

Case Study:

Site selection of fisheries areas for Maritime Spatial Planning with the help of tool “Marxan with Zone” in the pilot area Pomeranian Bight

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Executive Summary

Extensive specific data are constantly gathered for selected fisheries management issues. Those data have been developed for stock evaluations and fisheries research. Suitability maps however do hardly exist. Especially such data and maps are lacking that display the most valuable areas for fish spawning, recruitment and catches and which also take the limitations into account that are set by operation range of small coastal vessels or by competing uses and functions of the sea. This study takes first steps to show how the tool "Marxan with Zones" can be applied to produce such suitability maps. It is a first trial to localize best suitable fisheries areas for the purpose of integrating the fisheries issue as a sea use with spatial claims into Maritime Spatial Planning with the help of a decision support tool. The produced maps – if underpinned by good and reliable data – provide a tool to display the claim of fisheries as an important sea use in competition with other spatial claims for sea space. The results of the report can - due to very scarce spatial data - only be preliminary. However they demonstrate a new way how this very valuable information can be introduced appropriately into Maritime Spatial Planning schemes.

1. Introduction

1.1. Scope of the project

Fisheries are seldom included in Maritime Spatial Planning. This is partly caused by lack of data but also because it is often regarded as a traditional sea use that is guaranteed by special rights by the Law of the Sea and has thus not to be restricted or limited by other sea uses. Now that the discussion about competing sea uses in claim of the same sea space is becoming more and more intensive, it is a mere question of timing when to start treating fisheries in the same way as other sea uses. In consequence, a detailed analysis of suitability factors for exploiting the fish resources in the most sustainable way, a scheme of priority areas, restrictions and even of some no-take zones for fishing could offer a way to fully incorporate fisheries into a system of Maritime Spatial Planning.

Accordingly, this study aims to look at features of the sea areas in the Pomeranian Bight/Arkona Sea that describe and quantify the productivity of the area for fisheries. It also displays the limits set to fisheries by other sea uses or by the need to protect the resilient ecosystem. The study also incorporates operational factors of the on-going coastal fisheries practice like vessel size or operational distances in order to delineate suitable areas for certain kinds of fisheries in the pilot area.

The study was initiated by WWF within the project BaltSeaPlan to test if Marxan is a feasible tool even though it was known from the beginning that the work needs to be proceeded to develop the necessary definitions to achieve reliable results. It is therefore built on the assumption that zones with restriction for fishery activity can

- > Guarantee a profitable fishery, with good chances also for small fishermen
- > Protect the nature in general
- > Lead to a sustainable stock development.

Legal aspects (see instead BaltSeaPlan Technical Report No. 23, Schmiedel & Winter 2011) are excluded from the analysis as well as non-spatial mitigation measures (total allowable catches (TAC), minimum mesh size and other gear restrictions). Also the size of the closures and restricted areas was not influenced directly but accepted as proposed by the scenarios. Only very small patches were tried to avoid.

How Marxan can be applied to find valuable areas for fisheries instead of delineating sites where it is prohibited was already published (Ban, Vincent 2009). With the approach it was possible to choose areas which are suitable for all fisheries in relation to the existing fishery intensities and to one cost layer. In this study it is tested how the more complex site selection tool Marxan with Zones can model the requirements for a fishery approach in the Baltic Sea. The study site is limited to the pilot area Pomeranian Bight/Arkona Basin.

Unlike the first study with Marxan within the pilot area on the possibilities for offshore wind power (Göke 2011), the results of this study were not integrated into the planning process for the pilot area. The main goal of this report is testing the options of the modelling tool “Marxan with Zones” for a further application in real planning situations. During the development of the study, it had additionally to be realized that some data could not be accessed as expected. Therefore the author had to work with reduced input data and had to construct supporting data layers based on inhomogeneous data or data with a very low degree of detail in order to test the tool. The modelling results can therefore only be used to illustrate the options of Marxan with Zones and point out existing data gaps. **It has here to be stated explicitly that the quantitative results as well as the site proposal rely on these input data and thus have to be handled with extreme caution.** Especially the fisheries data are available only in very differing qualities and focussing on aspects relevant for the respective studies for which they were compiled. This study is specially focussing on the conflict between the diving birds and setnets which are to a high percentage the main gear of small fishing vessels with lengths below the reporting obligation or without site specific reporting. Thus data from small fisheries without or low reporting obligation were especially important.

1. Introduction

Marxan with Zones allows the combination of different target values from the fisheries sector as well as factors limiting fisheries suitability:

- > Fisheries target values: areas with high fishing success or abundance of commercial fish
- > Limiting parameters for good fishing suitability, ranging from geographical (distance from port) over biogeographical (habitat diversity, salinity, existence of spawning sediments)
- > Biological values that conflict with fisheries suitability (protected habitats and species, bird or mammal abundances, etc.)
- > Competing sea uses (existing shipping lanes, wind parks, sediment extraction).

The tool also allows to set a variety of targets in specific zones, e.g. setting up a management concept for all uses of the sea or simply setting targets for different types of fishery. In the latter case we looked at good conditions for small scale coastal fisheries in comparison with larger fishing vessels. This reflects the real situation, as in the pilot area more than 66% of the vessels are small scale (below 10 m length) with a limited operational range. Those vessels were until 2012 exempted from a reporting in detail (From 2012 on vessels below 8m in length do not have to report by logbooks).

The results of the assessment are different scenarios following different planning priorities which allow the planners to visualize different planning options. Within the planning cycle the Marxan tool can offer an interim evaluation of the value of a certain area for a certain type of fisheries. Thus the results can be used to defend the fisheries case against other spatial claims for the same area in a planning phase when the zones of the spatial plan are negotiated with stakeholders and within the planning team. The results can also form the basis for negotiating restrictions and measures that are allowed or not in a certain area. In the current study gear specific or species specific maps were not possible to produce due to lack of appropriate data. But in a follow up study this could well be done – the tool offers such possibilities.

1.2. Description of the area of the study

As study area the pilot project area Pomeranian Bight/Arkona Basin was chosen which comprises shares of the EEZs of Denmark, Sweden, Poland and Germany and stretches to their respective shorelines. (Figure 1)

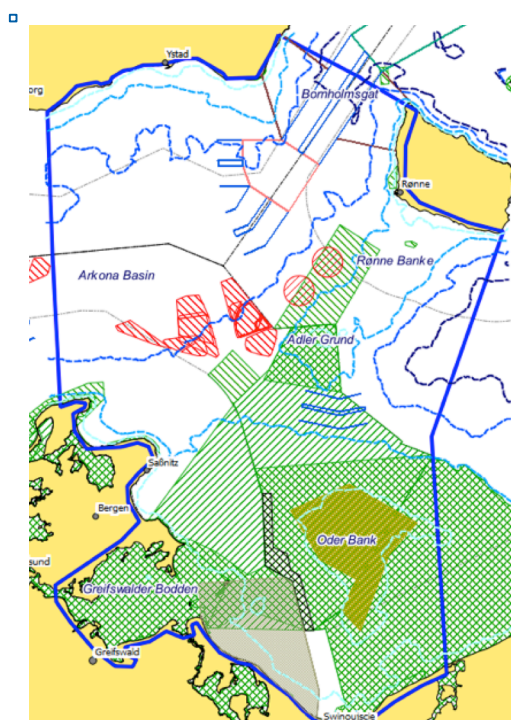


Figure 1 - Overview over the pilot area with nature conservation areas in green, offshore wind farms (red hatches) and the closure for active gear at Oder Bank and the restricted zone north of Usedom (grey). The EEZ border between Denmark and Poland not drawn due to unclear legal status. The Northern Approach / Roadstead Seaports of Swinoujście and Szczecin is hatched in black.

In total about 14,100 km², the topology is clearly structured. Arkona Basin in the northwest and connected through Bornholmsgat with Bornholm basin, supplies with depths larger than 40 m suitable spawning areas for cod whereas the south is dominated by shallow areas between 5 and 25 m which stretch over the open waters completely to Bornholm and which are preferred by diving birds. Adlergrund and Rønne Bank with depths between 5 and 25 m have an uneven surface with sediment from sand and gravel to musselbeds on boulders. Oder Banks is forming a sandbank of fine sands with depths less than 10 m. (Gee (ed.) et al. 2012)

Large parts of the more shallow areas are protected by Natura 2000 areas and an area closed for active fishing gear is placed on the Odra Bank. Germany has installed protected river mouth in several cases which are too small to be considered in this study. A zone of 3 nm from the baseline in Germany is restricted to trolling and passive gear, additionally an area north of Usedom up to the latitude 54° 15' is closed for trawling with mesh sizes below 105 mm between June 1 and October 31. (IfAÖ 2007)

Shipping routes are crossing the pilot area as connections from east to west as well as north–south. The central part of the study area shows good conditions for the use of wind power. Several sites are therefore under consideration for offshore wind parks. (read Gee (ed.) et al. 2012 for further information)

The pilot area covers important spawning areas for the commercial fish cod and herring (Gee (ed.) et al. 2012). The exact locations of the important areas for the different fish stages are only partly known. In figure 2 the spawning areas for herring are indicated. They are located at depths up to 6 m on sandy substrate and in macrophyte habitats. The information for the spawning areas for cod has changed with time. Recent studies indicate that cod spawns in the Arkona basin at depths below 40 m and even larger depths in the Bornholm Basin which partly extends into the pilot area south of Bornholm (Bleil, Oeberst 2007). The nursery areas for cod are also not well known. Older data indicate areas in the Arkona Basin itself stretching through the Bornholmsgat and southwards around Bornholm. Since different versions of this information as GIS layer exist, these datasets were not considered reliable or applicable for the working scale of this study. In the BALANCE project different areas were estimated by asking fishermen about their experience with bycatches of young cod. The areas are variable and were indicated to be typically at the south-eastern slope of Rønne Banke and north of Rügen. (Nielsen & Kvaavik (eds) 2007)

Non-commercial fish is also protected by the Natura 2000 sites, in the open sea it is sturgeon and twaite shad with very low densities and additional species in the Greifswalder Bodden. The sturgeon is a small stock recruited from an on-going reintroduction project in the Odra system.

