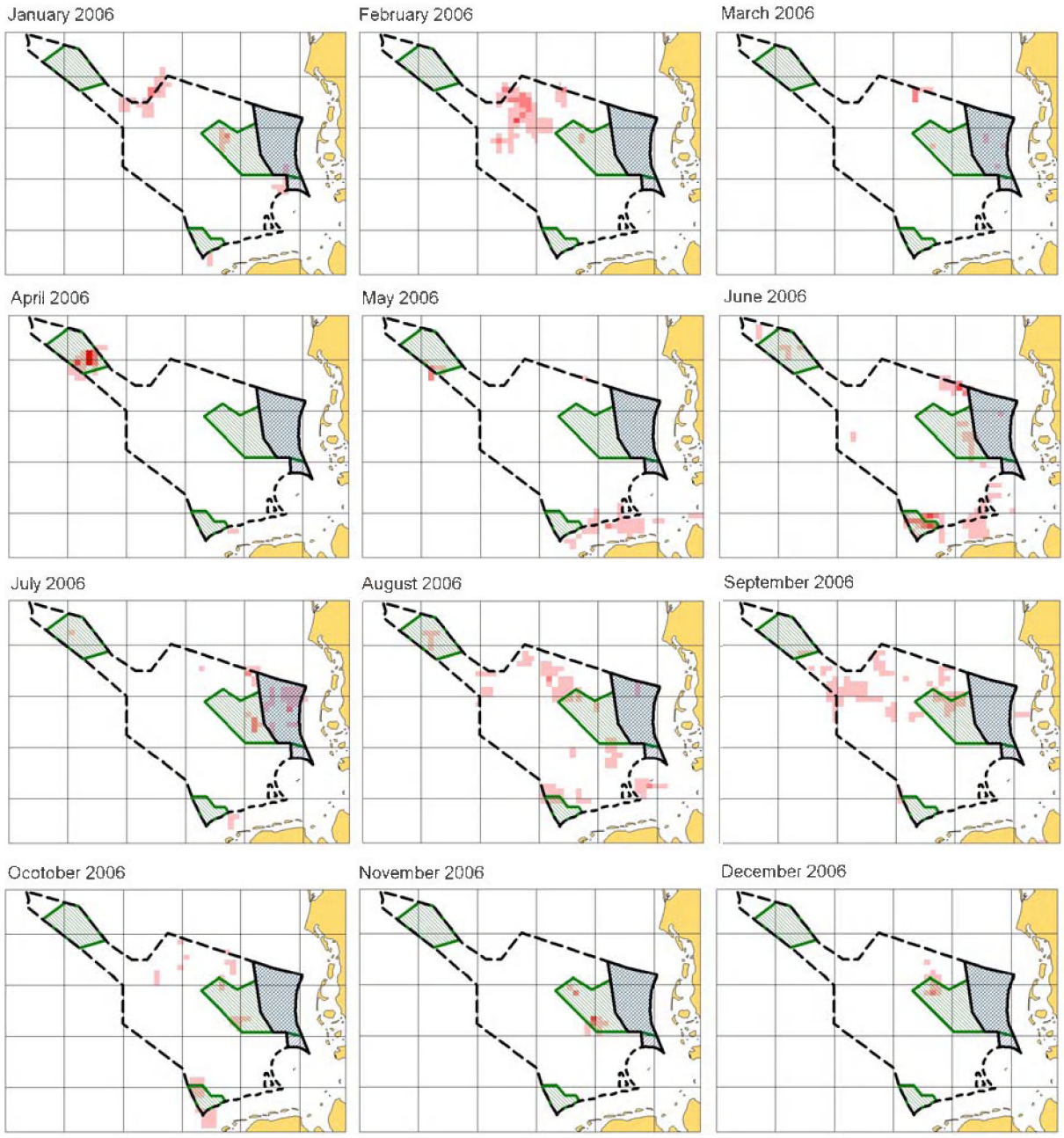


Figure 1e.
Calculated fishing time (hours) of unspecified seine nets (SX) by 3x3 nmile squares and month.

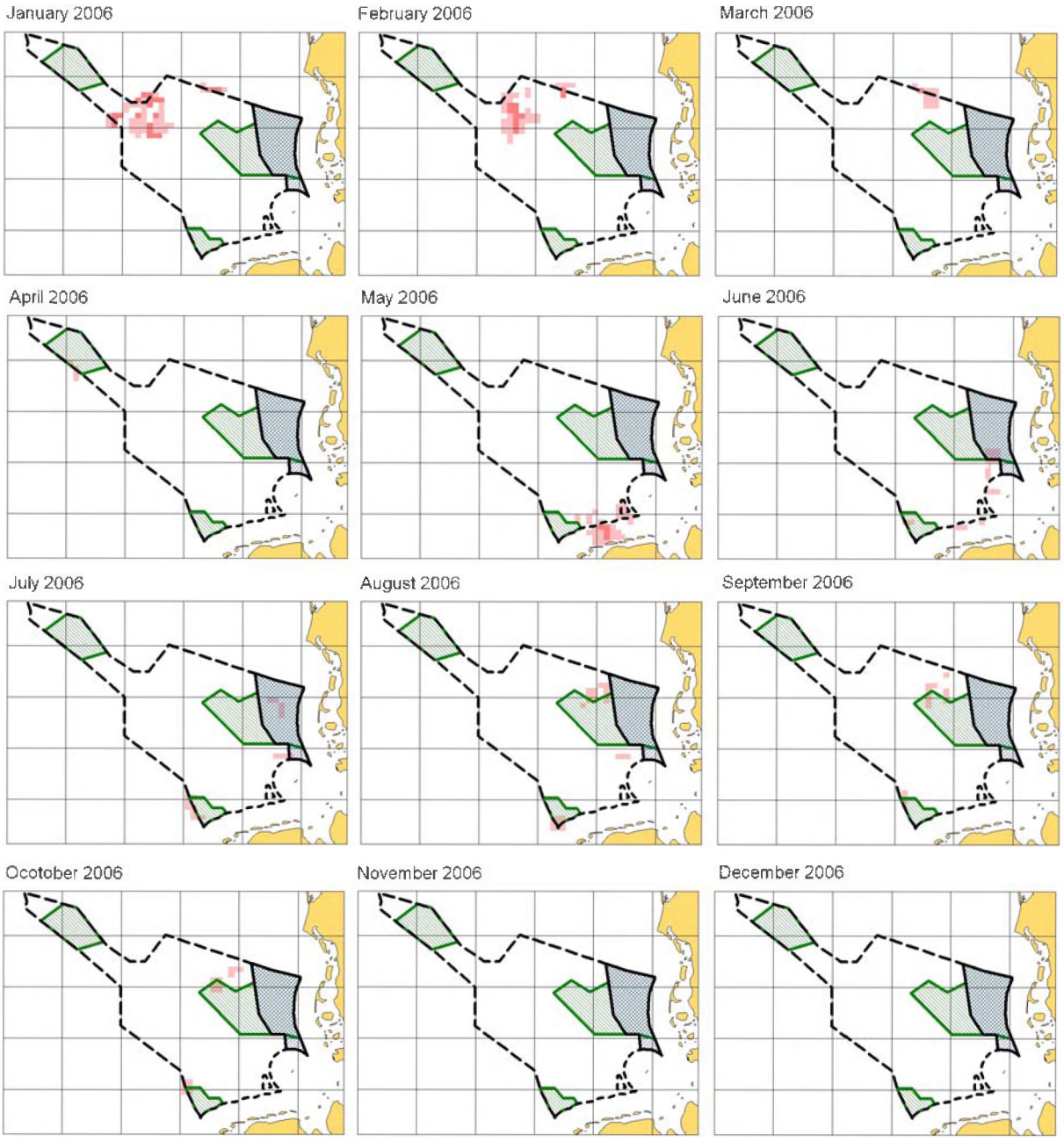


Figure 1f.
Calculated fishing time (hours) of gill netters (GN) by 3x3 nmile squares and month.

