# A FLOOD OF SPACE

TOWARDS A SPATIAL STRUCTURE PLAN FOR SUSTAINABLE MANAGEMENT OF THE NORTH SEA

# COLOPHON

This book is a reflection of the spatial-analytical and design aspects of the GAUFRE report "Towards a Spatial Structure Plan for Sustainable Management of the Sea". A complete scientific report of the GAUFRE project can be found on the accompanying CD-rom.

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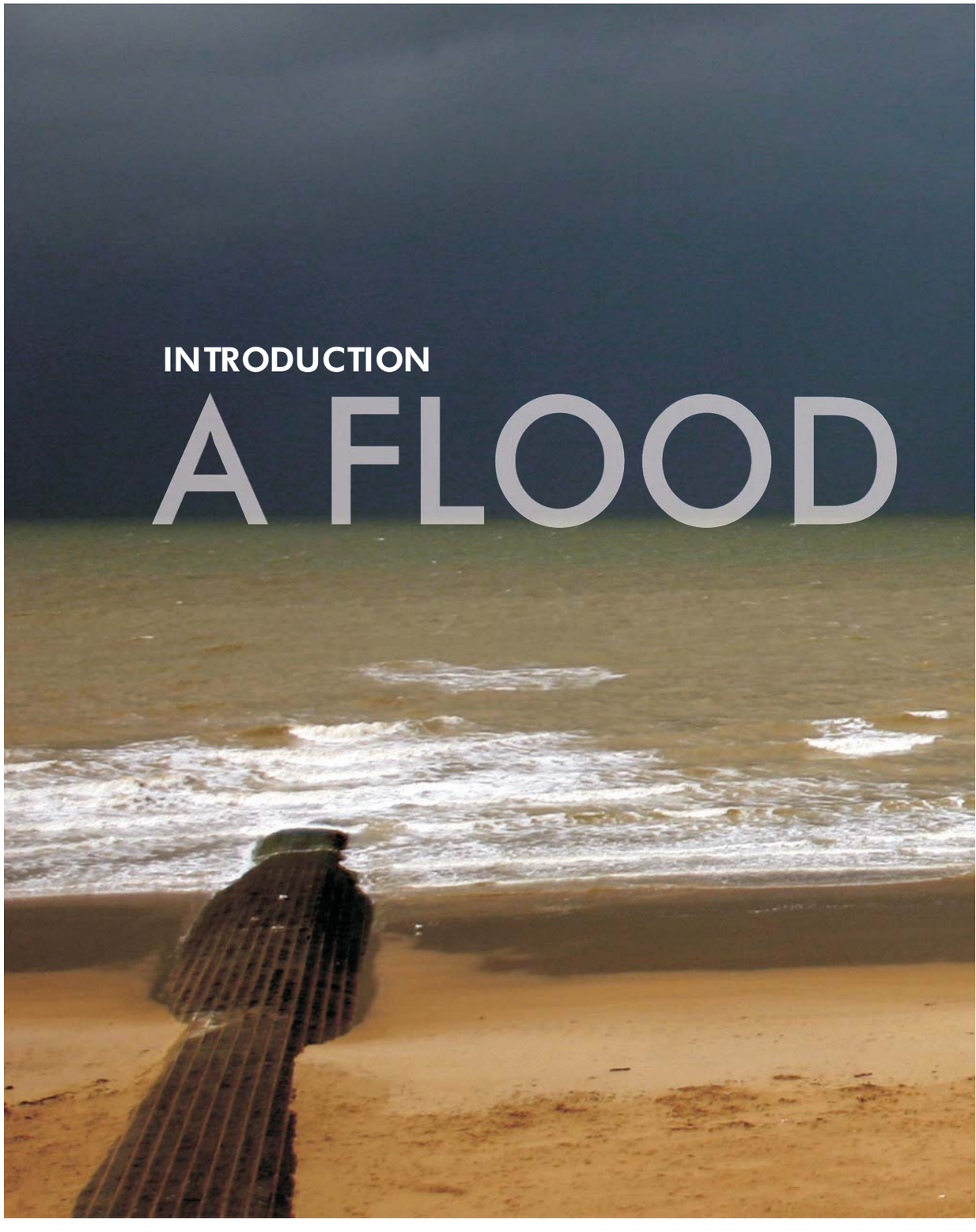

INTRODUCTION

# A FLOOD


OF SPACE ...

UNIVERSITEIT GENT

BELGIAN SCIENCE POLICY

C POINT R E

## GAUFRE
## Towards a spatial structure plan for sustainable management of the North Sea

The GAUFRE project combined four partners in order to collect scientific knowledge about the use of the North Sea and their possible effects. This scientific knowledge was used to create a vision for an optimal spatial planning of the Belgian part of the North Sea. 'Sustainable development' was the major issue of concern throughout this process.

The partners were a combination of three research teams from the University of Gent (the Maritime Institute, the Renard Center for Marine Geology and the Marine Biology Section) and Ecolas, an environmental consulting group. The project commenced in 2003 and ended in April 2005. The GAUFRE project fits within the framework of the Second Scientific Support Plan for a Sustainable Development Policy (SPSD II) and was funded by the Belgian Science Policy (BELSPO).

The major focus was on the development of a specific methodology for spatial planning at sea with emphasis on interdisciplinary and public participation. In the course of the project, two workshops were organised. One workshop involved international experts and another dealt with stakeholders that are directly involved as actors in the process (both policy makers and public).

## Framework for the GAUFRE project

A variety of previous projects was used as input for the GAUFRE research.

The Belgian Science Policy, over many previous years, has supported research of the North Sea ecosystem. Until now, this research was mainly focused and linked to one discipline, such as, seabirds, sea mammals, macrobenthos, or dealt with sustainable management of the North Sea (1).

The 'Limited Atlas of the Belgian Part of the North Sea'(2) created in 2000, was a direct predecessor of the GAUFRE project. This atlas gives an overview of the spatial use of activities in the Belgian part of the North Sea (BPNS) that were most prominent at that time. As well, the current and future conflicts were briefly addressed in this atlas.

In the meantime however, new activities and demands for space have developed. The two major future demands include the allocation of MPAs (marine protected areas) and the allocation of wind turbine parks. Moreover, the previous atlas was not complete in addressing actual uses such as cables, pipelines and fisheries. The atlas also neglected to address the intensity of the uses, such as, the number of shipping movements per km² or per unit of time. Finally, scientific data such as biological and geological maps were not included.