1. Introduction

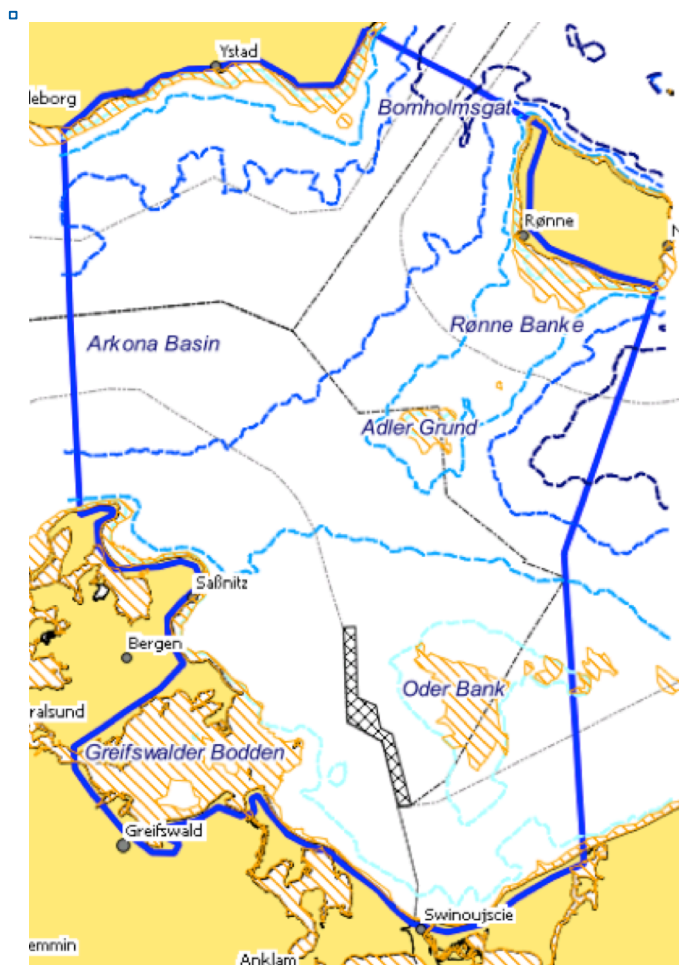


Figure 2 - Spawning areas for herring (hatched)

The Pomeranian Bight with Adlergrund and Odra Bank is one of the ten most important habitats for migratory sea birds in the Baltic Sea for wintering, resting and moulting. Ideal conditions for diving species with food supply within depths of up to 20 m, are not only found in the coastal zone but also in the open shallow waters, e.g. at the mussel beds of Adlergrund and Odra Bank. (Gee (ed.) et al. 2012)

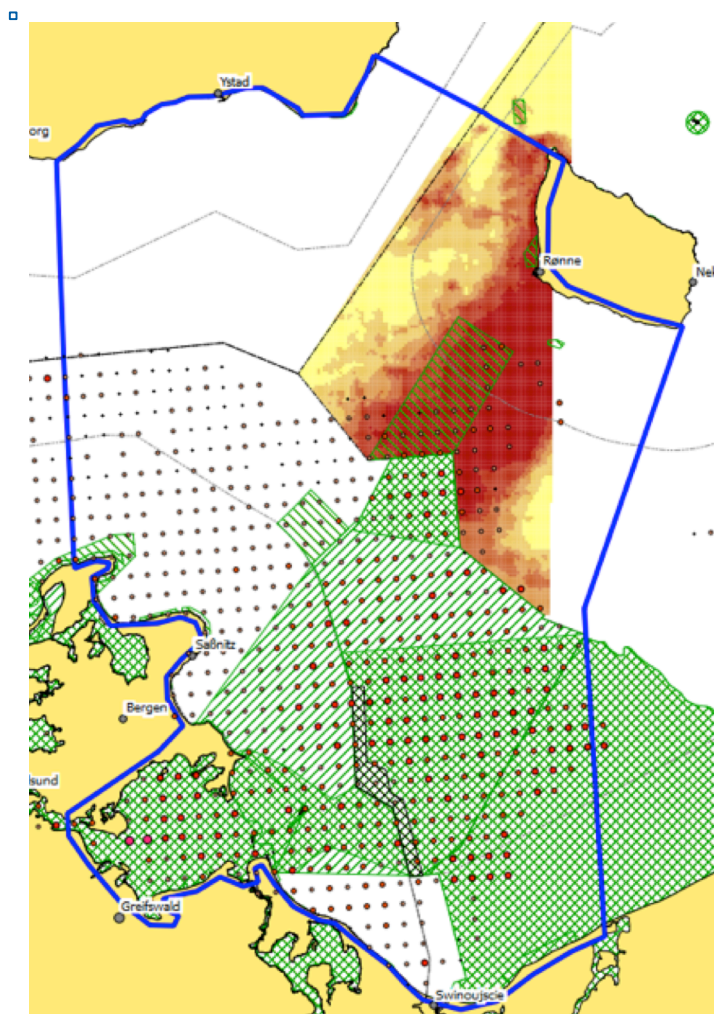


Figure 3 - Monitored abundance of diving birds during November to April from the German Seabird at Sea database (circles) and modelled distribution of the long tailed duck in Denmark (Petersen & Nielsen 2011)

The most abundant sea ducks are long-tailed duck, common scoter and velvet scoter with slightly differing demands on their wintering grounds. For common scoter the Oder Bank is one of the most important resting areas in the Baltic Sea. Another bird present in winter is the Red-necked grebe. (Gee (ed.) et al. 2012)

The harbour porpoises which have been sighted in the area are expected to be of the eastern Baltic population which has a much lower density than that of Kattegat and the Belt Sea. The numbers of individuals of this population have decreased to a level between 200 and 400. It has therefore been found that bycatches, habitat deterioration and disturbance should be strictly avoided to not further harm the population (HELCOM, 1996). The harbour porpoise individuals are highly mobile and their distribution within the pilot area not exactly known (Signe Sveegaard, personal communication). In future more detailed information can be expected as an output from the international project SAMBAH (Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise, 2011 - 2014)

The area has regional importance for fisheries. The total commercial fisheries landings show a medium intensity compared to the rest of the fishery activity in the Baltic Sea, fig. 4 c. The importance for fisheries with specific gears differs. In figure 4 a and b the examples bottom trawl and coastal and stationary fisheries are chosen as two examples with high intensity in the area.

ICES landings do not include all fishing activities. Small vessels with a length below 10 m are not obliged to report their landings. In the report on fishery activities (IfaÖ 2007) it was estimated that 94 % of vessels with their harbour of registry in Mecklenburg-Vorpommern are falling under the below 10 m – margin and thus not obliged to report. The small scale fishery has a specific role since it is contributing to a high rate to the stationary fisheries. The size also limits the operation range from the respective harbours.

1. Introduction

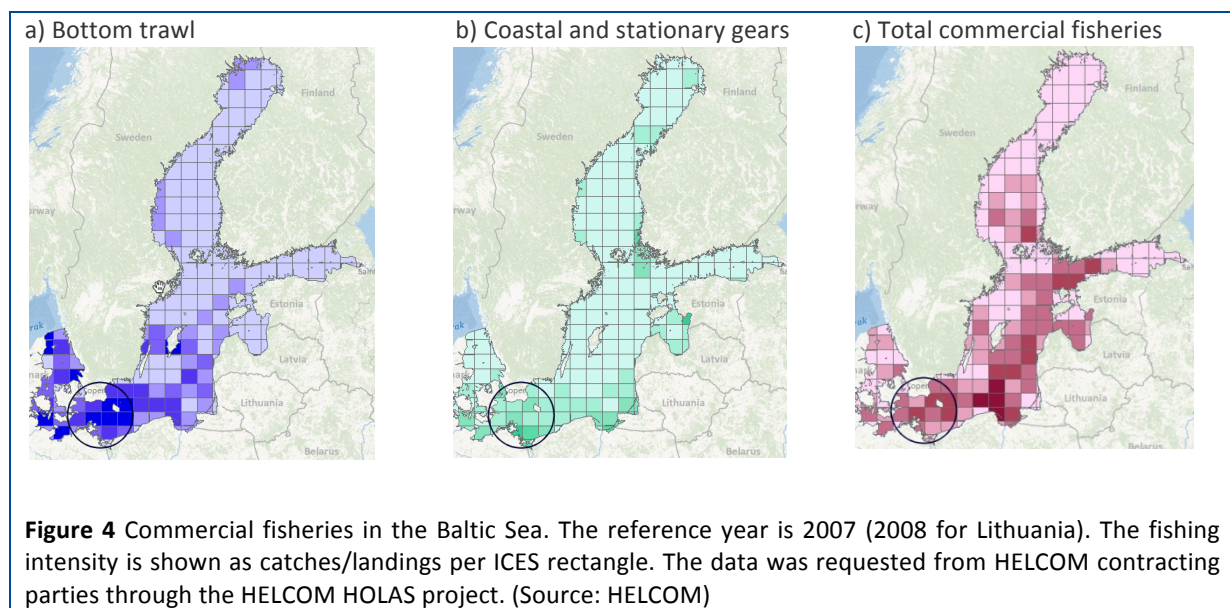


Figure 4 Commercial fisheries in the Baltic Sea. The reference year is 2007 (2008 for Lithuania). The fishing intensity is shown as catches/landings per ICES rectangle. The data was requested from HELCOM contracting parties through the HELCOM HOLAS project. (Source: HELCOM)

1.3. Existing and expected conflicts between fisheries and other uses and nature protection and management options

Marxan is applied to develop solutions for the problems that were identified during the conflict analysis. As basis for the conflict identification the EMPAS study (Environmentally Sound Fisheries Management in Marine Protected Areas) was taken. It was a substantial study conducted by ICES during the years 2006 – 2008 for the German government to gather information on the distribution and impacts of fisheries in Natura 2000 sites in the EEZ. ICES analyzed the effects of each type of fishery gear separately.

The seabed habitats are vulnerable to bottom trawling. For reefs bottom trawling has ecological as well as physical effects whereas for sandbanks mainly ecological effects are expected by mobile bottom-contacting fishing gear (ICES2009). The extent of the impact was not quantified.

It was found that the greatest impact for both seabirds and harbour porpoises arises from bottom setnets, in which the animals drown unintentionally. A detailed overview on the different kind of impacts is shown in table 1. Additional to the risk of bycatches for birds and harbour porpoise, a risk for food depletion and disturbance was identified. For protected fish, e.g. sturgeon or twaite shad a risk of bycatch exists. In this case the risk is not limited to setnets.

Fisheries have also an immediate effect on the commercial target species. Additional to reducing the fish stock, the general effects is that *the larger specimens are removed by fishing and over time this selective fishing mortality is expected to lead to changes in growth rate and reductions in age and size at maturity.* (ICES2006)

Table 1 Conflict between diving birds, harbour porpoise, twaite shad and sturgeon and fisheries reduced to species used in the model, a = very conflicting (very likely), b = conflicting (likely), c = little conflicting (little likely), d = no conflict (not likely) (source ICES 2009)

		Gillnet demersal	Longlines	Otter trawl	Danish sein	Pelagic trawl	Food depletion - industrial fisheries	Food depletion - mussel fishing	Disturbances by fishing
<i>Gavia stellata</i>	Red-throated Diver	a	c	d	d	d	b	d	a
<i>Gavia arctica</i>	Black-throated Diver	a	c	d	d	d	b	d	a
<i>Podiceps auritus</i>	Slavonian Grebe	a	c	d	d	d	b	d	b
<i>Alca torda</i>	Razorbill	a	c	d	d	d	b	d	b
<i>Podiceps grisegena</i>	Red-necked Grebe	a	c	d	d	d	b	d	b
<i>Uria aalge</i>	Guillemot	a	c	d	d	d	b	d	b
<i>Cepphus grylle</i>	Black Guillemot	a	c	d	d	d	b	d	b
<i>Clangula hyemalis</i>	Long-tailed Duck	a	d	d	d	d	d	a	a
<i>Melanitta nigra</i>	Common Scoter	a	d	d	d	d	d	a	a
<i>Melanitta fusca</i>	Velvet Scoter	a	d	d	d	d	d	a	a
<i>Podiceps cristatus</i>	Great Crested Grebe	b	c	d	d	d	b	d	c
<i>Mergus serrator</i>	Red-breasted Merganser	b	c	d	d	d	d	d	c
<i>Sterna hirundo</i>	Common Tern	d	c	d	d	d	b	d	d
<i>Sterna paradisaea</i>	Arctic Tern	d	c	d	d	d	b	d	d
<i>Larus minutus</i>	Little Gull	d	c	d	d	d	c	d	d
<i>Phalacrocorax carbo sinensis</i>	Great Cormorant	not included in EMPAS							
<i>Phocoena phocoena</i>	Harbour porpoise	b	c	c	b	c	b	d	c
<i>Acipenser sturio</i>	Sturgeon	a	a	b	a	d	d	d	d
<i>Alosa fallax</i>	Twaite shad	a	d	a	c	a	d	d	d

In the Baltic Sea, several non-spatial as well as spatial options to manage the fish stocks have been agreed. One of the main measures are the yearly appointment of total allowable catches (TAC) for several stocks (cod, herring, salmon, sprat and plaice) minimum mesh size and closures. In the internal and territorial waters additional national restrictions apply.

2. Method and Data

With Marxan with Zones, zones can be defined in which either specific local restrictions apply or which are open for fisheries. The target is to find areas where restrictions have the least impact on fisheries and at the same time help best to achieve the specific protection targets. It is possible to make differences between different types of fisheries as well as different conflicts and restrictions. Besides gear types it is also possible to consider the specific requirements for small scale fisheries with their limited operation range.