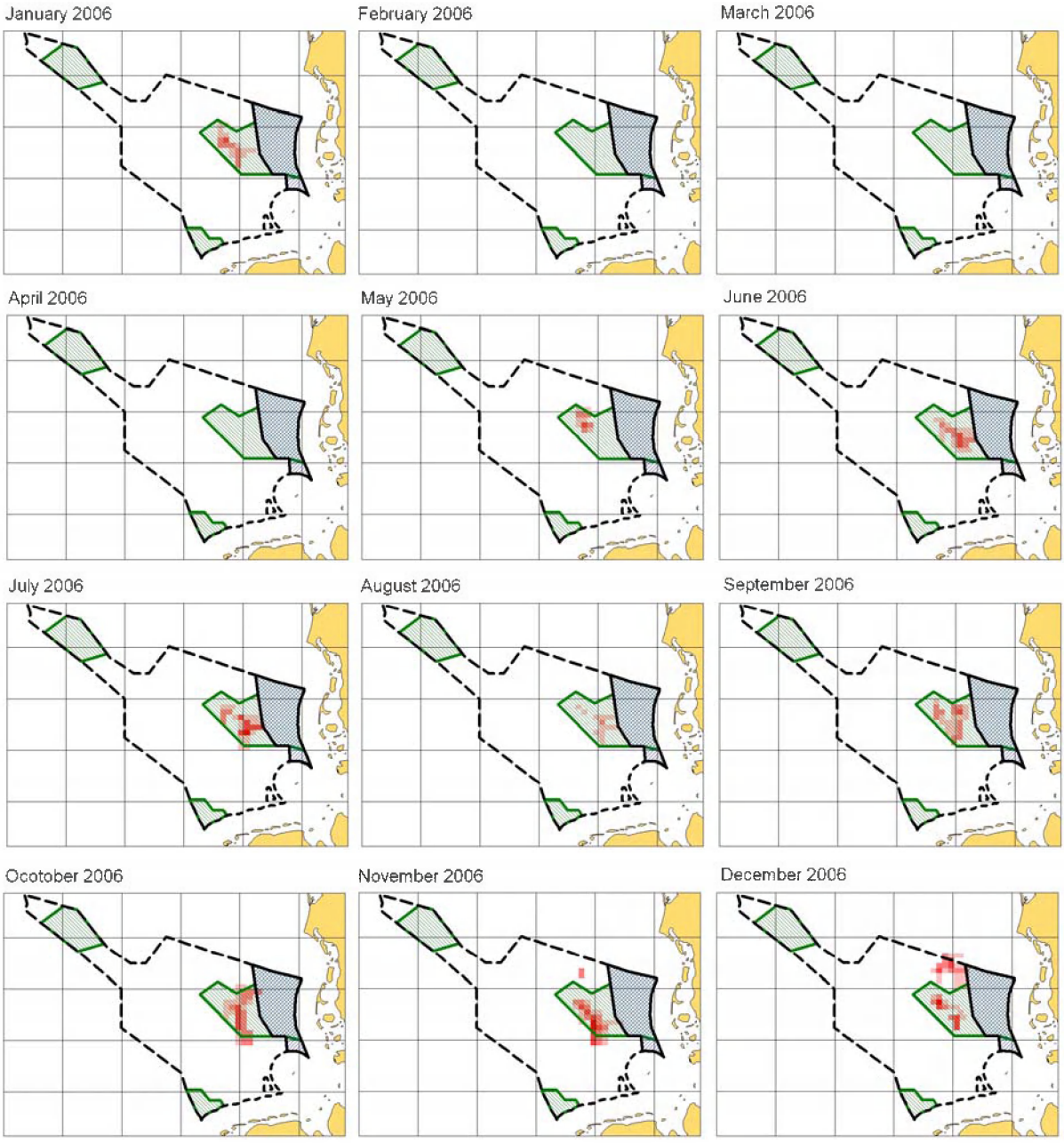


Figure 1g.
Calculated fishing time (hours) of potters (FPO) by 3x3 nmile squares and month.

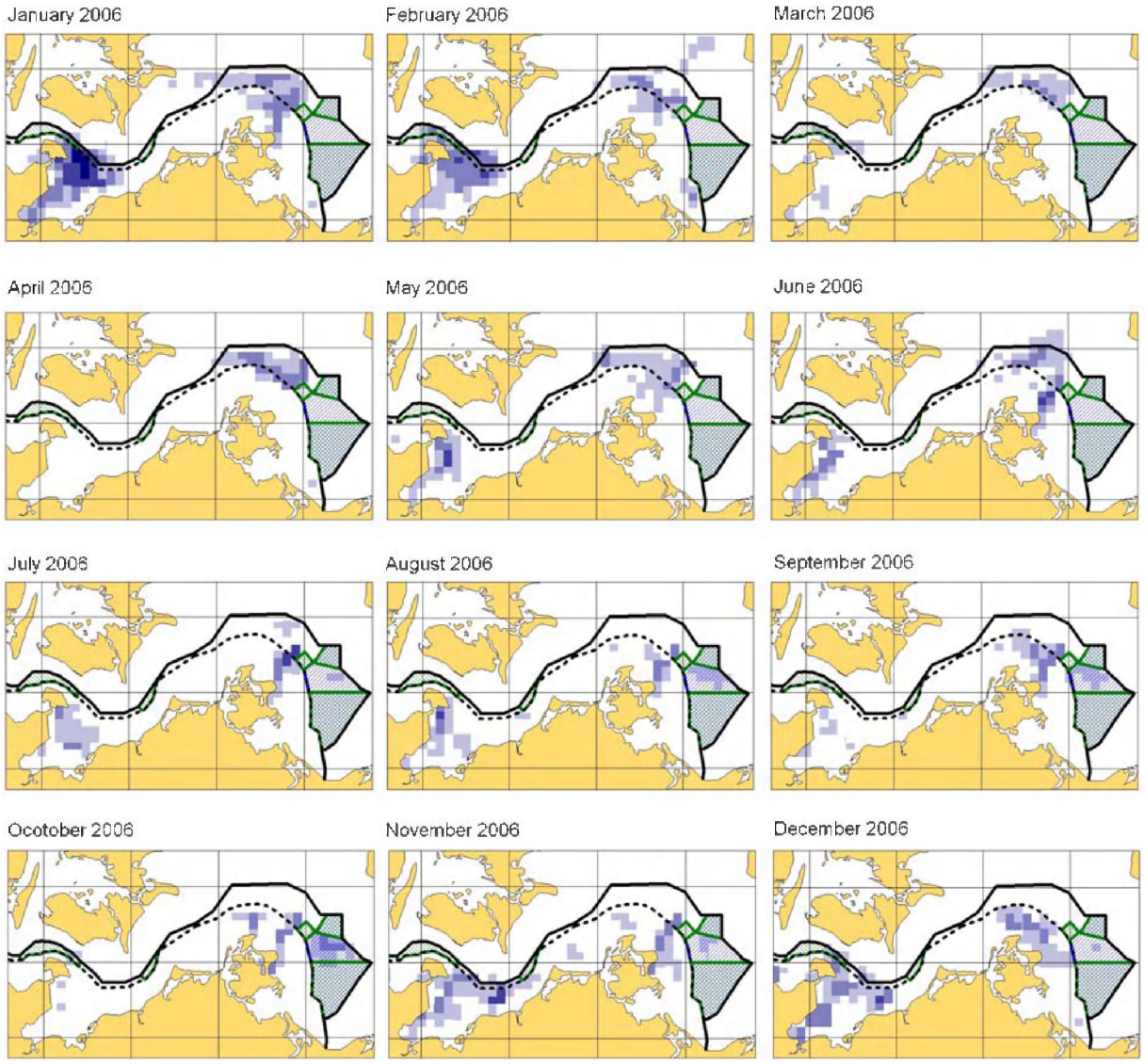


Figure 2a.
Calculated fishing time (hours) of bottom otter trawls (OTB) by 3x3 nmile squares and month.