## Why a spatial structure plan for the North Sea?

The sea plays a major role in the organisation and development of coastal and delta areas. However, we continue planning with our back towards the sea. The Belgian Atlantic Wall and the Dutch Delta Works, which view the sea as a natural element that is either of great beauty or of great danger, are existing examples.

Important economic, social and ecological changes however, make it necessary for the sea to be taken into account when planning. The demand for marine space by recent activities is increasing. This demand leads to discussions and public conflicts as to how to use the marine space in the future (wind turbine parks, nature reserves at sea, the European fisheries policy,...).

Additionally, international policy options point at the importance of a spatial planning process for nations surrounding the North Sea. The challenge is to find a balance between the urge for protecting marine ecosystems and the demand for space by the different activities on and in the North Sea.

## Results of the GAUFRE project

The most important objective of the project was to synthesize the scientific knowledge about the use and the possible impact of different activities in the Belgian part of the North Sea.

Based on these data, GAUFRE tried to initiate a spatial structure plan of the Belgian part of the North Sea. It takes the conflicts between stakeholders and an active participation of these sectors into account. These issues were identified during meetings of researchers and end user committees during the final workshop.

The creation of one 'ideal and final' structure plan however was beyond the scope of the project. The major focus was on the development of a methodology for spatial planning of the BPNS rather than on the resulting plan. This methodology would provide guidance while developing a vision for the future use of the North Sea space and should eventually lead to the development of different scenarios of planning for this part of the North Sea.

## About this book

This book reflects the thinking process that lead to different scenarios for the future of the BPNS.

This book is not meant to be a summary of the scientific report of the GAUFRE project but rather to focus mainly on the issue and the methodology of spatial planning at sea. The hard and basic scientific data can therefore be found in 'Towards a Spatial Structure Plan for Sustainable Managements of the Sea' (Maes et al. 2005) as included on the CDrom.

The first part of the book describes the study area in general and gives a listing of the major aspects, presented in maps, that need to be taken into account while developing a vision for the BPNS. The major aspects include the physical and natural characteristics and values of the area, together with aspects that threaten the previously mentioned. This is then followed by the presentation of the infrastructure and activities on the BPNS.

Using the first part as a basis, the second part of the book is dedicated to the search for a vision for the BPNS. This search resulted in six rather 'extreme' scenarios for the future of the BPNS.

## Structural planning methodology as a basis

The methodology for the research and vision development represented in this book is borrowed from the methodology used for spatial structural planning 'on land' in Flanders.

In structural planning space is seen as an area of structural unity, in which spatial decisions need to be balanced against each other. In contrast with so-called 'end situation planning', structural planning does not determine what can and cannot be done on every single piece of space.

The structural plan is rather a global and strategic vision on the desired spatial development of a particular area, a framework for sustainable spatial content represented by structural maps rather than detailed final planning maps.

Structural planning tries to detect large and smaller inter-connected units or 'structures' and structural elements and formulates these into a strategic vision that is relevant within the scope and scale of the studied area.

The structural plan is intended to make provision for existing issues and problems as well as potential opportunities.

Another essential difference with end situation planning is that a structural plan needs to be refined and updated every so many years so as to react to societal changes. In other words, flexibility is a major starting point of structural planning: after all, space is never 'finished'!

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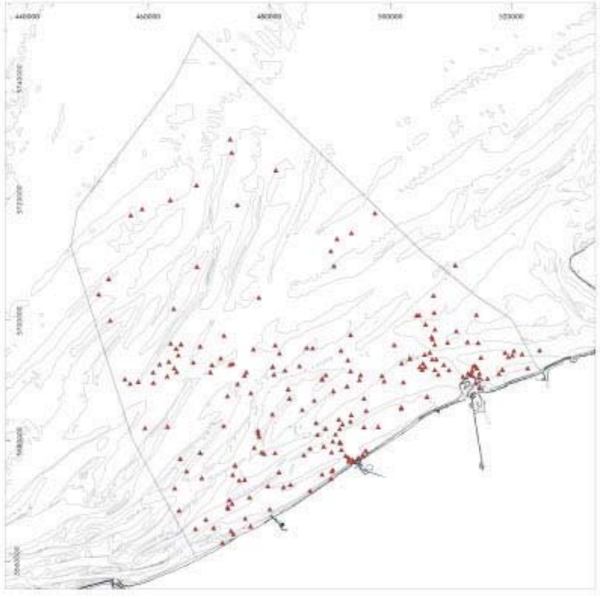
## From GIS to structural maps

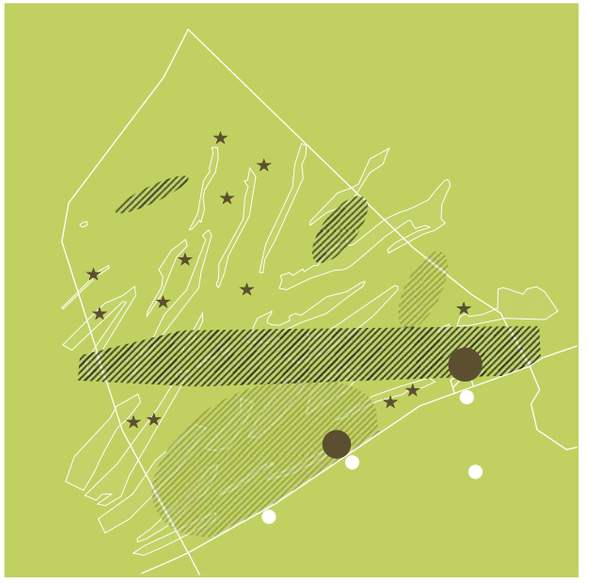
Both GIS and structural maps are useful for the analysis and development of a vision for a particular area.

GIS (geographical information system) is widely used. GIS is not only a tool to produce maps, it is particularly used to present data with a spatial component (for example the number of ship movements per square kilometer). GIS software is used to 'map' these data as accurately as possible.

GIS maps are geographically accurate ('georeferenced'), which means that the exact locations of all users and their impacts can be represented on such maps. GIS maps are drawn up on the basis of exact numerical data from databases linked to zones, lines or points that are determined from a geographic point of view. This makes GIS maps perfectly suited to scientific analysis and the representation of numerical localised data.

However, the creation of a so-called 'mental map' of the studied area is very important for spatial planning. Mental maps are drawn up on the basis of things such as major infrastructures and/or activity zones, sub-areas with a distinct profile,... which determine the spatial structure of a studied area. Simplifying structural maps are a good tool to produce mental maps.