The measures taken into consideration in the scenarios are on the one hand areas completely closed for fisheries and on the other hand areas with gear restrictions. The no-take areas aim at minimizing the disturbance for all species and habitats, avoiding size selection of the commercial fish by fisheries and supplying an area with undisturbed fish stock development that is sustainable.

Many different measures can be applied to protect different species and habitats. In this study they are only handled as one restriction zone disregarding the specific needs of the area. Examples for management measures already in use are:

- > No active gear
- > No bottom trawling
- > Minimum mesh size to avoid bycatches of small and underage fish
- > Restrictions on the use of setnets to avoid bycatch of birds or harbour porpoise
- > Other, e.g. pinger for reducing bycatch of harbour porpoise without reducing the catch.

The measures constrain fisheries to different degrees. Additionally, while some of the protection targets require the same restriction and by that does not increase the restrictions further, other protection targets within the same area require different measures and have therefore more impact on the fisheries.

Furthermore, the requirements can differ in the different vertical zones or in respect to the time of the year in which protection is needed. E.g. migrating birds can require seasonal protection and the risk of bycatch of sturgeon (demersal) and twaite shad (pelagic) occurs in different vertical zones. Also vertical zoning and seasonal restrictions or closures can be handled with Marxan with Zones by setting their impact lower than that of other measures. But none-reoccurring temporal irregularities are difficult to handle with a spatial tool like Marxan. This can be relevant for the protection of the juvenile cod. The BALANCE report 20 emphasizes the fact that it is difficult to protect juvenile cod in the Baltic Sea with closures or restrictions in specific areas since its occurrence is variable due to the hydrodynamic conditions in the respective years (Nielsen & Kvaavik (eds.) 2007). This would demand a more flexible management regime including a good spatial and temporal monitoring of the occurrence of the species in the juvenile phase.

2.1. Marxan with Zones

The software Marxan was developed to provide decision support for systematic conservation planning. Marxan with Zones is an extension of Marxan software developed by The Ecology Centre, University of Queensland. (Watts et al. 2009, Watts et al. 2010)

Marxan with Zones has its starting point like Marxan in the wish to use an optimization method, designed to find the most cost efficient suggestions for suitable marine conservation areas which meet a number of ecological, social and economic objectives. Additional to the functionality of Marxan, Marxan with Zones is able to allocate the sites to multiple zones which have different levels of protection and handle several costs or suitability layers independently (Ardron et al. 2010). By that it is possible to manage several activities or uses as well as conservation targets.

The approach is much more complex than Marxan and requires deep expert knowledge. Prior to the modelling targets and conflicts have to be set for each target and cost layer within each zone. Therefore it is recommended to first test the setup with Marxan (without zones) in several projects and then to combine those into one Marxan with Zones project (Ardron, pers. communication).

Like in Marxan, the study area is divided into Planning Units (PU), for which typically a regular raster is chosen, e.g. a raster of hexagons to have the same boundary length between all neighbouring PUs. The costs and the availability of the target features are assigned to the PUs. The terms used in Marxan with zones reflect that it was developed for nature conservation planning. Therefore, it is often referred with “species” to the target features. Different to Marxan, the costs are not merged into one single cost layer but can be specified for each single cost factor.

Several zones can be defined. The targets that are set for the single target features can be further split up to the single zones. The same applies to the contribution each target feature has in each zone and the importance of the costs or conflicts within each zone.

There are several options to influence the clumping/clustering of the zones. It can be influenced how much the selected PUs within one zone or different zones clump together.

Restrictions can be set for each PU, e.g. pre-selection, exclusion from selection or restriction to specific zone(s). The options to define distance or size requirements like in Marxan do not exist, but a lot can be achieved by the boundary costs between the zones.

2.1.1. Marxan with Zones for fisheries

Within this study, a setup was developed which focuses on fisheries as target feature. The more classical approach would be to start from the conservation point of view, with an inner no-take zone and then fewer restrictions in the outer zones.

The good locations for fisheries and the conflicts differ for the gear used, target species and size of the vessels. Since a PU can only be selected for one zone, the zones have to be defined in a way that if two zones partly overlap, a third zone has to be created to represent the overlap. For a complete setup, the consequence is a high number of zones.

This study focuses on testing the approach to apply Marxan with Zones for fisheries and it was limited by the amount of available data. The targets were not set per gear type/target species but only for large and small vessels separately. Small vessels were taken as a separate target since they are limited in their range of operation from their home harbour. The zones are overlapping; small and large fisheries do not completely exclude each other. Thus in this zoning framework it is not meant in the way that zones for small-scale fisheries are closed for large vessels. But within the zones identified for small-scale fisheries, it cannot be guaranteed that it is suitable for large vessels. The settings are additionally slightly less restrictive to strengthen small-scale fisheries and offer opportunities for all harbours within 6 nm.

As an exemplary use, wind power was used as conflicting with fisheries. At the moment, offshore wind power sites are closed for fisheries and have therefore a defined conflict with fisheries. The intensity of the potential conflicts or synergies between offshore wind power sites and commercial fish, other species or habitats are not clarified yet.

For both sizes of vessels, two zones were used with different levels of restriction; a third zone with fisheries completely banned applies to both types of vessels:

Fisheries:

- > No restriction
- > Restrictions to avoid bycatches and to reduce disturbance of the species at risk and food depletion. Possible measures to avoid bycatches include deterring away of animals, disturbance can occur.

2. Method and Data

No fisheries or mixed uses:

- > No-take areas: fisheries prohibited with the objective of nature protection. In the first test settings this zone is merged with the zone “available”.
- > Available: Rest area is needed for technical reasons in the more complex setups. It is also possible to separate uses, e.g. offshore wind parks, from the protected areas.

In the simplified setup, it was not taken into consideration, which kind of measures would be necessary. The measures can be seasonal/temporal variable or differ to protect different species and habitats. If two conflicts occur in the same PU, they are handled the same, no matter if they require the same or different measures. Thus the summed conflicts have the same weight if the same measure would address the conflict or if two different measures are needed which restrict fisheries far more.

Table 2 describes the zoning concept in a simple overview for the basic setup without the technical necessities which are described later:

Table 2 Zoning concept for fisheries in general and small scale coastal fisheries with different levels of restriction

Activities	Zones	Description	Target features
Small-scale fisheries	Small-scale fisheries	Possibilities without conflict for small-scale fisheries, normally near to coast but all other fisheries possible, no restrictions	Short distance from fisheries harbour, high setnet density
	Small restricted	Small-scale fisheries in spite of conflict with species/habitats	
Large vessels	All	No restrictions	High fishing success for all fisheries (except for small-scale fisheries)
	All restricted	Fisheries in spite of conflict with species/habitats with restrictions	
No-take /Mixed use		Fisheries completely prohibited, either due to conflict with other uses or nature protection targets plus rest area without any restrictions. No-take areas are also considered useful for developing full size fishes, therefore should commercial fishes also occur.	High occurrence of vulnerable ecological features / no targets for mixed use

In table 3 the conflicts and available data sources are described in more detail. Data availability and scope of the study is limiting the implemented amount of target features and suitability factors. Bold indicates those used, the list is not exhaustive. Details about the considerations concerning the data are described in the next chapter.

Table 3 Conflicts and data describing the conflict, bold - implemented

Type	Conflict groups	Features describing conflict
Abundance/ecology	Harbour porpoise	No data available
Regulation	Harbour porpoise inside Natura2000	Natura 2000 with protection target harbour porpoise

Abundance/ecology	Diving birds	Abundance modelled from surveys (German seabirds at sea database)
Regulation	Bird inside Natura 2000	SPA
Abundance/ecology	Seabed habitat	BALANCE , marine landscapes best available at the moment
Regulation	Seabed inside Natura 2000	Natura 2000 areas with the respective protection target
Regulation	Fish protected	Natura 2000 with protection target for the respective species
Abundance/ecology	Fish spawning	Cod and herring spawning areas
Abundance/ecology	Fish nursery	Rough outlined with help of Balance report and older data, needs strong improvement and possibly handled flexible according to actual occurrence(REF)
Human uses/activities	Ship routes	AIS data, not used / not visible on relevant fisheries data
Human uses/activities	Offshore wind power	Planning material for Germany and Denmark, completely prohibited, therefore excluded from selection

2.1.2. How to connect costs and target features

The options for Marxan with zones are much more complex than Marxan. In Marxan starting with the two input files for target features and costs, basically only the targets have to be set per feature. In Marxan with zones, a connection between targets and costs to the zones is necessary. This can be achieved for the target features by either also setting targets per zone (and species) or the zone contribution to the feature. The latter solution was chosen. The zone contribution expresses at which ratio a zone adds to the feature target, i.e. if a feature contributes to two zones, the zone with a higher contribution ratio is preferred. The costs get a factor to calculate their importance for each zone. Setting target per feature or target per zone has different advantages and disadvantages:

Setting target per feature

- > By setting targets per gear or commercial species the composition of the fisheries can be influenced.
- > The balance for the size of the different zones can be achieved by setting the factor for contribution of the zone to the target or the cost that a feature has for the respective zone.

Setting target per zone

- > If data for the best profit is available, the most profitable fishery grounds can really be detected
- > If specific ideas exist about the ratio or exact sizes of fisheries, restricted and no-take zones, it can be directly set in the targets for the zone.
- > It is also possible to set target per feature within each zone
- > The zone target file and zone contribution file are not related to each other. (Watts et al. 2008), so these two options cannot be combined.

2. Method and Data

According to the management question, the setup can vary in its complexity. For the more complex setups, one input dataset (occurrence of activity or abundance of species) is used two times in the model and the contribution to the different zones is applied stepwise. After the description of the three setup-concepts below, the initial factors for zone cost and contribution are shown in table 4.

Option 1 - Focus on one management topic

With focus on fisheries, the different levels of fishery restrictions are set as zones and the conflicts only handled as costs. The fishing intensities are used as targets.

Option 2 - Management of different topics

In this setup targets are set for all features, i.e. for the conflicting features as well, allowing a management plan for all uses to be drawn. The conflicting uses are in that case part of the target feature dataset as well as of the costs dataset. For technical reasons, a zone without feature contribution is needed additional to the zones into which the features contribute, thus increasing the number of zones. In the fishery example, the zone without fisheries gets split into a “no-take” zone for conservation reasons and “available” for the rest, e.g. wind farms.

It is slightly uncomfortable having the same dataset at the same time as cost and as target layer, but this can be easily handled by the database.

Option 3 - Complete management

The complete setup is handling additionally the target features as costs for the other zones, i.e. in the case of fisheries selecting also the restricted and no-take areas where the least costs arise.

Table 4 Overview over the three management setups simplified for one fishery type: f-fishery target features, e - ecology target features/costs, u - human uses features/costs, m – medium factor, l – low factor

	Fishery		Fishery restricted		Not take		Rest
	contribute	cost	contribute	cost	contribute	cost	
Var 1	f	e, u	m * f	m * e, u	- (included in zone “rest”)		
Var 2	f	e, u	m * f, l * e	m * e, u	e		
Var 3	f	e, u	m * f, l * e	m * e, l * f, u	e	f	

The last setup is the most objective but also the most difficult to control. The setup was therefore successively increased, starting from the first (simple) version to the most complex version.

It is important to balance the costs between the zones. Otherwise those zones with the lowest costs would be the preferred zone. Therefore one layer was used both as target and as cost in the restricted zone. A factor can also be considered to balance a different number of e.g. fishery and ecological layers.

2.2. Data

This study is building on existing data. For some of the topics the available data is limited or only available at a low resolution or outdated. Other datasets are national datasets which are collected with different methods making it difficult to merge the data to one homogeneous dataset. Additionally some detailed raw data do exist which would need extensive processing and were therefore not used. To be able to make use of these data, larger studies would be needed which explore the data needs more in detail.