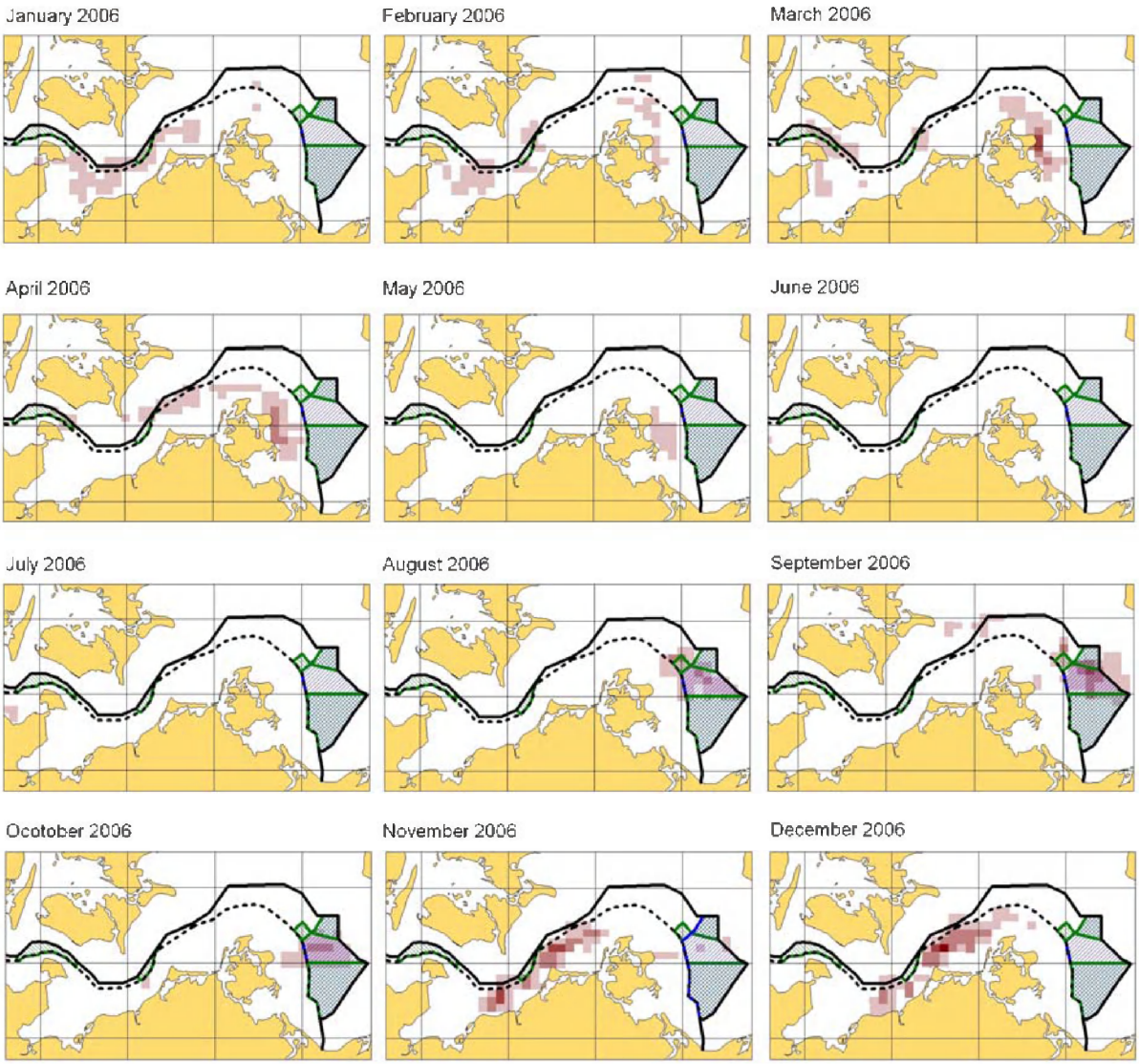


Figure 2b.
Calculated fishing time (hours) of demersal pair bottom trawls (PTB
by 3x3 nmile squares and month.

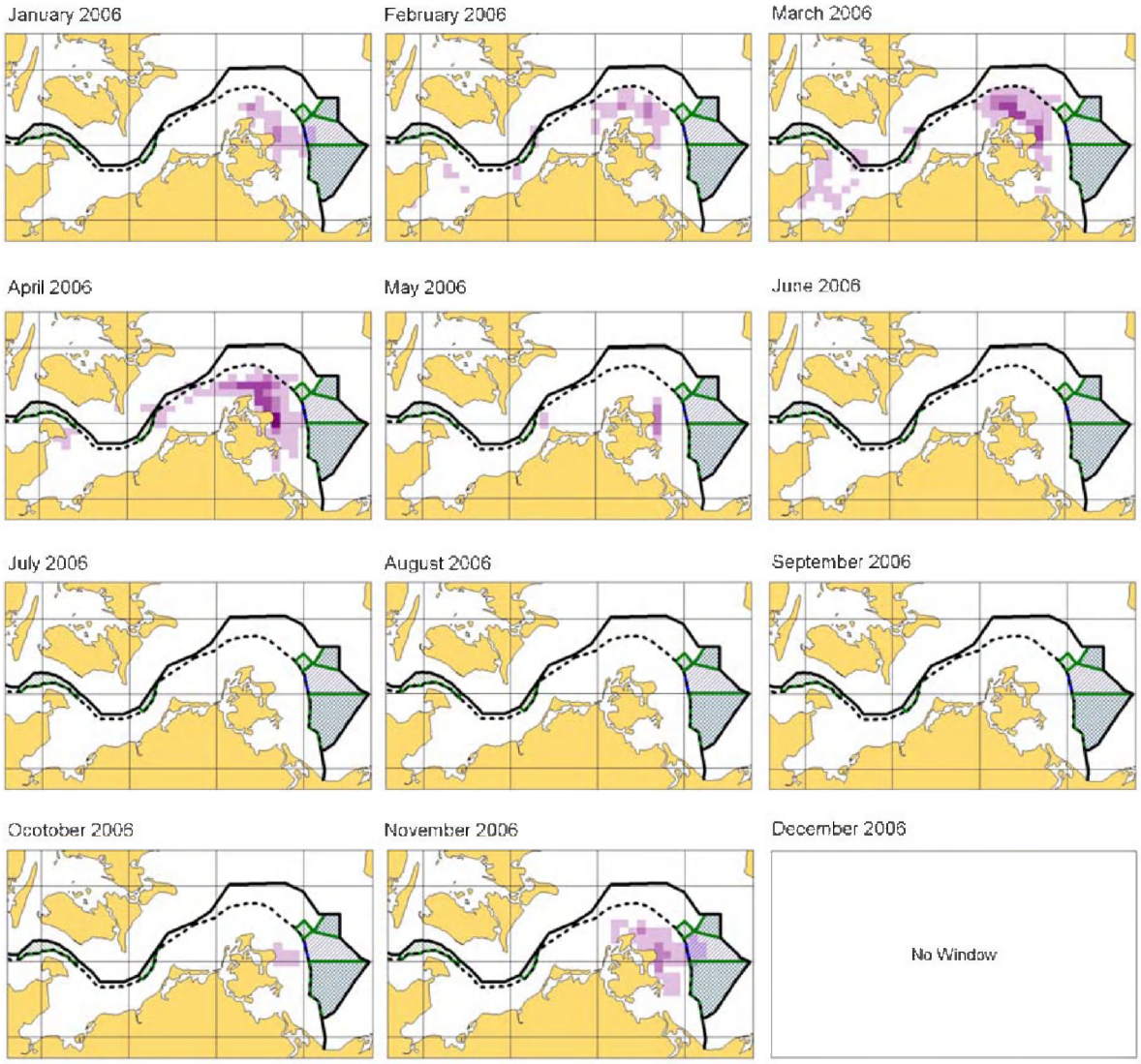


Figure 2c.
Calculated fishing time (hours) of midwater pair trawls (PTM) by 3x3 nmile squares and month.