***From GIS to structure maps***
*Location of ship wrecks in the BPNS transferred into a structure map.*

*This map clearly reflects the shipping routes to Zeebrugge and Antwerp. It also shows a concentration of wrecks close to the ports of Zeebrugge and Ostend and throughout the entire coastal region.*

*left map: © Ugent, Renard Center for Marine Geology*

Structural maps unlike GIS maps are not geographically accurate down to the last detail. Rather they illustrate specifically chosen information so that planners and policy makers can easily handle the information.

The chosen level of detail illustrated on a structure map is determined by the scale of the studied area. For example, when referring to spatial planning 'on land', a municipal structural map will indicate all inter-municipal connecting roads, considerable residential areas and local industrial estates in the municipality (in rather abstract form). This data is less important for a provincial structural map. Data represented on a provincial map will include such things as the main highways, large urban areas, regional industrial estates and large natural areas.

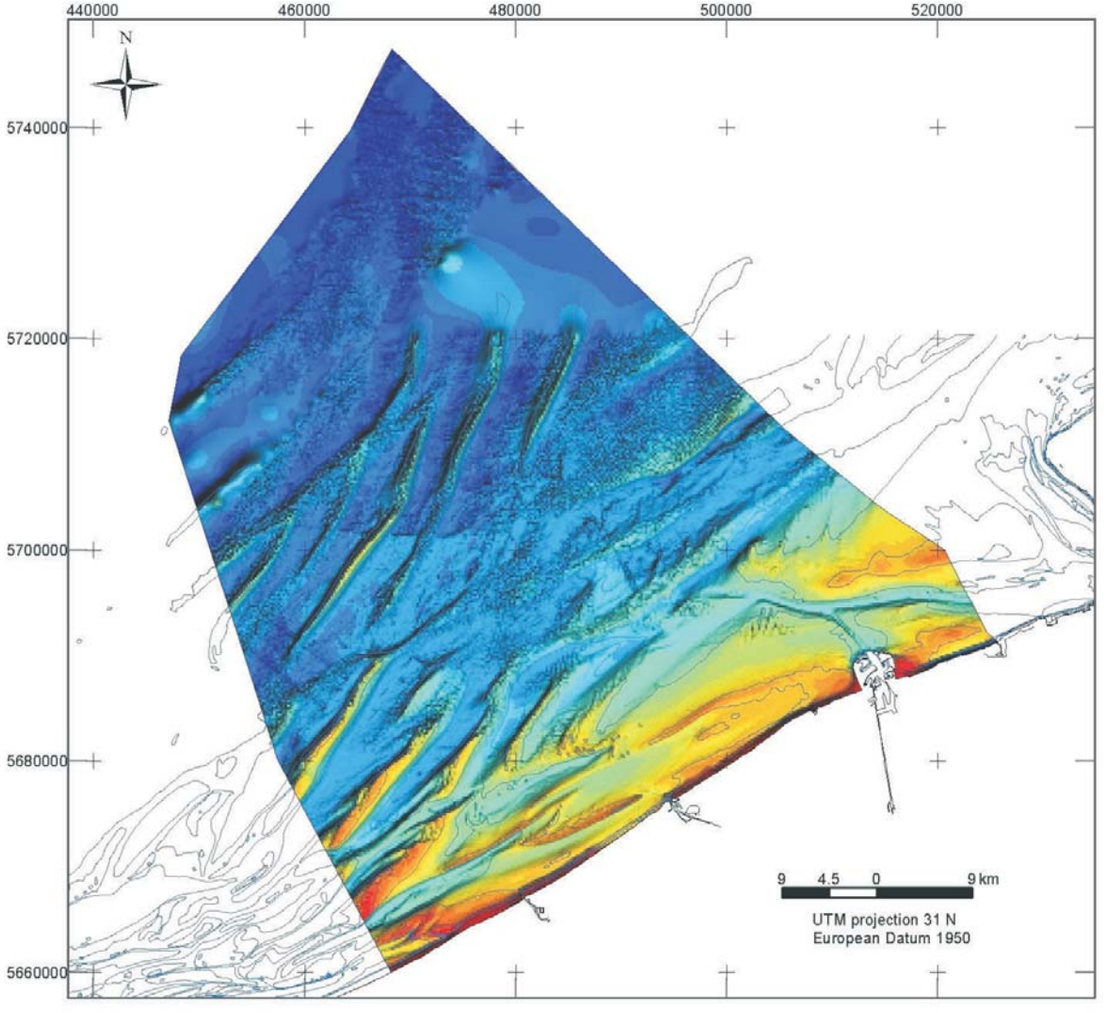
Structural maps are also used within the GAUFRE project. The structural maps in this book represent schematic versions of reality, with a focus on those elements (linear infrastructures, areas and points) that play a structuring role at the level of the studied area (which is in this case, the Belgian part of the North Sea or 'BPNS').

Therefore, the *exact* morphology of the sandbanks, groynes at the port of Zeebrugge, or coastal municipalities are not represented at this level. After all, at the level of the whole BPNS the detailed morphology of these elements is not important. Instead data that *does* matter at this scale is represented in a schematic form on every structural map in this book (e.g. the location of sandbanks, the port of Zeebrugge and major coastal towns in relation to each other and the entire BPNS, not their exact morphology).

***From GIS to structure maps***
*Average water depth in the BPNS (structure map, right) as derived from a bathymetrical GIS map (left).*

*The sandbanks are clearly identifiable on the bathymetric map. The structure map divides the BPNS into a number of subzones with comparable bathymetric characteristics (such as water depth and the presence or absence of a certain group of sandbanks).*

*left map: © Ugent, Renard Center for Marine Geology*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# THE NORTH SEA

The North Sea is situated in the Northwestern part of Europe. It is connected with the Atlantic Ocean, the Channel and the Baltic Sea. The North Sea takes up less than one five hundredth part of the total seawater mass on earth and consequently is little more than a small, shallow puddle in comparison with the oceans.

The North Sea is surrounded by heavily populated and industrialised countries and some of the busiest shipping routes in the world traverse the North Sea using its waters. In addition most of the North Seas coastal areas have been intensely developed to cater for tourism and recreation. The Belgian coast for example draws intense tourism.


## Geographical demarcation

The North Sea is located between Great Britain, Norway, Sweden, Denmark, Germany, the Netherlands, Belgium and France. The delimitation of the continental shelves of the North Sea coastal states is the result of agreements made since the 1960s and 1970s.