All costs and targets were made comparable by setting the sum of targets and costs in all PUs for one complete layer to a constant.

2.2.1. Fisheries – Data for vessels registered in the Vessel Monitoring System and smaller

Data availability

Within the scope of the study it was not possible to produce a consistent dataset on the fishery activities within the pilot area. It can be stated that fisheries for the different gears and target species differs just as in the Baltic Sea.

Data on fisheries is available as VMS (Vessel Monitoring System) data for vessels larger than 15 m, as landings for ship between 10 and 15 m and no information exists for fisheries with vessels smaller than 10 m. Even larger vessels are monitored by the AIS (Automatic Identification System) which has a better temporal resolution than VMS.

VMS and AIS data have good resolution to be used in the pilot area context; due to data privacy protection the data is not completely freely available. Typical aggregation are $3 \times 3 \text{ km}^2$ to get a good resolution or $3 \times 3 \text{ nm}^2$ to fit the data to the borders of the ICES rectangles. Logbook reporting is done per ICES rectangle (30 min latitude and 1° longitude, approx. $30 \times 30 \text{ nm}^2$) and has even for the total Baltic Sea not an adequate resolution.

In the past several studies have estimated the importance and impact of the different fishery branches. The studies work with different data sources during different years and focus on specific aspects and parameters, often lacking detailed information on small scale fishery which is not included in the VMS system and partly not at all reported. These estimations help therefore only to get an impression of the importance on non-VMS data but are not directly comparable.

In the German Baltic Sea, the ships without reporting obligation are estimated to be 66 % of the total fishing vessels and 94 % without obligation for VMS tracking for 2008 (Sell et al. 2011). For setnet fishing effort it is estimated that > 50 (reference year 2002, IfaÖ 2007) to > 70 % (ICES 2009) of the effort is done by small fishing vessels without VMS.

From the Danish data (provided by DTU aqua for the Baltic Sea 2009) it was assessed that 80 % of the landings in the Baltic Sea are caught by vessels with VMS obligation compared to those from logbook reporting without VMS, thus it is not the total of all landings from vessels included because the smallest do not have a logbook obligation. The percentage of landings by vessels $> 15 \text{ m}$ differs dramatically, from 96% for Danish seine to below 1 % for gillnets and longlines (table 5). Gillnets are also expected to be used for fisheries without reporting obligation.

For the Danish VMS data, pelagic trawl is the dominant fishing method, followed by otter trawl and summing up to 99 % of the landings. For the landings from ships with logbook but without VMS, otter trawl is dominant with 53 % followed by gillnets with 26 %. Seasonal differences can be seen, especially the pelagic trawl and gillnet fisheries peak during January to March. (figure 5)

Table 5: Danish fishery activity 2009 in the Baltic Sea, data provided by DTU aqua

Gear	Landing with VMS (kg)	Landing without VMS (kg)	Landing with VMS [%]
Otter trawl	17,406,390	9,451,612	65
Gillnet	282,547	4,573,241	6
Longlines	2,072	295,970	1
Pelagic trawl	52,610,437	3,538,117	94
Danish seine	659,914	28,542	96
Fishing dredge	695	1	100
Total	70,962,055	17,887,483	80

2. Method and Data

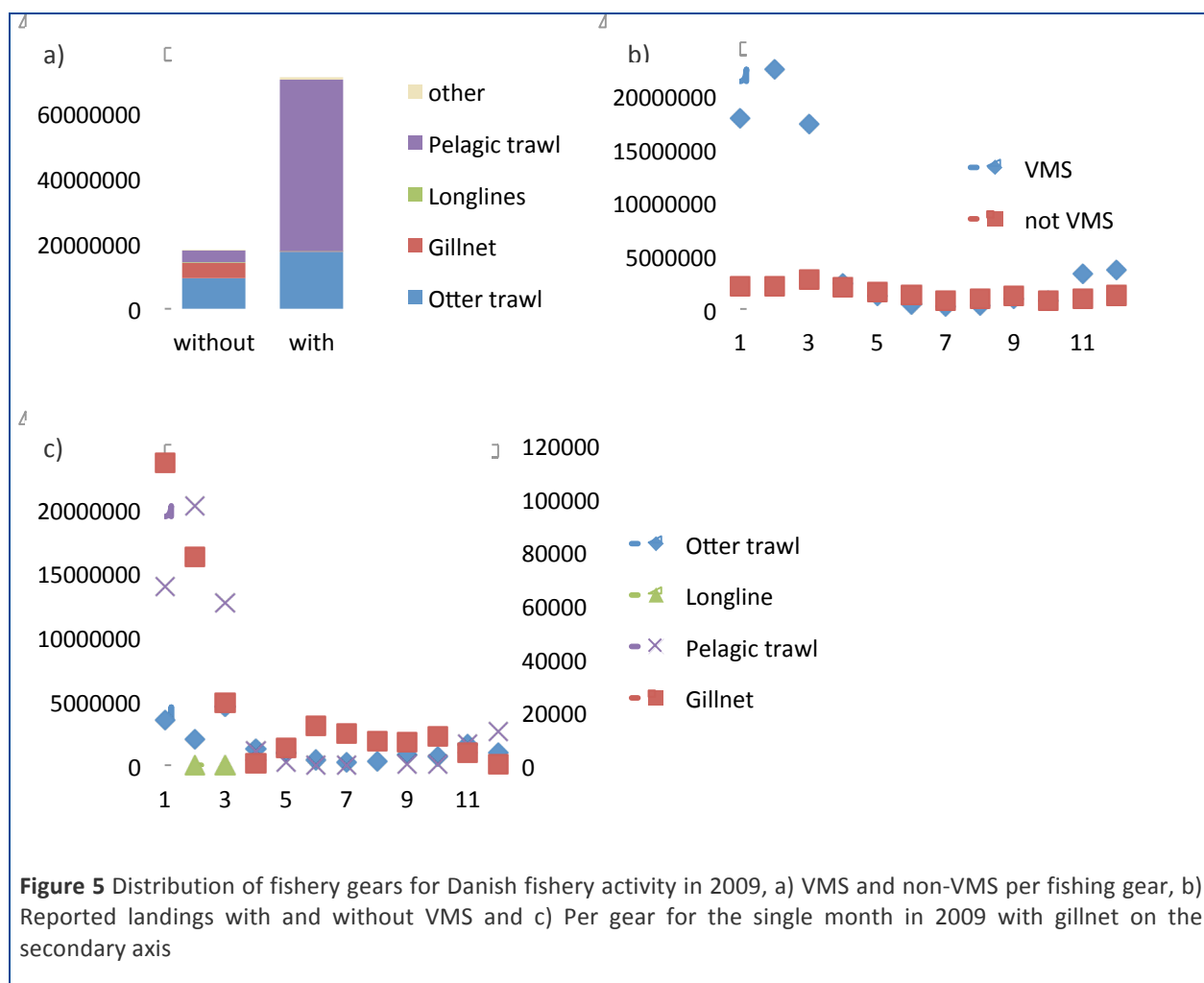


Figure 5 Distribution of fishery gears for Danish fishery activity in 2009, a) VMS and non-VMS per fishing gear, b) Reported landings with and without VMS and c) Per gear for the single month in 2009 with gillnet on the secondary axis

For the German waters, complete seasonal data was not available but Erdmann et al. 2005 states that gillnet fishery is used primarily during the period in which the water birds overwinter. Bellebaum (2010) found in a bycatch survey that the highest bycatch events were observed from November to April, whereas the highest numbers registered for the inner and outer coastal waters and areas in the EEZ only in April and June. The gear types vary according to the season. Dominant are bottom set gillnets (target species cod, flounder, pike-perch, pike and perch) in winter, pelagic gillnets (herring, garfish) in the spring season and long-lines (eel) in the summer. (Bellebaum 2010). An ongoing study on fisheries bycatch conducted by WWF and von Thünen Institute reveals that gillnets are used all year round with concentration in spring (herring) and autumn (cod) (pers. comment J. Lamp).

The fishery activities in Poland show a similar picture: Coastal fisheries is undertaken mainly with fixed gears (gill nets, traps) on species as herring, flounder, cod and perch. For the offshore areas bottom trawls dominate over gillnets and midwater trawls on cod, flounder and herring whereas the fishing on sprat is done mainly by pelagic trawling offshore (Chmura et.al 2012).

The data that was available to indicate good fishing grounds based on VMS for Denmark and Germany, in the case of Sweden AIS was different for the four countries of the pilot area. For the Polish area, VMS data did not become available in a similar format. Instead landings with a resolution of $10 \times 10 \text{ nm}^2$ were available and were not separated into VMS – non-VMS data. Sweden as the only country has supplied data about the fishing success for cod, eel, flounder, plaice, salmon, turbot and whitefish. Some commercial fish (e.g. herring) were not included, presumably due to relatively good fishing success throughout the total area. The fishing effort was taken as indicator for areas that are valuable for fishing for Germany and Denmark, not data containing fishing success. Even though the effort and the fishing success do not necessarily cohere, the effort shows

where fishermen expect good success. For Poland, landings per 1/9 ICES square were available. The German data were not supplied but had to be digitized from the EMPAS report (ICES 2009).

Since the data does not have an acceptable quality for reliable modelling, only 3 fishing methods, namely pelagic trawl and otter trawl as the most intensive for VMS fishery and demersal seine, were selected to test the general approach. From the data which were available for landings of the different fish, the landings of those species were grouped that were expected to be fished with a specific method.

It was not possible to balance the data of the different provider into a homogeneous dataset. German and Danish data were supplied in nearly the same format but for different years. To make the data approximately comparable the difference of the two TACs for the respective years was used as a calculation factor. For Poland and Sweden, a factor was calculated that resulted in a mean value per PU in the same range as the mean value for Germany and Denmark.

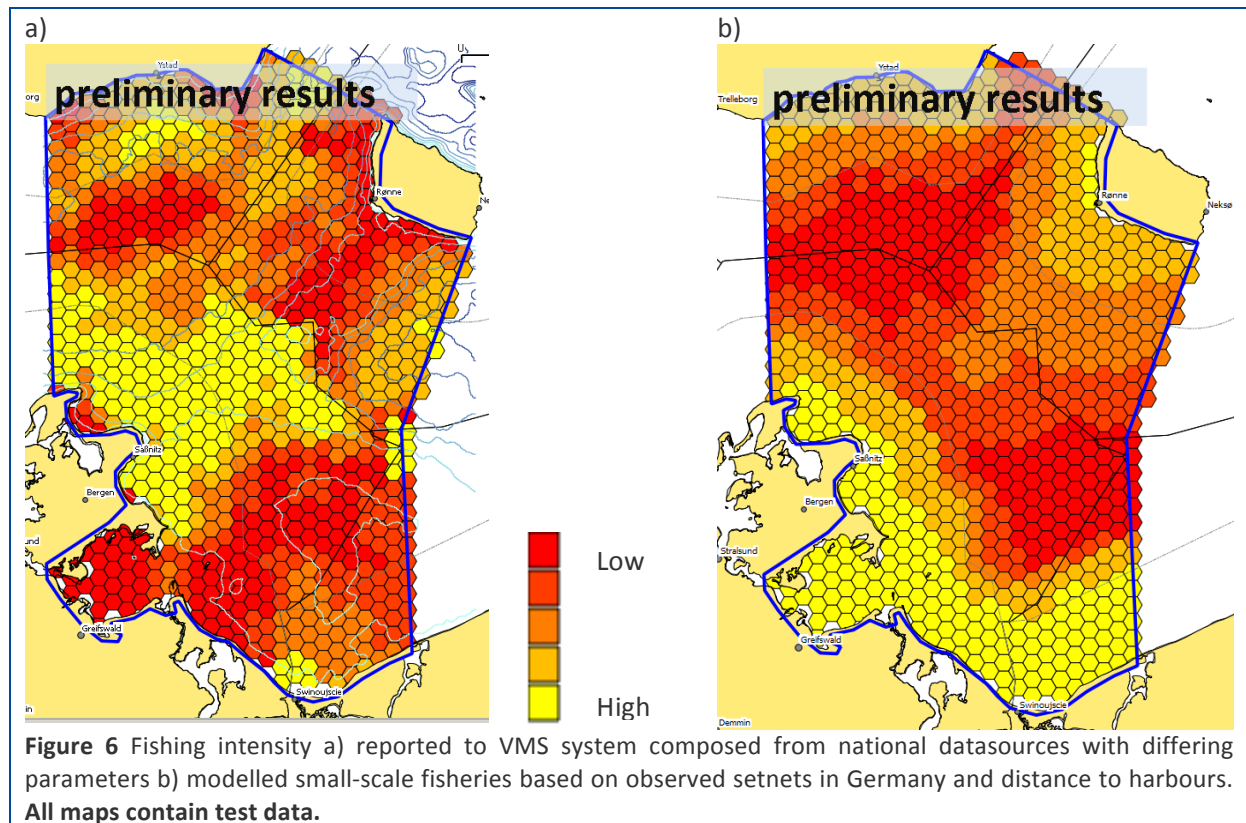
For the small-scale fisheries two approaches were used: 1) Since a high percentage of the setnets is used by small vessels, the distribution of setnets was used. This dataset has the disadvantage that it is also including other setnets of larger vessels and it is only available for parts of the region. Therefore the distribution was modelled based on the density of setnets as a function of the water depth and of the distance to the shoreline.