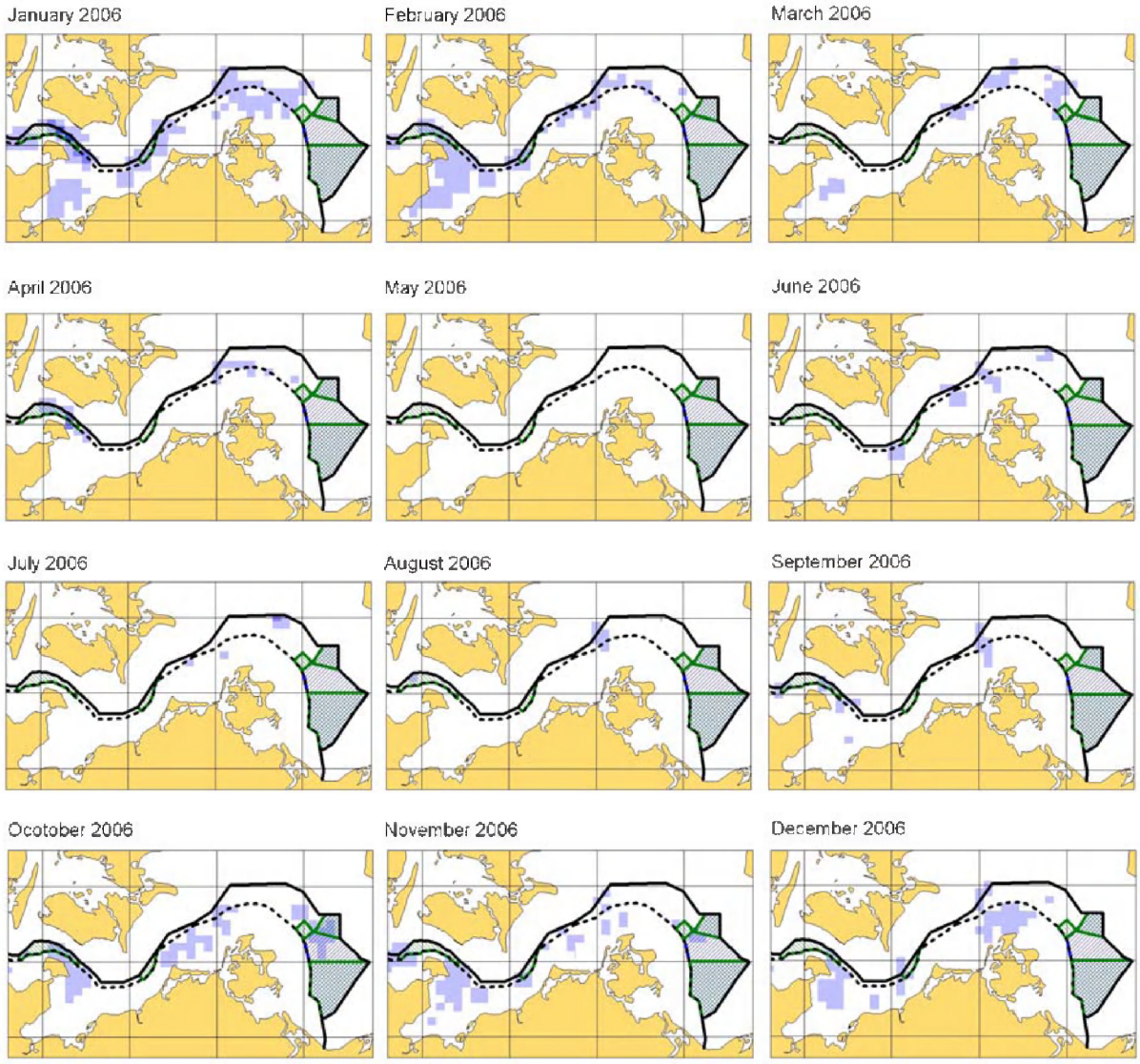


Figure 2d.
Calculated fishing time (hours) of not specified trawls (TX) by 3x3 nmile squares and month.

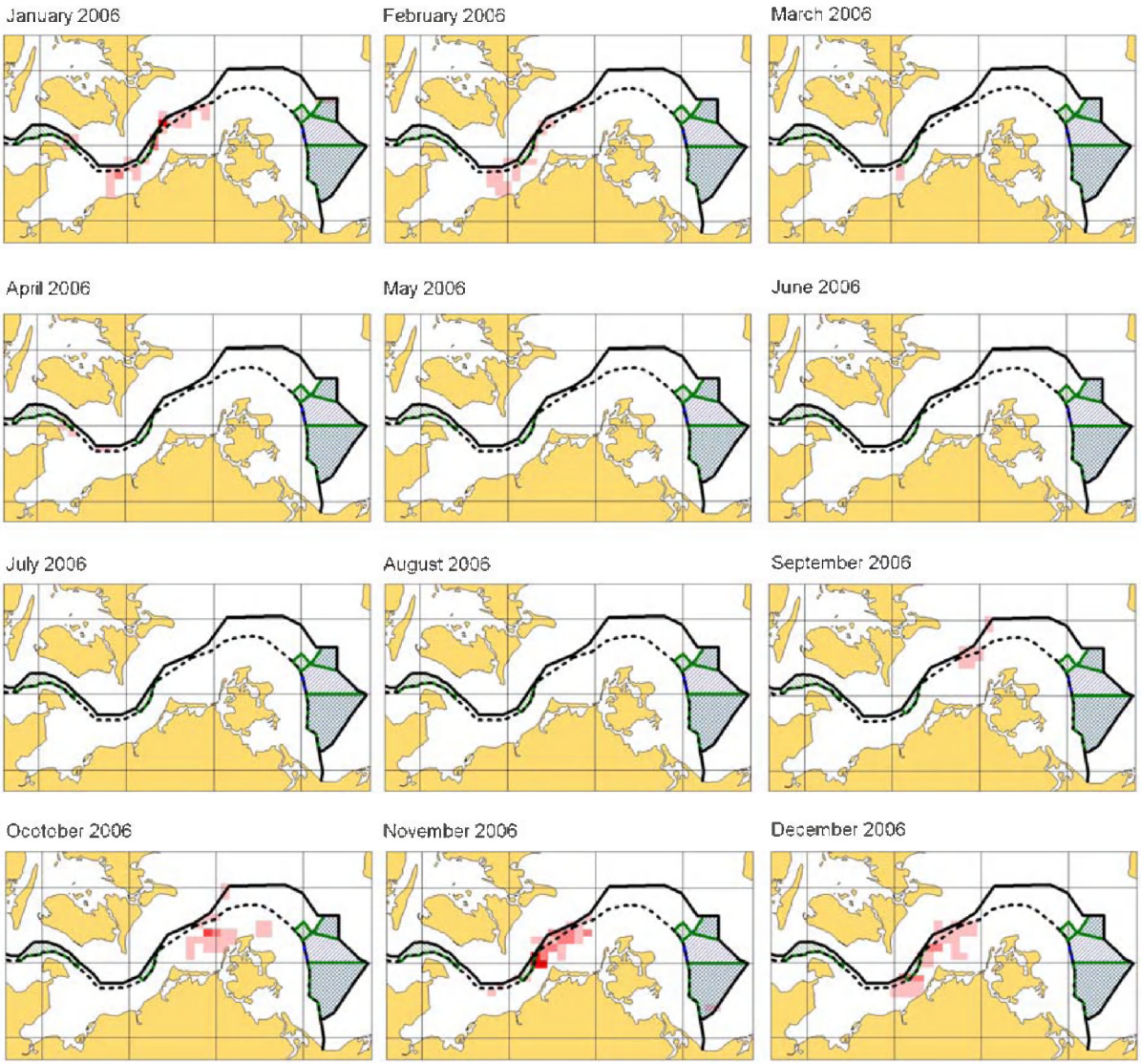


Figure 2e.
Calculated fishing time (hours) of Danish seines (SDN) by 3x3 nmile squares and month.