The geographical demarcation of the North Sea may vary depending on the purpose of the demarcation or the research discipline within the scope of which the North Sea is demarcated (1). A much used geographical demarcation can be found in the Third Ministerial Declaration on the North Sea (1990) and the Fourth Ministerial Declaration on the North Sea (1995). In these declarations the North Sea is defined as:

- "the mass of water south of latitude 62° north, and east of longitude 5° west in the north west;
- north of latitude 57°44.8' north from the most northern point of Denmark up to the Swedish coast
- and east of longitude 5° west and north of latitude 48°30' north in the south".

According to this demarcation the North Sea comprises the Channel and the Straights of Dover to the south west, the Skagerrak to the east and a part of the Atlantic Ocean to the north west of the Orkney and Shetland Islands. Consequently, almost the entire south coast of Great Britain, the entire north coast of France and part of the Swedish coast, north of Gothenburg, are located within the North Sea area (2).

## Topography

The North Sea is a shallow sea with an average depth of about 94 metres.

In general, the bottom descends from the south to the north. The depth off the coast of France, Belgium, the Netherlands, Germany and Denmark varies between 0 and 40 metres. Off the coast of Scotland the North Sea measures over 100 metres deep in places. Off the south coast of Norway the Norwegian Channel is situated with depths varying between 200 and 500 metres. The only pit, measuring between 500 and 700 metres deep, is located in the centre of the Skagerrak. The North Sea is nowhere deeper than 700 metres.

The seabed of the North Sea mainly consists of glacial sand and gravel deposits. Silt and mud can be found in the south eastern part of the North Sea (Oyster Ground, Elbe/Rhine postglacial valley), in the deeper areas surrounding and to the north of the Dogger bank, in the Norwegian Channel and the Skagerrak. Areas with a rocky bottom are mainly located off the Scottish coast, the English north-east coast, the French north coast, the Danish south-west coast and the Norwegian coast (2).

## Water circulation

Water circulation in the North Sea is rather complex and depends on the depth and the weather.

The water can clearly be seen to circulate anticlockwise. Ocean water is pushed into the North Sea by the prevailing west winds, tidal waves and density differences. Density differences mainly occur in coastal waters and are caused by the supply of fresh water with a low salt content from the coasts. Consequently, coastal water is slowly distributed to the open sea and polluted river water usually lingers along the coast longer.

The location and the distribution of the masses of water are seasonal. Differences in the topography of the bottom or the configuration of the coast can also give cause to local water swirls (eddies) or other related movements.

The average residence time of water in the North Sea is 1 to 2 years at most, which means that the North Sea water is completely refreshed in most places within this time period. However, there are significant local residence time differences, ranging from 32 days off the Danish coast to 131 days in the Skagerrak. The residence times off the Belgian and Dutch coasts vary between 50 and 80 days, depending on the study.

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## Salt content

The salinity of the North Sea varies depending on the season, the fresh water supply from the rivers and the rainfall.

A litre of North Sea water contains about 33-35 grams of fixed salt. The Atlantic water has a salt content of 35 grams or more, while the coastal waters to the south east of the North Sea have a lower salt content of 29-30 grams. This is caused by the supply of fresh water from the rivers.

## Temperature

The warming of the surface water in spring and summer results in the generation of relatively warm surface water (15 to 20°C), which is separated from the colder deep water (6°C) by a sharp temperature change (thermocline). The thermocline disappears in autumn when the seawater is thoroughly mixed as a result of the storms and the cooling of the water surface.

Depending on the location the temperature of the water generally ranges between averages of 15 to 20°C in summer and 0 to 3°C in winter. The largest temperature fluctuations can be observed in the coastal waters.

## Stratification

The differences in salt content and temperature make it possible to distinguish four regions in the North Sea on a purely hydrographic basis:

- The southern coastal areas of the North Sea and the German Bight are homogenous as regards temperature (homothermous) and salinity (homohaline).

- The area to the north is thermally layered and hence prone to seasonal or permanent thermal stratification (thermocline) without vertical salinity differences (homohaline).

- Along the Norwegian Coast there is an area with seasonal or permanent strong haline stratification (halocline or vertical differences in the salt content of the water) resulting from the supply of deep Atlantic water, with significant seasonal variations.

- Between the thermally layered area in the middle of the North Sea and the Norwegian Deep there is a less thermally layered transition area where the seasonal haline stratification is less significant than along the Norwegian coast.

Areas with stratification as a result of differences in salinity and temperature are characterised by a reduction of the vertical mingling. This reduction affects the productivity and purification capacity of the water. In the bottom water layer the oxygen and nutrients are gradually used up by the biological life forms whereas there is no new supply from the water above. A low-oxygen situation may therefore arise at the end of the summer due to the lack of strong winds in summer.

## Tides

The generation of tidal waves results from the gravitational forces from the sun and the moon upon the masses of water of the oceans. The twice-daily tides with two oscillations a day and the daily tides, which give cause to two successive tides, constitute a dominant hydrodynamic process in the North Sea.

The tides are characterised by a periodic sea level variation (vertical tide) with amplitudes varying due to a tidal current pattern varying in strength and direction (horizontal tide).

Tidal currents (the displacement resulting from the movement of the tidal wave) are stronger and tidal differences are larger in the narrower parts of the southern and western parts of the North Sea compared to the northern and eastern parts of the North Sea. The strongest tidal currents (over 1 m/sec) can be found in the Straights of Dover, along the coasts of the southern part of the North Sea and between the islands to the north. The tidal currents gradually decrease in strength towards the Skagerrak (less than 10 cm/sec).

Areas with weak tidal currents are to a larger extent influenced by the wind and are characterised by more variable currents. In areas with very strong tidal currents the combination of waves and tidal currents can intensively influence the sediments on the seabed.

## Sediments and sediment transport

### gravel

Gravel does not move in the North Sea except in very shallow areas along the coast where waves have a stronger influence. In any case, gravel only moves over very small distances.

### sand

Sand displacement is mainly limited to areas with strong tidal currents and waves, i.e. along the shores and off the coast in most parts of the southern North Sea, the Skagerrak and between the islands to the north.

During heavy storms sand can temporarily be displaced at a depth of over 100 metres, whereas the effects of the surface waves along the coast will be limited to a depth of 10 to 15 metres. Sand is suspended in the surf along the shores or above shallow sandbanks and is generally transported over or just above the bottom.