2) The second approach was based on the assumption that small fishery vessels operate within a relatively small vicinity of the harbour. For Germany and Poland the fishery harbours and the amount of vessels are known (IfAÖ 2007, Chmura et al. 2012). In the concerned fishing harbours at the Polish coast 48% are operating in a range of 6 nm from the port, 21.5% within 12 nm and 12% within 30nm from the shore. 14% are operating internationally (Chmura et.al 2012). For Denmark and Sweden the harbours were taken from a topographic map and the fishing intensity calculated by a factor derived from the distribution of stationary and coastal gear on the ICES rectangles.

For both types of fishery the information was handled separately in single layers. In figure 6 it is summed to show the modelled overall fishing intensity. **Please be aware that the data is a generalized showcase to illustrate the principle approach and does not reflect the exact situation!**

It is difficult to estimate how large and where the mistakes are. On the first glance it seems that the fisheries in the German waters are overestimated. But also the data on the ICES rectangles (figure 7) shows high total fishing activity north of Rügen and in the Greifswalder Bodden for stationary and coastal gear.

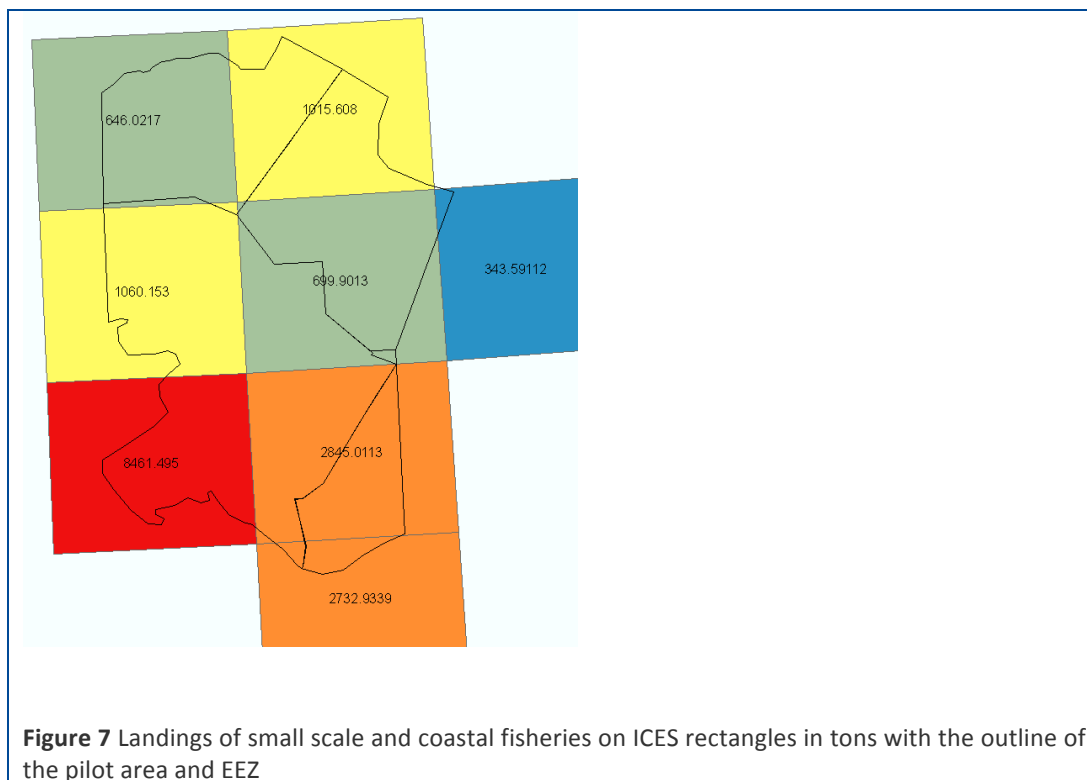
2. Method and Data



The data for the activities for large vessels and small-scale fisheries overlap. This can be due to the real situation, but to an extent also because it was not possible to separate the two different kinds of fisheries. By splitting fisheries up into two zones it is not possible to differentiate and calculate the effects of small reductions of the fisheries areas on the profit for fisheries and the expected reduction in costs as it has been done in other studies evaluating the impact of non-fisheries zones (e.g. Ban and, Vincent 2009).

The fishing intensity for small scale fisheries in figure 6 b) is including the setnets modelled from German seabirds at sea database (Sonntag et al. 2012) and ICES landings of coastal and stationary gears distributed to the planning units close to harbours. The setnet layer is not completely limited to small scale fisheries. Since setnets/gillnets used by VMS vessels also occur in the open sea (ICES 2009, Sonntag et al. 2012) the distance to the shoreline was taken as a cost factor for small scale fisheries with the effect that no sites at the open sea are chosen.

In all datasets the existing fisheries intensity and by that already existing conflicts, closures and restrictions was reflected (e.g. Landings, VMS data, setnet sites) with the exception of the data containing the distance to harbour.

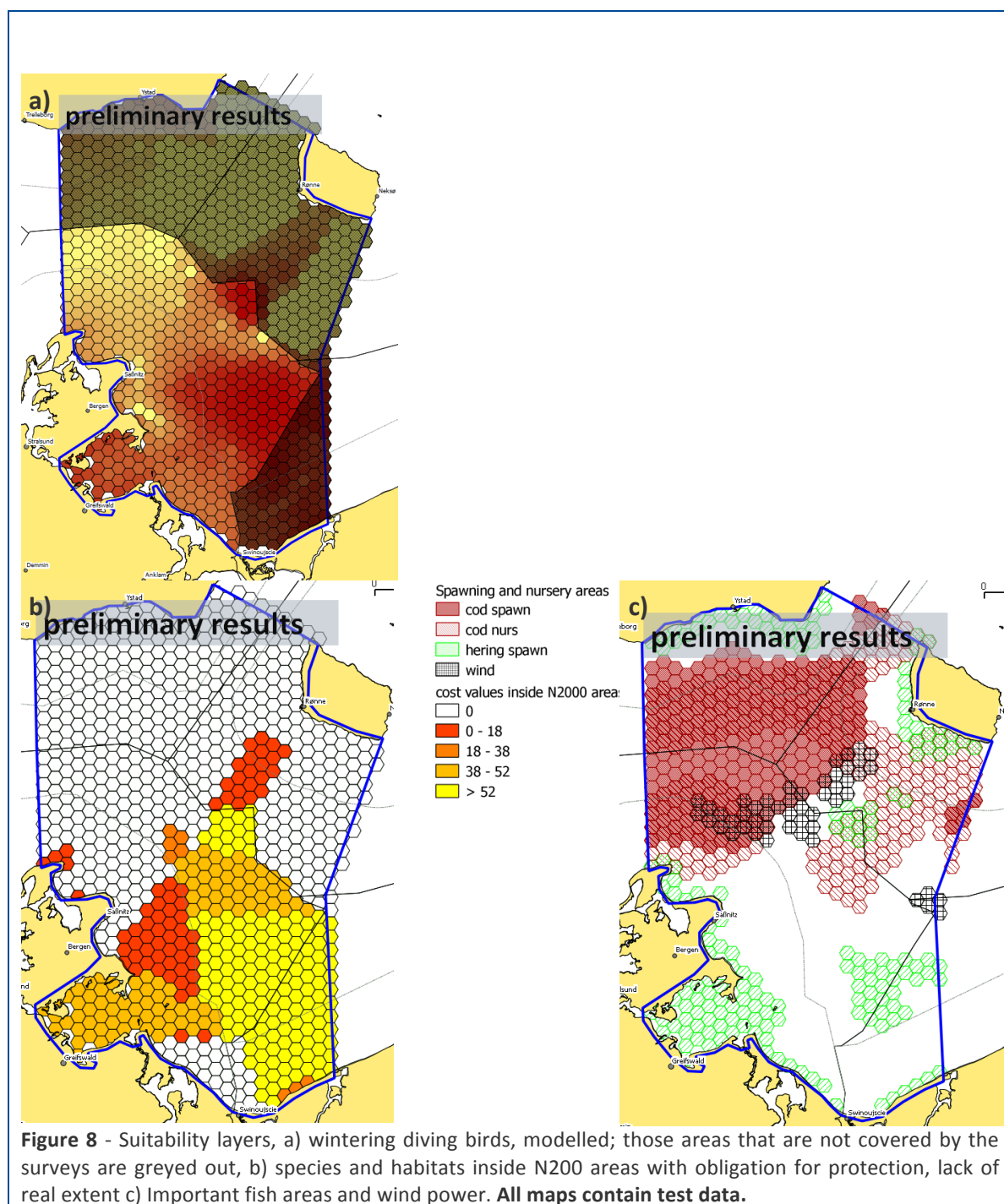


2.2.2. Suitability or cost layers

To illustrate the conflicting ecological data, three types of data were used. The best available data was the abundance of diving birds for Germany (German Seabirds at Sea database). Due to the frame of the study, the bird abundance for the remaining area was modelled for all species together as a function of depth and distance to coast. For the spawning areas of cod (Bleil & Oeberst 2007) and herring and the nursery areas of cod (data from Nord Stream and HELCOM), only rough outlines are documented. A constant was used for the area so that the complete area contributes with the same intensity to the cost layer. Where not even information about the simple occurrence of the species was available, the protected sites were used with a value depending on the relevant protection targets. The layers were aggregated for birds, fish, harbour porpoise and habitats). (figure 8)

The cost layers had unfortunately to be constructed on an unreliable basis. Even though better data for birds are meanwhile available, the data could just not be supplied in time to be incorporated into the distribution model. It is expected that the reliability can especially be improved for the Danish waters.

The spawning areas for both cod and herring are quite clearly defined by the depth (for cod also in relation to salinity and oxygen level) and for herring also by the substrate, but the importance of the resulting subregions is not known. **The databasis for nursery areas is insufficient.** It was supplied with rough estimates from the BALANCE project which is based on interviews with fishermen.



3. Results

3.1. Calibration and comparison to Marxan

The setup for the model is much more complex than for Marxan and it is more difficult to identify the reasons for unexpected results. Since ready-made tools are not available to check the input datasets an interim step had to be taken. This was also necessary because some quite specific requirements exist for some of the input datasets, thus thorough checks are necessary to see if all datasets are read properly. Those requirements may amongst others concern the order by a specific parameter, requirement for a blank line or none.