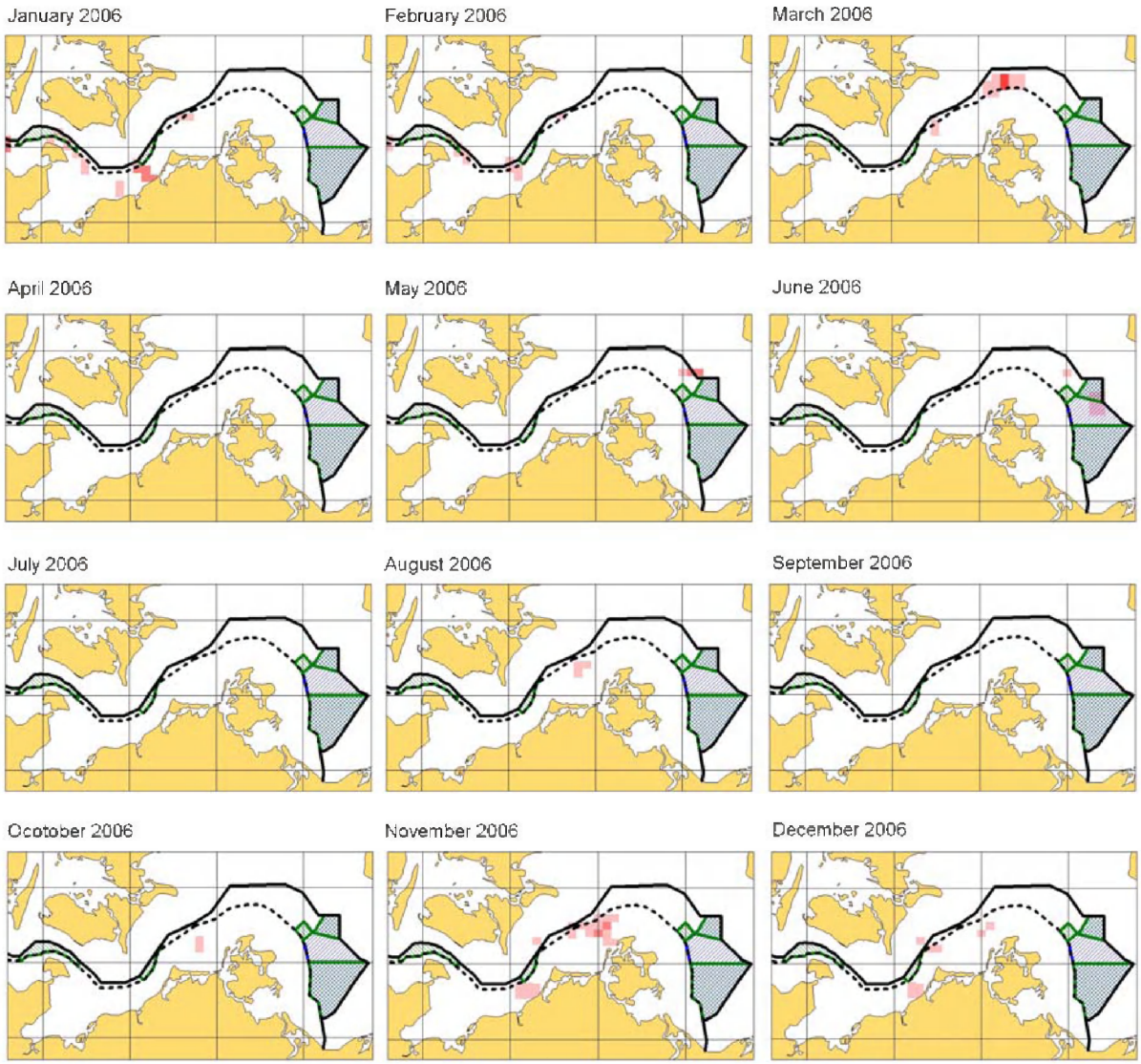


Figure 2f.
Calculated fishing time (hours) of seine nets (SX) by 3x3 nmile squares and month.

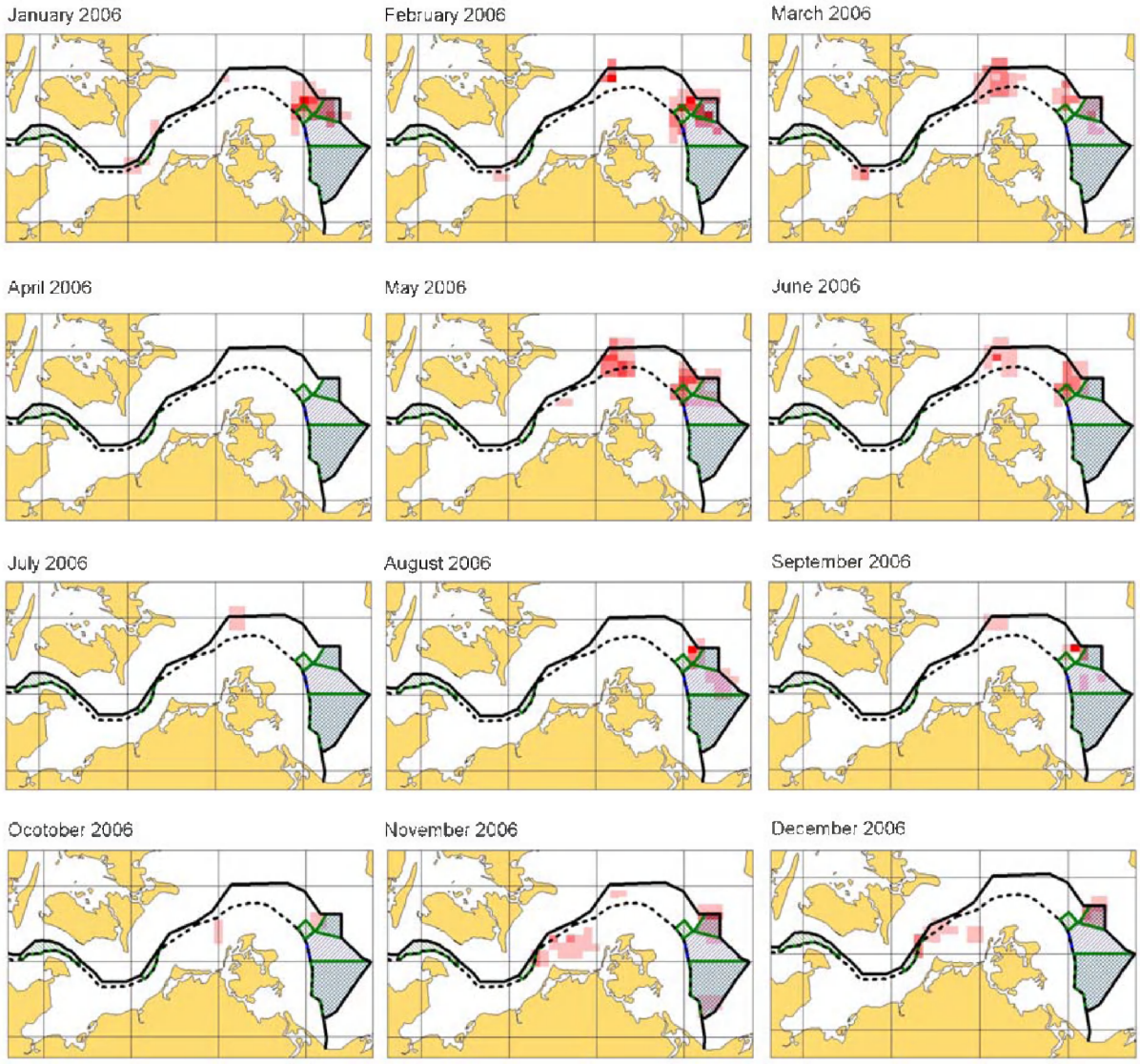


Figure 2g.
Calculated fishing time (hours) of gill netters (GN) by 3x3 nmile squares and month.

Annex 3: Tasks defined in the WKFMMPA 2007 report

Selected and tasks discussed at the Hamburg meeting 11. December 2008 and action taken (need to be taken) to fulfil them are outlined (bold text) under each task (ICES, 2008).