### silt

Suspended silt or fine-grained sediments with a grain size of less than 63 $\mu$m diameter move throughout the entire North Sea and follow more or less the direction of the water transport. They chiefly deposit at the eastern side of the North Sea. Major silt sedimentation areas are located in the German Bight, the Norwegian coast and more in particular in the Skagerrak. Most suspended matter originates from the Atlantic Ocean to the north of the North Sea and from the Channel, though in low concentrations. The highest concentrations can be found along the coast as a result of the coastal water circulation and major supply sources located along the coast (estuaries, cliffs, shallow seabed). Plankton production is another supply source.

The average annual amount of silt supplied to the North Sea equals over 48.7 million tonnes of dry weight.

## importance for the ecosystem

Bottom sediments and matter in suspension are a major component of the ecosystem of the North Sea.

They create a natural living environment for organisms that live in or on the seabed or adhere to suspended matter (seabed fauna, micro-organisms) and contain nutrients in the form of organic matter for pelagic and benthic organisms.

In addition they provide favourable living conditions as required by higher organisms that feed on seabed fauna and use certain seabed sediments as breeding grounds.

Silt or fine-grained sediments are also an important medium by means of which numerous absorbed contaminants can move from the rivers to the coast and from the coastal waters to the open sea/ocean.

Sediments in suspension may furthermore affect biological life by blocking natural light and thus slowing down the photosynthesis in deeper, turbulent waters (3).

## Chemical characteristics

### nutrients

Next to water, light and carbon dioxide, nutrients are essential elements for the growth of phytoplankton (algae).

Nitrogen compounds and phosphates are macronutrients and are as such indispensable for phytoplankton growth.

In autumn and in winter nutrients from the deeper water and sediments are mingled with the surface water as a result of the mixing of the water and the reduction of daylight and subsequently accumulate in the surface water to reach maximum concentrations by the end of the winter.

This natural process also includes the supply of nitrogen compounds (nitrate and nitrite) and phosphates to the North Sea from the Atlantic Ocean, the rivers and the air.

Over the years river water as a natural supply source has become more and more polluted with nitrogen compounds and phosphates from non-natural sources including the discharge of (untreated) sewage and agricultural fertilisers. Nitrogen compounds and phosphates from fossil fuel combustion processes originating from traffic, shipping, households and industry also end up in the sea through the atmosphere.

### the oxygen household

In the North Sea dissolved oxygen levels tend to be high, close to or even above the saturation level, with temperature-related fluctuations.

In summer the vertical stratification of water layers combined with calm weather can result in the obstruction of the oxygen supply to the bottom. Oxygen shortages do occur in the German Bight. In the Westerschelde estuary oxygen shortages are also possible in summer as a result of the decomposition of organic matter originating from the land. Especially the seasonal (August-October) oxygen shortages to the south and to the east of the Kattegat are alarming when the oxygen concentrations drop below 5 to 10% of the saturation level and create a virtually oxygen-poor living environment.

There are no considerable oxygen shortages along the British coast and in the vicinity of the river estuaries.

### heavy metals and organic compounds

The natural level of heavy metals (cadmium, copper, mercury, lead...) in the North Sea is not known, as reliable analysis techniques for the detection of these elements in sea water were only developed after the sea water had been polluted for several decades. For practical reasons the concentrations in the North Atlantic Ocean can be used as a reference. In the North Sea similar concentrations can only be measured in water coming from the Atlantic Ocean and in the central part of the North Sea. An exception is the lead content, which is much higher in the central part of the North Sea than the normal concentrations in the Atlantic Ocean. This indicates that seawater is not only subject to the supply of polluted river water but to atmospheric lead pollution as well.

Organic compounds like PCB or DDT are artificial and do not occur naturally in the North Sea.

- Polychlorinated-biphenyl (PCB) is the collective name for a group of 209 different chemical substances. PCBs enter the North Sea through the rivers, by the dumping of harbour silt, through the atmosphere and by off-shore oil production. High PCB contents are found in the immediate vicinity of estuaries. The highest PCB concentrations are measured in the south-eastern

part of the North Sea and along the south-west coast of Norway.

- Where hexachlorocyclohexanes (HCHs) are concerned, the highest concentrations are found in the southern part of the North Sea and in the German Bight, namely up to 20 times the concentration found in the open Atlantic waters.

- The highest concentrations of tributyltin (TBT), which is mainly used in ship paint, are found in the estuaries and in the vicinity of large ports.

For other organic compounds there is insufficient comparable scientific data available to come to general conclusions about the presence of these substances in the North Sea water.

Heavy metals and organic compounds appear in dissolved or particle form. The form of chemical compounds of the substance in question may also vary (oxide, hydroxide, sulphide, ionic, molecular). It is furthermore important to distinguish the different living conditions of organisms.

There are two different manners in which these substances can be absorbed and concentrated, namely:

- by absorption or adherence of the substance to a particle and deposition on the seabed;

- by absorption by and concentration in organisms.

The mechanisms contributing to the accumulation of high concentrations of metals or organic compounds in organisms are less well known and the toxic or potentially toxic consequences of many substances are generally hard to assess. Furthermore, there is a lack of knowledge regarding the possibility that marine organisms and the marine ecosystem can to some extent adjust to changing conditions, such as an increased supply of toxic substances.

## Biological interactions

The different plankton populations in the North Sea are influenced by various water characteristics, including temperature, salt content, nutrient concentrations, turbidity, stratification level, water circulation, point in time and biological factors.

Following the rhythm of the marine seasons, phytoplankton (vegetable plankton or microscopically small single-celled plants) gets its energy from sunlight and uses it to convert mineral nutrients and carbon dioxide into living matter. This is the primary production by the generation of organic matter with algae being both the producers and the products. The phytoplankton directly or indirectly serves as food for most other living creatures in the North Sea. The size of the primary production determines the quantity of fish production in the North Sea.

Each spring the North Sea is characterised by phytoplankton growth. On an annual basis phytoplankton production is highest near the coastal waters of the southern and south-eastern part of the North Sea. In this area primary production increases in March and remains high until October.

In certain cases exceptional phytoplankton or algae growth can also be observed, which is not unusual in the North Sea. Exceptional phytoplankton biomass production also occurs. The latter gives cause to public unrest as it may result in water discoloration, foam formation on the water and/or fish mortality and may be potentially toxic for human beings.