The tests were accomplished by using Marxan without zones, not using costs or setting targets only for selected zones. Especially the tests without cost layer were interesting and the significance is not clear. In Marxan with Zones the setup without costs showed random pattern for low targets and the higher the targets were set the better the additional areas were chosen according to expectations. For low targets even PU with no occurrence of the contributing target layers were selected. With the same dataset adapted to run with Marxan the suitable areas were clearly selected within the areas with the highest occurrence of targets, so an error in the dataset seems not likely. The iteration process in Marxan and Marxan with Zones starts with a random selection of PU, independent of the occurrence of target features. It is possible that Marxan with Zones needs a much higher number of iterations than it is needed when using costs.

The aim of the calibration process was to get a solution where

- > Coastal areas are classified as “small” with/without restriction
- > Open sea is classified as “all fisheries”
- > Restrictions occur in the Natura 2000 areas
- > The zones have relatively smooth outlines

The exact amount for each zone was not evaluated.

After the calibration, the following questions and options to steer the scenarios were identified:

- > How much prioritize small scale fisheries
 - Parameters:
 - By less conflict/cost than all fisheries
 - To balance against all fisheries: high penalty
 - Difficulty: The fishery zones do not exclude each other.
- > Ratio between no-take and restriction
 - Parameters:
 - By setting a factor for the costs. The zones with higher costs get less frequently chosen.
- > Minimum size reference area/effect for sustainable fisheries
 - Parameters:
 - Costs
 - Boundary length modifier
- > Different targets levels
 - Compared to other areas in the Baltic Sea, the pilot area is of higher ecological importance than average, already 38.7 % are designated Natura 2000 areas
 - Compare also to scenarios without costs or without ecological target.
- > Excluding possible offshore wind power sites for Germany, Denmark and Poland from fishery zones.

To visualize the results, in Marxan terms the “best solutions” are shown in the maps. During modelling the iteration is repeated several times and the “best result” is the result which is meeting the targets best and causing the lowest costs. For some scenarios it is compared, how well targets were met by comparing costs and shortfall. The shortfall is the difference for all features that have not met their target between target and achieved solution. If a feature target is met, there is no shortfall. (Watts et al. 2008) Since the targets for

3. Results

fisheries and small scale fisheries do not exclude each other and they can be partly overlapping. This cannot be reflected in Marxan with Zones. Therefore especially for higher targets higher costs or shortfall can occur. The minimum proportion of targets met (MPM) are given for all target features together per run as well as for the single target features for the single runs. This parameter is mainly used to calibrate the penalty factor for the single target features. All scenario tests were done with a repetition of 100 times and an iteration with 1 mi. steps, so that the results are not guaranteed stable.

3.1.1. Basic Scenario for calibration – 70 % target fisheries, no conservation targets

In the basic scenario, it was tested how the fishery restrictions look like based only on the actual fishery activity and ecological features as costs (figure 9 a). In figure 9 b the costs were removed to see, how Marxan would choose the best fishery zones without any other influence.

Scenario description:

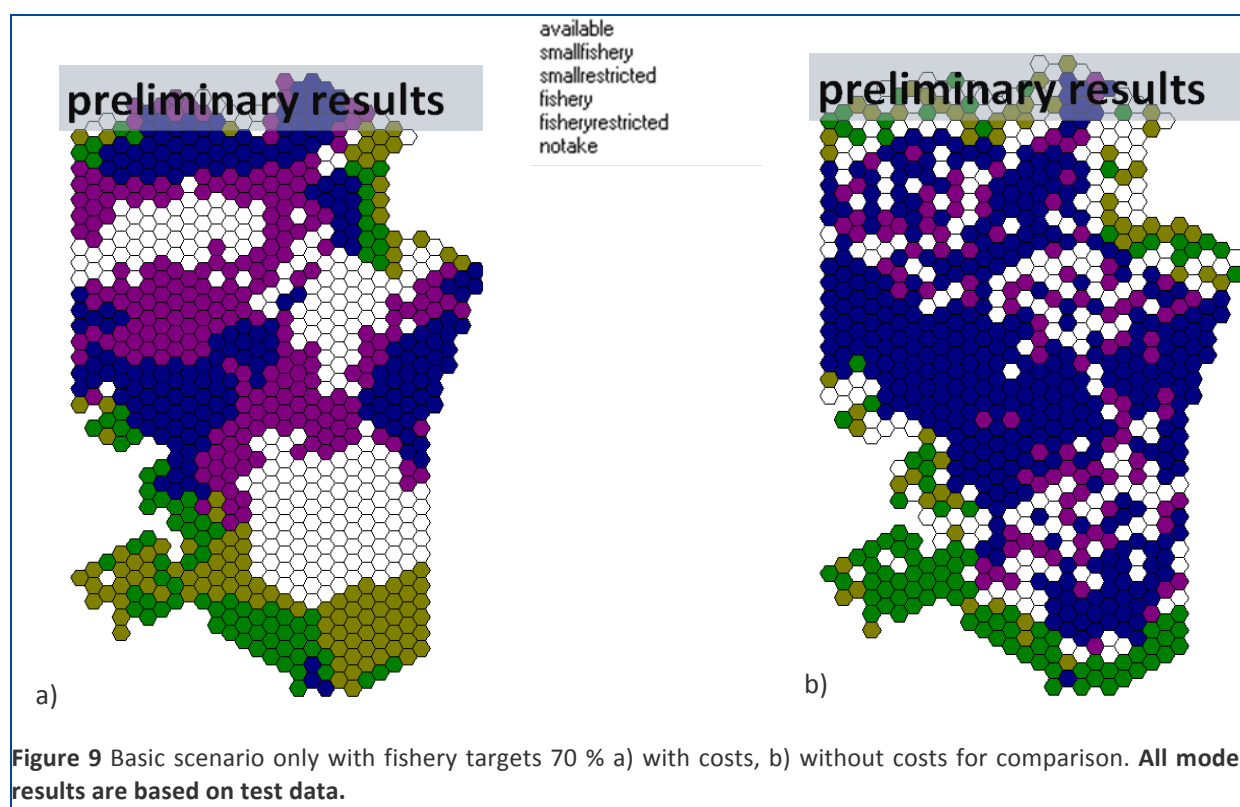
- > Targets for all fishery layers: 70 %, small fisheries with a higher priority
- > Zone contribution to target:
 - no restriction zones: 1
 - restriction small fisheries
 - contribution to small fisheries 0.5
 - contribution to ecological features 0.5
 - contribution to Natura 2000 protected species or habitats: 0.25
 - restriction VMS fisheries
 - contribution to fisheries 0.5
 - contribution to ecological features 0.5
 - contribution to Natura 2000 protected species or habitats: 0.15
- > Zone cost
 - Factor in no restriction:
 - Natura 2000 protected species or habitats: 10
 - ecological features: 5
 - Factor for zone with restrictions:
 - Natura 2000 protected species or habitats: 1
 - ecological features: 0.5
 - fisheries: 0.5

The setup was not coordinated in the working group but balanced in a way that all four zones occur in the area. Since the targets are set per fishery gear and not per zone it is not possible to directly steer the ratio between the zones for free fishery and restricted fishery. A high priority was set for small-scale fisheries in the coastal area but the other zones were not blocked out.

A target of 70 % for all fisheries leads to a selection of sites that offer good fishery conditions for several gear types. The two types VMS and small-scale fishery exclude each other in Marxan, but not in reality. Areas with restrictions in the current settings only contribute to a small fraction to a target. It was set to 0.25 (4 times the size to reach the target) for small-scale fisheries and 0.15 (6.7 times the size to reach the target) for VMS fisheries. Restricted zones were nonetheless appointed.

It is not possible to run Marxan with zones with the current targets completely without costs. Thus in the comparison run without costs caused by ecological features, the distance was set as a low cost factor for small and harbour for VMS fisheries.

In the main scenario on the left, the targets are met to 97 %. The figure 9 b was produced for comparison. To avoid too strong clumping of the fishery zones, the boundary length modifier had to be set to zero and consequently many single cells were chosen. The exact selection of each zone is therefore not important but those areas that are mainly selected or not selected for fisheries. It can be seen that the fishery conflict with the protection targets of the Natura 2000 areas and the cod spawning area leads to large areas of restricted fisheries in the north-western Natura 2000 sites and the southern part of Arkona Basin. **It has to be stressed again that the analysis is based on limited data sources and the best fishing grounds can differ in reality.**



In this scenario no-take areas are not distinguished from the remaining areas which are not optimal for any of the other zones. The areas not selected can either have low actual fishery activity, high conflicts with ecological features or both.

Most of the highest costs are limited to Natura 2000 areas due to limited information on distribution of the different species/habitats. Within the Natura 2000 areas, the zoning (next scenario also the no-take zone) is steered by the amount of protection targets per area and the fishery activity. The fishery activity can be influenced by already existing closures, e.g. on Odra Bank.

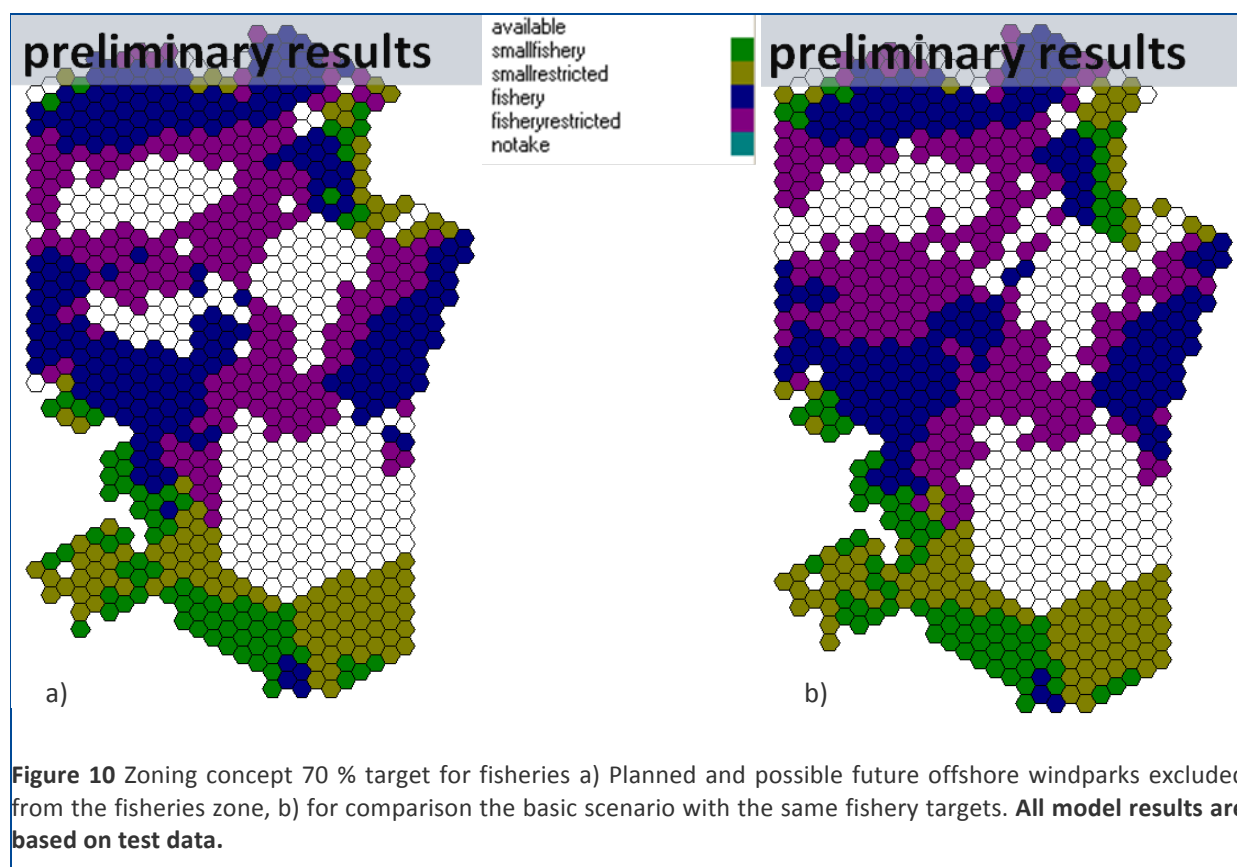
For the small scale fisheries, the scenario which considers costs – mainly conflict with diving birds – needs a much larger restricted zone to fulfil target than the version without costs. The conflict between small scale fishery and diving birds is difficult to handle by Marxan, because both features decrease with distance from the coast. Simplified this means that the best fishing grounds are at the same place as the highest densities of diving birds. Thus the option to lock the planning units closest to fishery harbours into the zones for small scale fisheries should be considered.