5.1 Analysis of fisheries - habitats (Sandbank/Reefs) interactions

5.1.1 Biological benthic community/species descriptions for each Natura 2000 site:

5.1.1.1 List of activities that can interfere with the physical integrity of sandbanks and reefs (e.g. Stone fishery) [BfN (Krause)]

5.1.1.2 Lists of "typical and characteristic species" (benthos and fish) for the sandbank/reef habitats which can be provided now - e.g. EUNIS [BfN (Krause); BFA-FI]

- ➔ **Assessment schemes marine habitat types under HD**
- ➔ **BfN has had a study on typical fish species associated with habitat by Fricke. BfN (Pusch) will do a list of the associated species and of the impact on the Annex II. BfN already has some study results and a report on this issue. This report should be presented and discussed with A. Sell (BFA-FI). To coordinate the latter information with fish distribution and habitats association studies by (BFA-FI).**

5.1.1.3 Some mapping and survey data are available to provide information on the status of the "typical species" [Krause/BfN; ICES BEWG (chairman Rumohr, report 2005/2006); energy sector e.g. DONG; expertise from inside/outside ICES – ICES (Pedersen) takes contact and coordinates information gathering].

- ➔ **Monitoring and reporting of conservation status (2001-2007) under HD. It is difficult to describe the actual status for the species. Some information exists from videos (Heye Rumohr has videos from bottom in areas north of Borkum Reef Ground). Ideally we would like to know the population status (densities, sizes) of "typical species"in the Natura 2000 sites and be able to say what would happen to the population status if fishing effort with certain gear increased in the sites. However, little or no data about the population status of the "typical species"in the Natura 2000 sites exits. One can only say something about risks from modelling scenarios.**
- ➔ **BfN looks for species associated with reefs and sandbanks. The question is then - what are the typical species for reefs and sandbanks? For reefs it may be easy whereas for sandbanks it is likely more complicated. For reefs there are hard substrate species. How sensitive is these species to fisheries disturbance? Since we have little local information about the benthic species composition we will first have to determine the sensitivity and then later extrapolate to areas of unknown species composition. What species compositions should live in the not fisheries impacted areas? Finally the extrapolated/predicted species compositions should be compared with the species composition actually found on the investigated areas or spots. Unlike in the North Sea, no information exists in the Baltic Sea of whether or not there are bottom impacting fisheries taking place. However, on reefs in e.g. the Adler Ground macro algae are only found on the upper part of the reefs although algae should also**

be found deeper down the reefs with sufficient light, but they are not there.

5.1.1.4 Analyses of the "ecological" states of the characteristic species. [Information from for example: ICES (2005) - Annex 9: Does the fauna in closed areas around wracks, Production Platforms in the Southern North Sea reflect different fishing intensity? Report of the Benthos Ecology Working Group (BEWG). 19-22 April 2005. ICES BEWG 2005 Report. ICES CM 2005/E:07. Ref. ACME, ACE; ICES (Pedersen) takes contact and coordinates information gathering].

5.1.1.5 Benthos Ecology WG should be asked to advice, with the knowledge that exists on North Sea and Baltic Sea Benthos, for each of the "typical species": (a) is its "productivity"/abundance curve likely to be linear, concave or convex, and (b) if concave or convex what is a reasonable estimate of the inflection point? [ICES (Pedersen) asks BEWG (Rumohr)].

➔ **FishPact**

5.1.1.6 The key issue to establish is whether at present the status of the "typical species" is in a favourable condition. Request the ICES expert group/experts (BEWG) about this. The plot of "productivity" against "population size" is a standard method of ICES to assess the population's status of species (mostly fish). [ICES (Pedersen) asks BEWG (Rumohr)].

➔ **FishPact (**This is not the direct aim of Fishpact and can not be answered by the chosen methods. However, FishPact will contribute to the discussion as far as our knowledge permits).

5.1.1.7 Development of management measures to improve the status of species, which are in a bad conservation status. [ICES (Pedersen) asks BEWG (Rumohr)].

5.1.1.8 Workshop on the assessment of the quality of the structure and function of the benthic communities of the sandbanks and reefs focussing on lifespan and size altered by fishing activities. [ICES (Pedersen) asks BEWG (Rumohr)].

➔ **FishPact (**This is not the direct aim of Fishpact and can not be answered by the chosen methods. However, FishPact will contribute to the discussion as far as our knowledge permits).

5.1.1.9 Draw a conclusion on whether or not a reduction in mortality is needed because the actual fishing activities have negative impacts on the conservation status of sandbanks and reefs, their structure and function and their characteristic species. [ICES (Pedersen) asks BEWG (Rumohr)].

➔ **FishPact (**This is not the direct aim of Fishpact and can not be answered by the chosen methods. However, FishPact will contribute to the discussion as far as our knowledge permits).

5.1.2 Quantification/documentation of the possible fisheries induced impacts on the habitats sandbank and reefs:

5.1.2.1 Screen the literature for impacts of fishing - review of existing reviews/literature on the subject, incl. Working Group on Ecosystems Effects of Fishing (WGECO), BEWG, Kaiser et al. [ICES (Pedersen)].

➔ **FishPact**

5.1.2.2 Studies of quantitative relationship/models between gear type/fishing technologies, effort and the mortality on the benthic species and communities on the two habitats in and outside the Natura 2000 sites [ICES (Pedersen) and WGECO].

➔ **FishPact**

5.1.2.3 Quantify effort by fleet, nation, temporal and spatial resolution for each habitat type in and outside Natura 2000 sites. Results in numbers in tables (e.g. hour or m2). Total effort by nation and national efforts combined. [BFA-FI (Fock/Böttcher); BfN and ICES (Pedersen) in cooperation].

➔ **BFA-FI (available)**

5.1.2.4 Mapping of the fishing efforts (previous bullet point) and overlay with the distributions of benthic species distributions and features to be protected [BFA-FI (Fock/Böttcher); BfN and ICES (Pedersen) in cooperation].

➔ **BFA-FI (available)**

➔ **FishPact**

➔ **Workshop, Isle of Vilm 09.-11.04.2008**

➔ **A step by step approach: 1) We know where the habitats to be protected are. It is the maps with dots (VMS positions) on e.g. sandbanks and we know where the reefs are. 2) Describe what kind of fisheries are fishing in the areas (we know that from the BFA-FI data). 3) Ask the fishermen do we have the correct information for our analysis? We need an additional step: "the coupling between fishing effort and predicted impact on the benthic fauna and flora from the FishPact project". To include this latter step we need to solve problems with the spatial-temporal resolution of the effort data. The 3x3 nmil resolution will overlap reefs and sandbanks and other habitat types. The filtered VMS data show exactly the positions where fishing takes place. It is possible to count the number of VMS dots in a certain area to get an index for the effort in that area. One dot represents a certain fishing effort in the area and the dots can be added to estimate the total fishing effort in the area. An impact factor can then be added to the fishing effort. At present the resolution of the VMS dots is one dot per 2 hours. Higher resolution will be achieved when the EU decides to change the VMS regulative and increase the VMS data frequency to for example 10 minutes. A problem with the present 2 hour VMS frequency is that there can be fishing on reefs although no dots are found in the reefs. However, from VMS dots it is possible to estimate fishing effort by fishing gear metier with relatively high resolution. The optimal resolution from the 2 hour VMS frequency data can be calculated. We will need fishing effort per year (2006) but also fishing effort over a longer time span back in time. As far back in time as possible.**

5.1.2.5 Additional data about fine scale temporal and spatial fishing effort, by-catch of non-target species from commercial fishermen. Specification of relevant data (fishing effort of vessels > 15m length (no VMS), < 8m no logbook obligation) [ICES (Pedersen) in cooperation with others, BfN project on bird bycatch in the Baltic Sea].

5.1.2.6 After the identification of potential conflicts, on a case by case basis (including fishing activities), identify management measures to reduce the negative impact of bottom contacting gears and mortality of characteristic, sensitive species. [Technical ICES expert sub-WKFMMPA working group meetings in autumn/winter 2007/2008 - ICES (Pedersen)].