One of the major links in the food web is zooplankton: communities of small animals floating in the water along with the phytoplankton and ranging from microzooplankton smaller than 0.2 mm, over mesozooplankton from 0.2 to 2mm up to macrozooplankton larger than 2 mm, such as fish larvae. There is one zooplankton group which mainly feeds on phytoplankton, namely the copepods. These small, mainly herbivorous crustaceans are by far the most numerous kind of zooplankton: 1 $m^3$ of water can hold millions of copepods. Almost all other zooplankton species in turn feed on copepods. The arrow worm constitute an example of a remarkable and very successful group of gluttonous predators that play an important role in the plankton community for the reduction of the larvae stock.

Some plankton species only live part of their lives among the plankton. The larvae of numerous shellfish and fish species begin their lives as plankton. In their larval stadium they hunt copepods and are hunted by other and larger zooplankton species such as arrow worms. When these species have reached adult size at the end of their stay in the plankton a massive diaspora takes place and the species move to a new environment where they are both predator and prey.

Species like herring, however, do not leave the plankton and stay in the community where they developed so as to feed on the other zooplankton species accompanying the copepods. Now that the herring has evolved from prey to predator he is at the top of the plankton food web, but at the same time he is at the basis of another food chain that ends with the larger predators living in the sea. Once fully grown, fish mainly feed on sand lance, herring and sprat.

In this manner a hierarchy of increasingly larger piscivorous fish species and seabirds (e.g. auks) evolves. Amphibious sea mammals, such as the grey seal (in the north west of the North Sea) and the smaller common seal (in the east and south of the North Sea), like a varied diet of fish, shellfish, sea urchins, shrimps and even birds. Other sea mammals like dolphins and whales live exclusively in the water and feed on a variety of fish species, feed exclusively on plankton or on a combination of both (e.g. fin whale).

This is not the end of the marine food chain. In places where the depth of the seabed exceeds 30 metres there is insufficient air for the photosynthesis of plants and the benthic community lives off the food that drifts down from surface waters to the sea floor: faeces, dead

plankton and fish remains. Some sea-floor dwelling animals, including crabs and fish, feed on large pieces of organic waste. Other species such as anemones, shellfish and feather worms filter the tiny food particles from the water (= filter feeders). These filter feeders are in turn eaten by larger fish. The waste produced by all these animals constitutes the nutrients for the next phytoplankton generation (2).

# 1 spatial analysis of the BPNS


The Belgian part of the North Sea (or BPNS) has a maximum width of about 65 kms and extends about 87 km from the coast. Its surface is comparable with an average Belgian province (about 3,600 km²). It only consists of a small proportion of the total North Sea (merely 0,5%). The marine part of the neighbouring countries is considerably larger.

# THE BELGIAN PART OF THE NORTH SEA


Despite its small size, the North Sea off the Belgian coast is characterised by several valuable habitats. This, in part, has to do with the presence of a complex system of sandbanks. The sandbank area stretches out from Zeeland to Calais. Such an area is otherwise only found in the southeast of England. The sandbanks in the Belgian Part of the North Sea are situated more or less parallel with the coast and some of them surface during extreme low tides. Together, they form a fascinating underwater dune landscape with a large biological value.

Shallow waters also characterise the BPNS (average of 20 meters and a maximum of 45 meters). By way of comparison, off of the coast of Norway, the North Sea reaches depths of a few hundreds of meters.

This book focuses on the BPNS. Relations with neighbouring countries are identified where needed or possible. Maps will guide the reader through the process of thinking. They all use a basic outline map on which the BPNS contours and those of the northern part of the Province of West-Flanders are indicated. White dots indicate the coastal towns of Nieuwpoort, Ostend and Zeebrugge and the city of Bruges. Additionally, the groynes at the port of Zeebrugge and the most important sandbanks are indicated on each map.

## A complex ecosystem

The North Sea ecosystem is very complex and dynamic. There are major seasonal differences resulting from temperature changes, currents, the strong tidal movements, etc. Even during the course of one day, major changes occur in the North Sea environment (see figure). The direction and strength of the current determine what kind of species are found in a certain area. Indirectly, currents have an effect on the ecological value of the BPNS, for example, through pollution of neighbouring areas or activities.

This dynamic and unpredictable system makes planning and organising in the BPNS very complex. It is not easy to demarcate the North Sea into different territories, due to the fact that water and the organisms that live in it, are not disturbed by boundaries, and neither are pollution and waste! Certainly at sea, the boundaries we create are only mental and political in nature.