3. Results

3.1.2. Basic Scenario plus wind – 70 % target fisheries, no conservation targets, wind as one human use which excludes fisheries

In this scenario the effect of a reduction of the fishery area due to offshore wind power was analysed. It assumes that fishery is not allowed in offshore wind parks.

The model compensates the loss of available area by choosing more into the non-restricted zone (figure 10 a compared to b). 5.8 % of the area was blocked out of the fishery zones for offshore wind parks. The target met reached 92 % but the costs were with 119% of the costs of the basic scenario substantially higher. Cost for establishing fishery zones does in this case not mean additional costs for the fishing activity but increased conflicts with ecological features.



Similar analyses for shipping routes are possible, if data with higher resolution gets available. The current fishery activities did not show a clear conflict except for setnets at the port entrance of Swinoujście (figure 11). But if the frequency of ships increases further fishing in shipping routes could become more dangerous or impossible.

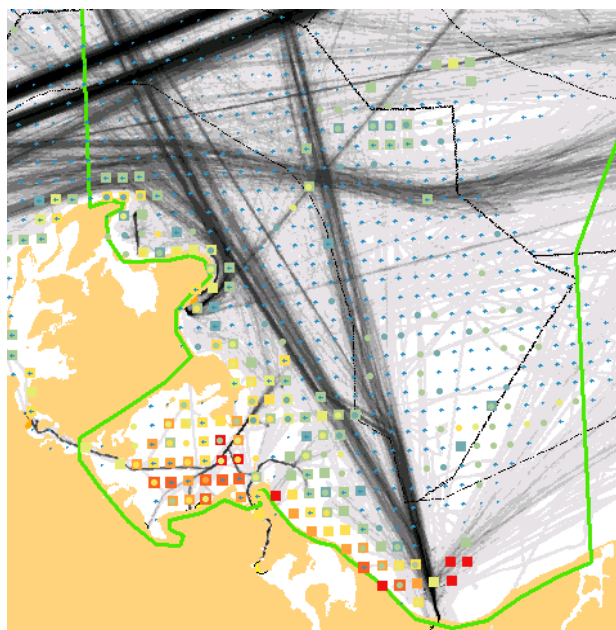
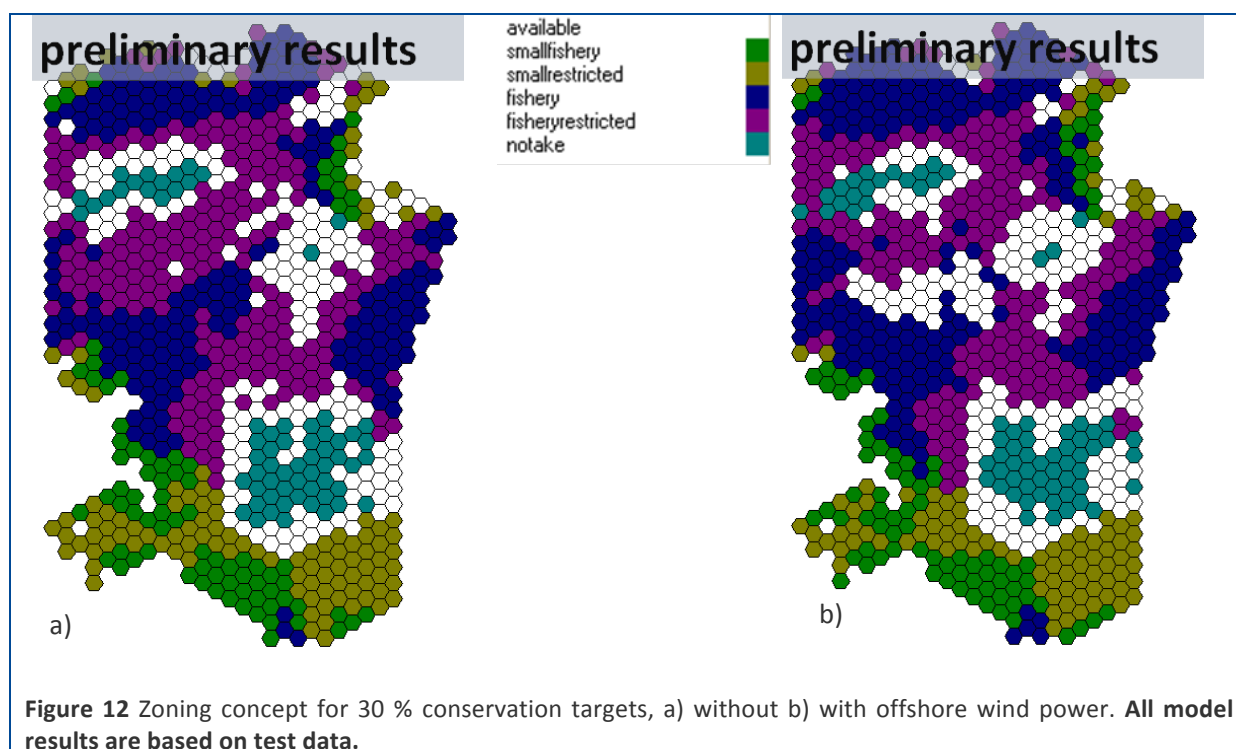


Figure 11 Setnet occurrence (gridded) and AIS ship traffic intensity. Round: winter, square: summer

3.1.3. Conservation targets with and without wind power

The conflict with ecological features is already taken into account in the previous scenarios. In the following scenarios it is tested how the allocation of areas change with changing settings. The first two scenarios have a target of 30 % for all used ecological features, irrespective of the kind of data, i.e. the distribution, a simple outline of the occurrence or a Natura 2000 outline.

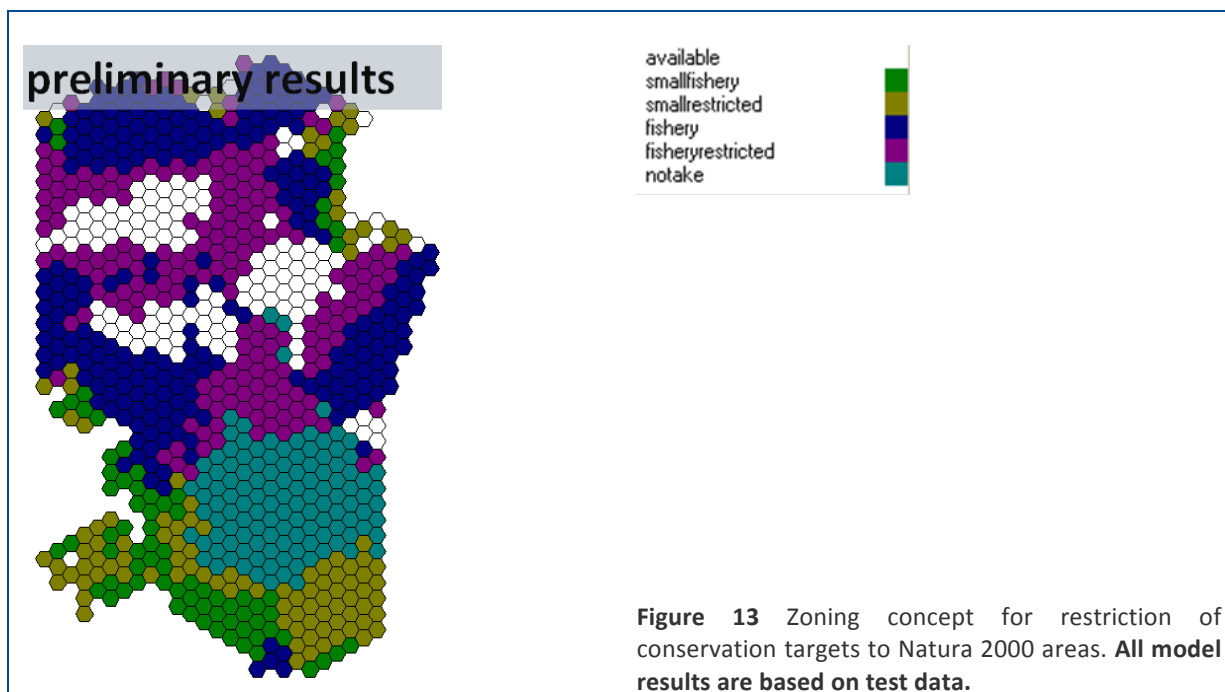
For the no-take zone the contribution is 1 for all ecological features and the costs are 10 for all fishery activities. The other settings are the same as in the previous scenarios. For both scenarios in figure 12, the no-take areas are mainly selected in the middle of those areas where no zone was assigned in the previous scenarios. The extent of the restricted zones shows some minor changes. The sites for offshore windpower are not distinguishable from those leftover where relatively low fishery activities meet relatively high conflicts.



3. Results

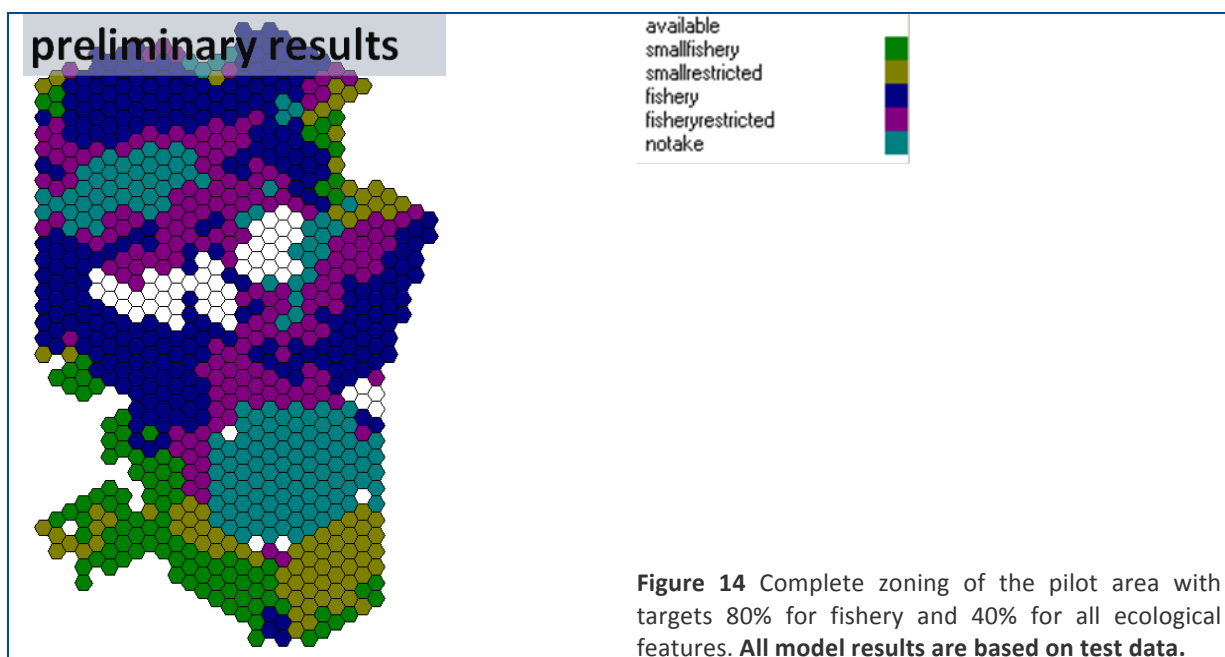
3.1.4. Steering of the no-take area

To keep the no-take area inside existing Natura 2000 areas, 50 % target only for the protection targets for Natura 2000 sites were tested. The conflicts between fishery and other ecological features were kept as before. The no-take area is selected mainly in the large Natura 2000 area of Oder Bank and Ostoja na Zatoce Pomorskiej at the border of Germany and Poland.