➔**BfN-Project: Alternative ecologically sound fishing methods in the North Sea (Bioconsult, Schuchardt & Scholle)**

5.2 Analysis of fisheries - species interactions

5.2.1 Fish:

5.2.1.1 Review of catch/bycatch data (commercial, observers on board, scientific surveys); presence data. [BFA-FI (Fock/Böttcher)].

5.2.1.2 Update of existing reports (e.g. Kloppmann, Stelzenmüller) [BFA-FI (Fock/Böttcher)].

5.2.1.3 Review OSPAR and HELCOM reports (check ICES groups also) [BFA-FI (Fock/Böttcher); BfN (Pusch)].

5.2.1.4 ICES Working Group on Fish ecology (WGFE): ToR 1) Conservation status of fishes listed on Annex II of the habitat directive, effects of fisheries on the protected species, conservation measures necessary to reach the conservation targets. 2) Population status and length distribution of fish species, which serve as host for river and sea lamprey. [The ICES Working Group on Fish Ecology (WGFE) needs to be asked for advice].

➔ **Fricke (Museum Stuttgart) is requested by BfN, to prepare a study about, typical fish species associated with reefs and sandbanks & impact of fishing activities**

➔ **Anne Sell and Heino Fock (BFA-FI) will contribute to this if it will be part of the ToRs of Fish Ecology Working Group for 2008.**

5.2.1.5 Update of projects for reintroduction of sturgeon and houting (?) [BfN (Pusch)].

➔ **Pusch (BfN) E&E Project reintroduction of sturgeon in the North Sea and Baltic Sea**

5.2.2 Marine mammals:

5.2.2.1 Conservation status of marine mammals in the German EEZ and in designated marine Natura 2000 sites.

➔ **Assessment monitoring and reporting of conservation status (2001-2007) under HD (BfN)**

5.2.2.2 Review EU regulation 812/2004 reports (2007, 2008) and check if data can be obtained in small spatial and temporal scale (ASCOBANS assessment?) [Working Group on Marine Mammal Ecology (WGMME) reports 2007, 2008, FTZ (Scheidat)].

5.2.2.3 Review/compile data regarding the feeding ecology and nutrition status of porpoises (Jastarnia, BfN project, FTZ, Dutch and Danish projects) in relation to potential food competition with fishing activities (industrial fisheries) [BfN/FTZ (A. Gilles?, FTZ)]

5.2.2.4 Review/ compile information on gear specific bycatch rates on marine mammals (Dutch IMARES study for porpoise bycatch) [ToR for WGMME; FTZ (Scheidat)].

➔ **German Hydrographic Museum (DMM), Database about stranded and by-caught harbour porpoises in the Baltic Sea**

➔ **BfN Workshop, Isle of Vilm 5.-9.05.2008: Impact of fishing activities on seabirds, marine mammals and protected fish species (in preparation)**

5.2.2.5 Review/compile health data [check if index of condition is available and if link to food availability exists; look at pathology workshop report of European Cetacean Society 2007; ask Garcia-Hartmann].

5.2.2.6 Review/compile telemetry data from UK, Denmark, Netherlands, Germany for seals; if possible combine it in a single database to describe feeding areas [CWSS – check Quality Status Report; EIAs Rodsand; NERI?; University of Kiel?; NERI (Sveegard)].

5.2.2.7 Use temporal distribution data of porpoises together with information on the relevant fishing activities to determine potential conflicts – for bottom set net fishery details on gear type, net length and soak time, bycatch rate [FTZ (Scheidat and Herr); BFA-FI (Fock)].

➔ **Herr (FTZ) and Fock (BFA-FI)**

5.2.2.8 Model seal distribution in offshore North Sea based on aerial survey sighting data to identify areas offshore of importance and potential conflict [FTZ (Scheidat and Herr)]

5.2.2.9 Review results of MPA workshop and small cetaceans by the European Cetacean Society 2007 [MUMM (Haelters)].

5.2.2.10 Review and investigate bycatch of seals – particularly gear type, amount of bycatch [NN?].

5.2.2.11 Combine aerial sightings and fishery data on static gear and trash and ghost nets [Check program "fishing for litter" (Veerman) – FTZ (Herr and Scheidat); Steins].

5.2.2.12 Review OSPAR reports (and assessments) on seals and harbour porpoises [NN?].

5.2.3 Birds:

5.2.3.1 Review species specific data on bycatch of birds [ToR for WGSE 2008 (ICES, 2007b), FTZ (Garthe); BfN].

➔ **Observer program to study the by-catch mortality of resting and wintering seabirds in the Pomeranian Bay (Institute for applied Ecology, IfaÖ in cooperation with FTZ). Project is funded by BfN. Combined knowledge of set net distributions with the fishery effort to evaluate how representative the available bycatch information/data from "Usedom" is for the ongoing fishery in the whole EEZ of the Baltic Sea. If funding is available this work can be made prior to the Isle of Vilm workshop 5.-9. May 2008.**

5.2.3.2 Use temporal distribution data together with available data on small scale spatial and temporal fishing activities to determine potential conflicts [NN?].

5.2.3.3 Analyse data on (fishing-) boat activities during the presence of bird species sensitive to boat traffic [FTZ (Garthe)].

➔ **EMSON report**

5.2.3.4 Review data on diet of bycaught birds (specifically as it relates to food competition) [FTZ (Garthe); BfN].

➔ **FTZ Stefan Garthe**

5.2.3.5 Review information available on alternative fishing gear and adaptations for fishing gear to reduce bycatch [BfN (Pusch, NN?)].

➔ **Pilot project for the applicability of fish traps in the Baltic Sea fishery [Start: July 2007]**

5.2.3.6 Review potential for the fishery to relocate effort in space and time and to reduce the conflict between bird aggregations and fishing activities [BFA-FI (Fock/Böttcher)].

Annex 4: Working Document: Materials and Methods for conflict analyses

For the existing and available data the key analyses to be performed are:

1) Determine a spatial scale at which to analyze catch rates.

Here two options, one better than the other, but both good enough to move the investigation forward.

> Option 1: Get a grid scale finer than the spatial scale of the smallest of the Natura2000 sites but large enough to be meaningful to management and superimpose that grid on the entire German EEZ. For each grid square calculate the CPUE for each gear used in the area. The most usable data matrix would have an entry for each individual fishing event with catch, effort, gear, date, and grid square. Very simple, and people have all known we need this from the outset. If it is awkward legally or socially to work at the scale of individual fishing events, aggregating all the fishing in a week or even a month would give us everything needed. The only consequence would be that we could not explore time-related management options to minimize conflicts on temporal scales less than the initial temporal scale of aggregation.
>
> Option 2: If getting the information on fine-scale grid is just not going to be possible, then the next level up is to get the same fishing information (catch, effort, gear and date [or range of dates]) on coarse scales. Whatever else, the individual Natura2000 sites would have to be data reporting/storing units. Outside the sites it would be most tractable to surround each site with reporting units of the same number of sq km, and sharing a common border.
>
> But whatever the units, participants have known we need these data sets from the start of the project.

2) Birds and habitats data

For the bird and habitat data, we need two types of information, and if possible at the same scale as the fisheries data, and certainly for the same total area. It is pretty unlikely that we can get the bird data on time scales that are very fine (monthly is probably optimistic), but that isn't a big problem. And for the habitat data, time scales finer than season or year are pretty much irrelevant.

One part of the data analysis is occurrence on the space and time scale feasible. We need what exists and we need to organize it systematically. Once we have the best data nature experts can provide, there are standard smoothing algorithms for estimating (with uncertainty) the missing cells in space and time.

The other part is expected mortality rates of each valued ecosystem component (bird or habitat feature) per unit of fishing effort, by spatial unit and time unit. Complete data won't exist here, either, but the team should have all the local data that do exist nicely organized by spatial and temporal units. Those data should exist by now, too.

Where we don't have local data, we interpolate if the data density is high enough. If the data density is not high enough we go to the literature. There are lots of data in the grey literature on seabird bycatch rates and habitat impacts of different gears. If by year 3 the national experts don't have local data to work with, we use the next best data, and those would be from the scientific literature – catch [or damage] rates by density of the feature, per unit of effort.