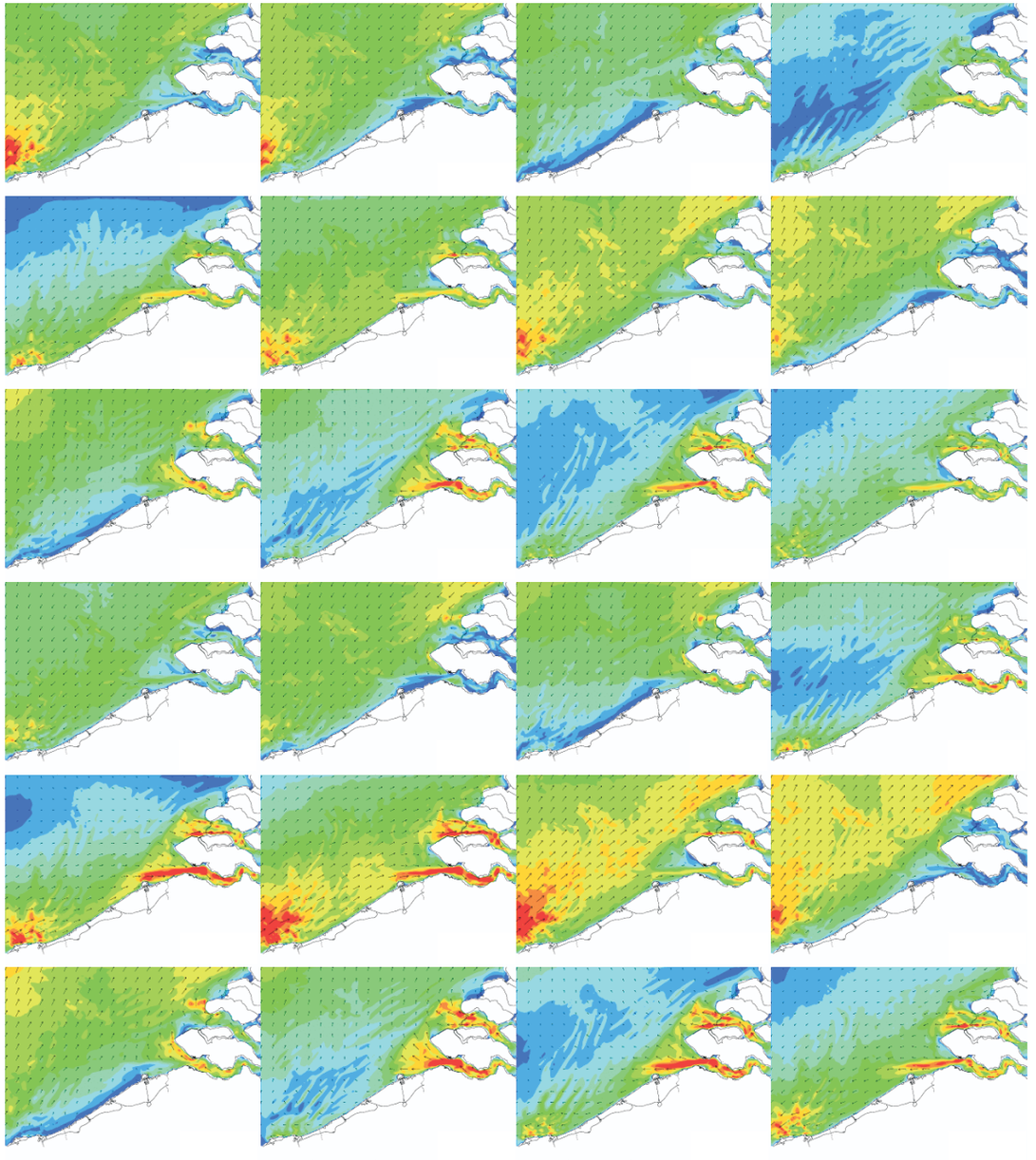
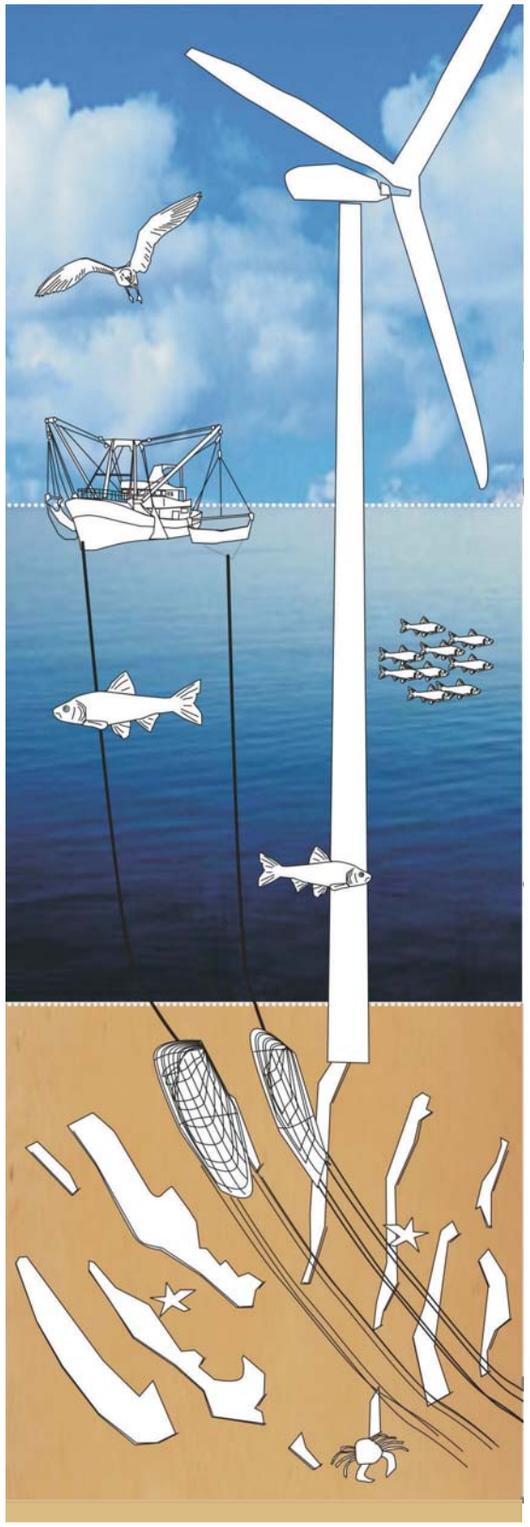


***Figure:***
***Force and direction of the surface currents in the BPNS (m/s)***
*© MUMM/BMM/UGMM 2005*
*http://www.mumm.ac.be*
*The maps show the currents during 24 hours (from 21 /03/2005 at 6:00 pm till 22/03/2005 at 5:00 pm). The stronger the currents are, the more red the colour. The fainter the currents are, the more blue the colour.*




The North Sea is even more complex because it consists of different layers. The seabed, the water column and the airspace, each enable specific uses, which can take place simultaneously due to the three dimensional structure. The three components determine the ecological richness of the BPNS through mutual interaction. The seabed for example, as a habitat for benthos communities, will constitute the basis for marine life in the water column (fish and sea mammals) and in the air (birds).

The character and relief of the seabed determine the organisms that live there and the depth of the sea is a contributing factor in the occurrence of birds. Typical are the shallow coastal waters and the variation between a primarily sandy seabed and the hard substrates of shipwrecks and groynes that will attract a completely different fauna and flora.

## An unknown sea

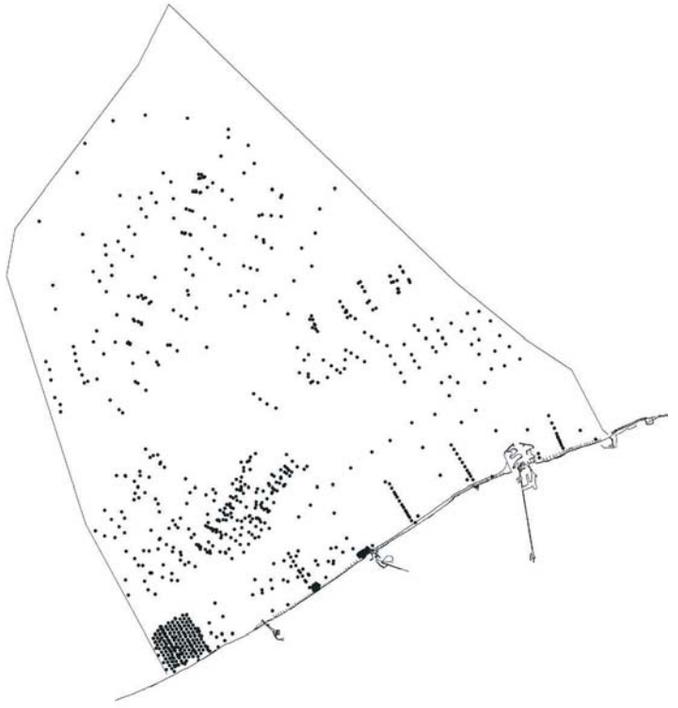
The BPNS is thoroughly sampled. By means of research boats, patrol planes, satellites, computers and acoustic techniques, we have gained a better insight into the sea.