3.1.5. Pilot area-wide zoning

For a zoning concept that covers all of the area, the targets for fishery were raised to 80 % and the conservation targets to 40 %. Now basically only the windpower sites are not assigned to a zone. An additional no-take zone is set for the central Arkona Basin due to the cod spawning area there.



4. Conclusions

The setup of Marxan with Zones is much more complex than Marxan, but offers also the option of more detailed management of an area. In order to handle the area, it is helpful to start with a reduced set of layers and check the effect of changes.

Especially the option to set how much a zone contributes to a target or to set a target for each species within each zone offers detailed management options, also within the conservation areas themselves. With more detailed data on the fishery success and even the profit for the different fisheries, the analysis could be extended to find the most profitable fishery regions.

Even though fishery data is stored for fishery vessels with a minimum length, the data available was not optimal to operate on. To optimize the analysis it is necessary to guarantee similar methods for the complete area, preferably work at one central place where there is access to the complete database since small amendments can be necessary. Working with VMS fishing effort or even success per fishery effort is generally good, showing the fish availability and suitability for gear types. The selection is reasonable due to the experience of the fishermen. But the effects of existing conflicts or closures are already visible in the data. Therefore, VMS data is not suitable to confirm already established closures or sites with restrictions. It can be considered to set overall fishery targets, targets per commercial species instead or to include the specific profits per species.

Data on small scale fisheries is more difficult to obtain than data on larger vessels. In future the minimum length for obligatory reporting will be reduced so that the fraction of vessels that do not report will be reduced. The use of the distance to fishing harbour combined with sighted setnets seems to be a promising approach. The modelling is nonetheless problematic due to the high conflict with birds. If the political will continued exists to strengthen the small scale coastal fisheries, the option to lock the planning units closest to fishery harbours into the zones for small scale fisheries should be considered.

For ecological data and the definition of potential conflicts the data basis was very scarce. Several studies are on-going which in future can provide better information about abundances, e.g. Sambah about harbour porpoise in the Baltic Sea, conflict descriptions, e.g. estimation of bycatches in setnets with the help of onboard video observation project (Pilotstudie zur Dokumentation von Seevogel- und – säugerbeifängen in der deutschen Stellnetzfisherei der westlichen Ostsee J.v. Thünen Institut / WWF Germany, on-going), or in the Harmony project which is currently evaluating which ecosystem components are sensitive to which human activities. Other datasources were simply difficult to access and development of documentation or a central database would help to easier access the data in future.

In addition to the need to improve the input data, it would be essential to involve planning agencies, scientists and stakeholders to refine the definition of conflicts and contributions, the reduced effectiveness of fishery with specific restrictions or how well protection with specific restrictions works. While some definitions that were not available for this study are knowledge gaps, others can be defined by political decisions. The question about the needed size of no-take areas to have the wished effect or about the effect of the new offshore wind power sites belong to the first group of questions. The question about target values for the size of fisheries areas or especially the decision to which degree to strengthen small scale fisheries needs political decisions (based on scientific recommendation).

Typical questions that occurred during the study were:

- > Do we want to strengthen small fisheries despite the conflict with diving birds?
- > What sizes of no-take areas have the wished effect?
- > What sizes of no-take areas can we afford, if we want to have fishery options close to all harbours?
- > Is it possible to combine offshore wind power sites and no-take areas?
- > How do the single features contribute or conflict with a target or within the single zones?

4. Conclusions

This study was carried out within the BaltSeaPlan project as a follow up of an investigation, how good Marxan can be applied to offshore wind power site selection. (Göke 2011) Compared to that topic, the setup was more complex (Marxan with Zones) and the conditions for fisheries and their concrete conflicts less known. The work started much later and could therefore not be as well coordinated with the pilot area working group.

These factors lead to insecurity in the initial definitions and results. But with more intensive data preparation and better integration into a planning group, Marxan (with Zones) can also be recommended to be applied to fisheries. Marxan with Zones needs much more careful definitions than Marxan, since small changes can change the results more.

5. Acknowledgement

The authors wish to thank the BaltSeaPlan community for the discussions and feedback. The authors further thank Oscar Törnqvist for providing information on the ship traffic, Nicole Sonntag for the extract from the German “Seabirds at Sea” database, Ib Krag Petersen for Danish data on birds, Josefine Egekvist for help with the Danish fishery data and North Stream for making their database available easily .

The Marxan with Zones software and Zonae cogito can be freely downloaded at <http://www.ecology.uq.edu.au>

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The BaltSeaPlan project in general

Activities

BaltSeaPlan activities were designed to support all major aspects of maritime spatial planning within the Baltic Sea region:

> Improving the joint information base / stocktaking for maritime spatial planning:

A forum for dialogue bringing together spatial planners and scientists to identify sources of data / information. Compiling current uses, conflicts and natural values of the Baltic Sea. Filling data gaps, exchange of data, improve integration of ecological and socio-economic data sets, identify relevant modelling methods, clarify MSP data needs.

> Including Spatial Planning in National Maritime Strategies

Assessment of national frameworks, methodologies and sectoral strategies that influence the use of sea space (e.g. energy, fishery, transport, tourism, as well as nature conservation)

Developing recommendations on spatial issues within National Maritime Strategies.

Exploiting the visions to foster a national cross-sectoral debate, discussing goals & targets for dealing with space and filling gaps in national sectoral policies & strategies

> Develop a Vision for Maritime Spatial Planning in the Baltic Sea 2030

taking into account transnational interdependencies and cumulative impacts

initiate a Baltic Sea region wide campaign as to discuss the BaltSeaPlan Vision 2030

> Demonstrate MSP in 8 pilot areas

- Danish Straights / T-Route (DK)
- Pomeranian Bight (DE/DK/SE/PL)
- Western Gulf of Gdansk (PL)
- Middle Bank (SE/PL)
- Lithuanian Sea (LT)
- Latvian Sea (LV)
- Pärnu Bay (EE)
- Hiiumaa and Saaremaa Islands (EE)

> Lobbying and capacity building for MSP

- stakeholder involvement & participative planning methods
- BaltSeaPlan series of guidelines & policy recommendations
- workshops & conferences for decision-makers

Partners

Germany

- Federal Maritime and Hydrographic Agency (BSH), Lead Partner
- Ministry of Energy, Infrastructure and Regional Development of Mecklenburg-Vorpommern
- WWF Germany, Baltic Sea Unit

Poland

- Maritime Office in Szczecin
- Maritime Office in Gdynia
- Maritime Institute in Gdańsk

Denmark

- Department of Bioscience, Aarhus University (formerly National Environmental Research Institute – NERI)

Sweden

- Royal Institute of Technology (KTH)
- Swedish Environmental Protection Agency

Estonia

- Estonian Marine Institute of University of Tartu
- Baltic Environmental Forum Estonia

Lithuania

- Klaipėda University Coastal Research and Planning Institute (CORPI)
- Baltic Environmental Forum Lithuania

Latvia

- Baltic Environmental Forum Latvia

BaltSeaPlan Publications

BaltSeaPlan Reports

- BaltSeaPlan Findings
- BaltSeaPlan Vision 2030 – Towards the sustainable planning of Baltic Sea space
- Become a Maritime Spatialist within 10 Minutes (EN, DE, LV, LT, PL, EE)
- BaltSeaPlan Bulletin #1
- BaltSeaPlan Bulletin #2
- BaltSeaPlan Project Flyer (EN, DE, LV, LT, PL, EE, SE)

Impact Assessments

- 1 - Strategies with relevance for Estonian maritime space
- 2 - Strategies with relevance for German maritime space
- 3 - Strategies with relevance for Latvian maritime space
- 4 - Strategies with relevance for Lithuanian maritime space
- 5 - Strategies with relevance for Polish maritime space
- 6 - Strategies with relevance for Russian maritime space
- 7 - Strategies with relevance for Swedish maritime space
- 8 - Implications of the international and national policy context for Baltic Sea space and MSP

Pilot MSP reports

- 9 - Developing a Pilot MSP for the Pomeranian Bight and Arkona Basin
- 10 - Developing a Pilot MSP for the Middle Bank
- 11 - Developing a Pilot SEA for the Western Gulf of Gdansk
- 12 - Preparing for a MSP at the Danish Straits
- 13 - Towards a Pilot MSP for the Pärnu Bay
- 14 - Towards a Pilot MSP for the Saaremaa and Hiiumaa Islands
- 15 - Towards a Pilot MSP for the Lithuanian Sea
- 16 - Developing a Pilot MSP for the Western Coast of Latvia

MSPs and SEA

- 17 - Pilot MSP for the Western Coast of Latvia (LV)
- 18 - SEA for the Western Gulf of Gdansk (PL)

Technical reports

- 19 - Modelling for MSP – Tools, concepts, applications
- 20 - Data exchange structure for MSP
- 21 - Effects of underwater noise on harbour porpoises around major shipping lanes
- 22 - Remote sensing methods for detecting small fishing vessels and fishing gear
- 23 - Legal and planning options for integrating fisheries into Maritime Spatial Planning
- 24 - Stakeholder Involvement in MSP
- 25 - SEA in MSP: Recommendations from the German and Polish experience
- 26 - Fisheries in the MSP context
- 27 - Seabed and habitat mapping in the Hatter Barn area
- 28 - BaltSeaPlan Web-advanced tool in support of MSP
- 29 - Case Study: Systematic site selection for offshore windpower with Marxan in the pilot area Pomeranian Bight
- 30 - Case Study: Site selection of fisheries areas for MSP
- 31 - Recommendations for legislative action regarding the MSP in Europe

Maritime Spatial Planning (MSP) has become a widely acknowledged and necessary tool for co-ordinating spatial use and balancing of interests in the sea. In view of expanding activities such as offshore wind energy parks and growing shipping traffic and at the same time increasing needs to protect the marine environment a systematic, integrative and forward-looking planning is required in order to safeguard the sustainable development of the seas. Currently, however, this tool is far from being established practice.

The 3.7 million € INTERREG IVB project “**BaltSeaPlan**” (2009–2012) has been the largest project in recent years dealing with maritime spatial planning throughout the Baltic Sea Region. Under the lead of the German Federal Maritime and Hydrographic Agency (BSH) and covering partners from all Baltic Sea countries (except Finland) the project has not only developed pilots in 8 demonstration areas, but also advanced methods, instruments & tools as well as data exchange necessary for an effective maritime spatial planning.

The results of BaltSeaPlan are published in a series of reports all available for free download under www.baltseaplan.eu.

Although specific data exist for selected fisheries management issues, suitability maps about the most valuable areas for fish spawning, recruitment and catches which also take the limitations by operation range or by competing uses and functions of the sea into account do practically not exist. The **BaltSeaPlan Report N° 30 “Case Study: Site selection of fisheries areas for MSP”** shows the attempt undertaken within BaltSeaPlan to use the tool “Marxan with Zones” to produce such maps. It is a first trial to localize those suitable areas with the help of a MSP related decision making tool. The results of the report can - due to very scarce spatial data - be only preliminary. However they demonstrate a new way how to get to this very valuable information for appropriate MSP.