Once we have the two types of the data, the "conflict analysis" just doesn't seem that hard – a little time consuming, but not hard.

Impacts on the bird or habitat features with no change in fishing are estimated as the product of Effort by gear type per grid square/time unit X best estimate of catch/damage by gear type per unit of effort in that place and time, calculated for all gear types and summed over all the spatial units in the Natura2000 sites. Easy!

Benefits of closing the Natura2000 sites to fishing are estimated by looking at the difference between the above number and the sum of

a) effort by gear type per grid square/time unit in the weeks (if any) when the Natura2000 area is not closed to fishing by each gear X best estimate or catch/damage by gear type per unit of effort, summed over gears and spatial units, AND

b) effort by gear type per grid square OUTSIDE the Natura2000 site, gear X best estimate or catch/damage by gear type per unit of effort, summed over in the weeks and grid squares considered most likely to receive the displaced fishing effort. How this allocation of displaced effort will be calculated is discussed below.

3) How to calculate the impact on fisheries?

Direct impacts (lost potential catch) are just like direct impacts on birds or habitats- product of historical effort by gear type per grid square/time unit X best estimate of catch of target species by gear type per unit of effort in that place and time, calculated for all gear types and weeks (or other time units) affected by a closure, and summed over all the spatial units in the Natura2000 sites that would be closed. Also Easy. (all these estimates have uncertainty, so some bootstrapping or other similar analysis would have to be done, to put CIs on the estimates throughout. But those tools are standard now.)

However, it is also necessary to take the step of assuming that the industry would not forego the lost catch. They would relocate fishing in space or time to take the total estimated lost catch in other places or times. The algorithms to relocate effort can get VERY complex quickly, and that should be the only hard part of the whole project, if people would just get down to work. The "best case" scenario would be to relocate ALL foregone catch (by gear type) to the grid square outside the Natura2000 site that would offer the highest catch rate to that gear type in the same week (or time unit). Whatever that catch rate, you calculate the effort needed to take the foregone yield from the closure. That change in effort has two uses. First, it is a minimum estimate of the cost of the closure to the fishery. Second, multiplied by the expected bycatch/damage estimate for that grid square and gear type, it is the estimate we need for b) above.

Now the assumption that ALL the effort will move to the grid square with the highest catch rate that week is probably unrealistic. There are concentrations of effort so high that local depletion occurs rapidly. Hence additional scenarios – not the Minimum possible impact, but the more realistic possible impacts would have to be estimated. These involve putting a cap on how much effort would be located into any grid square outside the closed area. Three rules for setting the cap, all of which should be explored:

a) Relocate effort into the grid square with the expected highest catch rate for that gear and week, until the effort in that grid square is as high as the highest effort in ANY square for that gear in ANY year. Once that cap is reached, relocate effort into the grid square with the next highest expected catch rate for that gear and week. Repeat until you have enough effort that the sum of products of the increased effort per grid square times expected catch rate in the square equals the foregone yield from the closure (historic fishery operations inform us about the maximum concentration of effort the industry will tolerate, and the detailed spatial features of an area does not change that upper bound)

b) Relocate effort into the grid square with the expected highest catch rate for that gear and week, until the effort in that grid square is as high as the highest effort ever observed in THAT SPECIFIC GRID SQUARE in any historic year. Repeat as in a) (Historical fishery operations inform us about the distribution of tolerable concentrations of effort in space, as well as overall). If we only have very short time series of effort per unit, then it will be necessary to make some arbitrary assumption about how much effort might increase per unit area – say no more than 25% above the highest observed for each cell. This is something we can discuss with the industry.

c) Relocate effort into the grid square with the expected highest catch rate for that gear and week, until the effort in that grid square is as high as the highest effort within any grid cell in the Natura2000 site in that year. Repeat as in a) (Fishing operations in the specific year reflect specific conditions in that year, and these need to be considered in the simulation. Fishermen inside the Natura2000 site are fishing at their density tolerance now, and they would keep that density tolerance anywhere else.

Between those three (or 4 if we do both things in b)) scenarios we would have explored enough different possibilities that there would be a basis for informed dialogue on consequences of closures.

Annex 5: ToRs WKFMMPA workshop 2008

2007/2/MHC11 The **Workshop on Fisheries Management in Marine Protected Areas** [WKFMMPA] (Chair: Jake Rice, Canada) will meet at the ICES Headquarters in Copenhagen, Denmark, from 2–4 June 2008 to:

a) consolidate all information on position, effort, and fishing activities in and around the Natura 2000 sites, and finalize maps and data tables of this information;
b) review all Conservation Objectives that have been proposed by the German Nature Ministry for each Natura2000 site for clarity and specificity, and if necessary provide operational ecological interpretations of individual objectives;
c) based on a) and b), identify all areas where fisheries activities may affect achievement of the Conservation Objectives, and to the extent possible describe and quantify the associated risks;
d) consolidate and report any other information on fisheries operations and goals that may be relevant to fisheries management plans in the Natura 2000 sites, including social and economic information;
e) review socio-economic aspects to be considered in fisheries management plans in the Natura 2000 sites;
f) develop options for managing fisheries in and around the German Natura 2000 sites, including consideration of co-management systems appropriate for management within an ecosystem approach. For each option report on the possible impacts of the management measure(s) on the fisheries, and the likelihood of achievement of the conservation objectives for the site.

WKFMMPA will report by 15 August 2008 for the attention of an ICES review group.

Supporting Information

PRIORITY:	High as an advisory request from the German government
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	Action Plan No: 2.2, 2.3, 2.11, 2.13, 3.2, 3.3, 5.2, 5.3 Back to back meeting with WGECO has been highly appropriate to facilitate the progress and success of the workshop. This was not an option for 2008, however, WGECO will consider relevant questions that may arise in preparing 2008 WKFMMPA. ToRs e) and f) in particular should build upon existing work in ICES, particularly ACOM and WGECO, and the Guidelines for Implementation of the European Marine Strategy (CRR #273).
RESOURCE REQUIREMENTS:	There are ongoing research programmes in the North Sea and in the Baltic which may provide input to this group. The additional resource required to undertake additional activities in the framework of this group is negligible.
PARTICIPANTS:	The Group will be attended by German scientists and by participants from EU member states bordering the German EEZ, such as UK, The Netherlands, Denmark, Sweden, Poland, and other ICES member states that are able to contribute with their experience in similar or related cases. Participation of representatives for fishermen and the fishing industry is important.
SECRETARIAT FACILITIES:	Meeting facilities as appropriate
FINANCIAL:	Costs including travel and per diem will be covered by a project sponsored by the German Federal Agency for Nature conservation, INA Vilm, Germany.
LINKAGES TO ADVISORY COMMITTEES:	ACOM, ACOM
LINKAGES TO OTHER COMMITTEES OR GROUPS:	There is a very close working relationship with the groups of the Fisheries Technology Committee. It also is of close relevance to the Working Group on Ecosystem Effects of Fisheries, and to the Living Resources Committee and the Resource Management Committee.
LINKAGES TO OTHER ORGANISATIONS:	none

Annex 6: Draft management scheme document for Natura 2000 sites

Suggested structure of a management scheme document for each Natura 2000 site

1. Conservation objectives

1.1 Species and habitats to be protected
1.2 Management implications of the conservation objectives
1.3 Current state of species and habitats at the site
1.4 Monitoring requirements

2. Fishing activities (commercial and recreational)

2.1 Fishing activities which may cause deterioration or disturbance
- within site boundary
- around boundary

2.2 Assessment of the significance of each fishing activity
2.3 Fishermen involvement and knowledge
2.4 Fishermen cooperation
2.5 Socio-economic issues

3. The need for management

3.1 Assessment of existing fishing activities and site conservation objectives
3.2 Identification of the need for management (conflicts analysis)
3.3 Investigate potential management measures

4. Development of a fisheries management plan for the site

4.1 Suggested management measures
4.2 Management scenarios
4.3 Monitoring programme for the site and reporting structure
4.4 Evaluation/revision plan