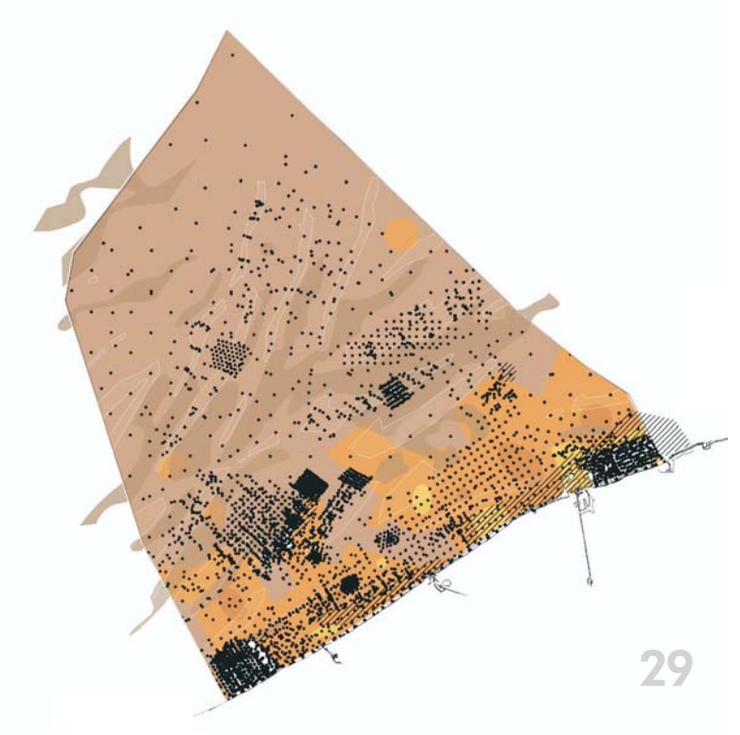
Two ships - the Belgica and the Zeeleeuw - are used for scientific research in the BPNS. The Belgica is a federal ship under the authority of the Belgian Federal Science Policy. It is operated by the MUMM (Management Unit of the North Sea Mathematical Models) and spends approximately 200 days a year at sea. The Belgica monitors sea quality and is also used during incidents at sea, such as oil contaminations. The ship is not exclusively used for research in the BPNS but also operates elsewhere.
The Zeeleeuw is managed by the Flanders Marine Institute (VLIZ) and the Fleet Division of the Waterways and Maritime Affairs Administration of the Ministry of the Flemish Community. This ship is used for marine scientific research as a sampling platform and operates both in the BPNS and in the Western Scheldt (1 ,2).

However, despite a considerable amount of data, our knowledge is still limited. We still know very little about the sea and the marine life that dwells within. On the adjoining maps we have indicated all the locations in the Belgian Part of the North Sea where biological and soil samples have already been taken. It is clear that some places are thoroughly sampled

while other parts of the Belgian Part of the North Sea remain unknown grounds.

Because of this, the impact of spatial interventions in the marine environment, (e.g. the installation of windfarms), is still hard to assess. We need more information to be able to take well-founded decisions regarding the planning of activities at sea. After the decisions have been made, we have to continue to take samples and monitor the possible impact, especially in cases where uncertainty about the effects exist.
Nevertheless, in each of the following chapters we have started from as many scientific results and samplings as possible to describe the ecological structures and values in the BPNS. Additionally, other factors that influence the marine environment are grouped under the label 'pollution and disturbances'. Their impact on the marine environment is being assessed as good as possible.



***Maps:***
*Left: Locations of the biological (above) and soil samples (below) that have been taken in the BPNS © UGent, Renard Center for Marine Geology*
*Right: the same maps appear in overlay with structure maps with an initial impetus to create an ecological valuation of the BPNS (above) and the average grain size of the sand on the seabed of the BPNS (below).*

# THE ROUGH SEA

## PHYSICAL ASPECTS OF THE BPNS

# RELIEF

The Belgian part of the North Sea is characterised by a limited water depth and a small seabed gradient. The water depth ranges between 0 metres at the coast and a maximum of 40-45 metres in the north-western part. 10 to 20 kilometres from the coast the maximum depth amounts to 15 metres. Near the Hinder and Zeeland Banks the sea is 15 to 35 metres deep. In the very north of the BPNS the water is about 45 metres deep. Just to the West of the BPNS, in the French part, the gradient is much steeper: 20 kilometres off the coast of Dunkirk the sea is already 30 to 35 metres deep.

***Average water depth in the BPNS (structure map)***

- 0-20 m deep with sandbanks up to 2 m deep
- 20-30 m deep with sandbanks up to 10 m deep
- 20-30 m deep almost without sandbanks
- 20-40 m deep with sandbanks up to 10 m deep
- 20-40 m deep with sandbanks up to 20 m deep
- 30-40 m deep almost without sandbanks

In addition the BPNS is characterised by a complex sandbank system. These banks can be subdivided into five groups consisting of banks and channels alternately, running parallel to each other:

- the Coastal Banks: the Wenduine Bank, Stroom Bank, Nieuwpoort Bank and Trapegeer run parallel to the coast.
- the Vlakte van de Raan off the coast of Knokke-Heist and near the Westerscheldt is also a coastal bank, but this bank is oriented north-west/south-east. In addition the Vlakte van de Raan is separated from the other coastal banks by the channel to the Port of Zeebrugge.

- the so-called 'Flemish Banks' (Oostende Bank, Middelkerke Bank, Kwinte Bank, Buiten Ratel, Oost Dijck, Smal Bank and Bergues Bank) are oriented north-east/south-west. The Smal Bank (which is usually counted among the coastal banks) also has a north-east/south-west orientation.

- like the Coastal Banks, the three 'Zeeland Banks' (Akkaert Bank, Goote Bank and Thornton Bank) run parallel to the coast.

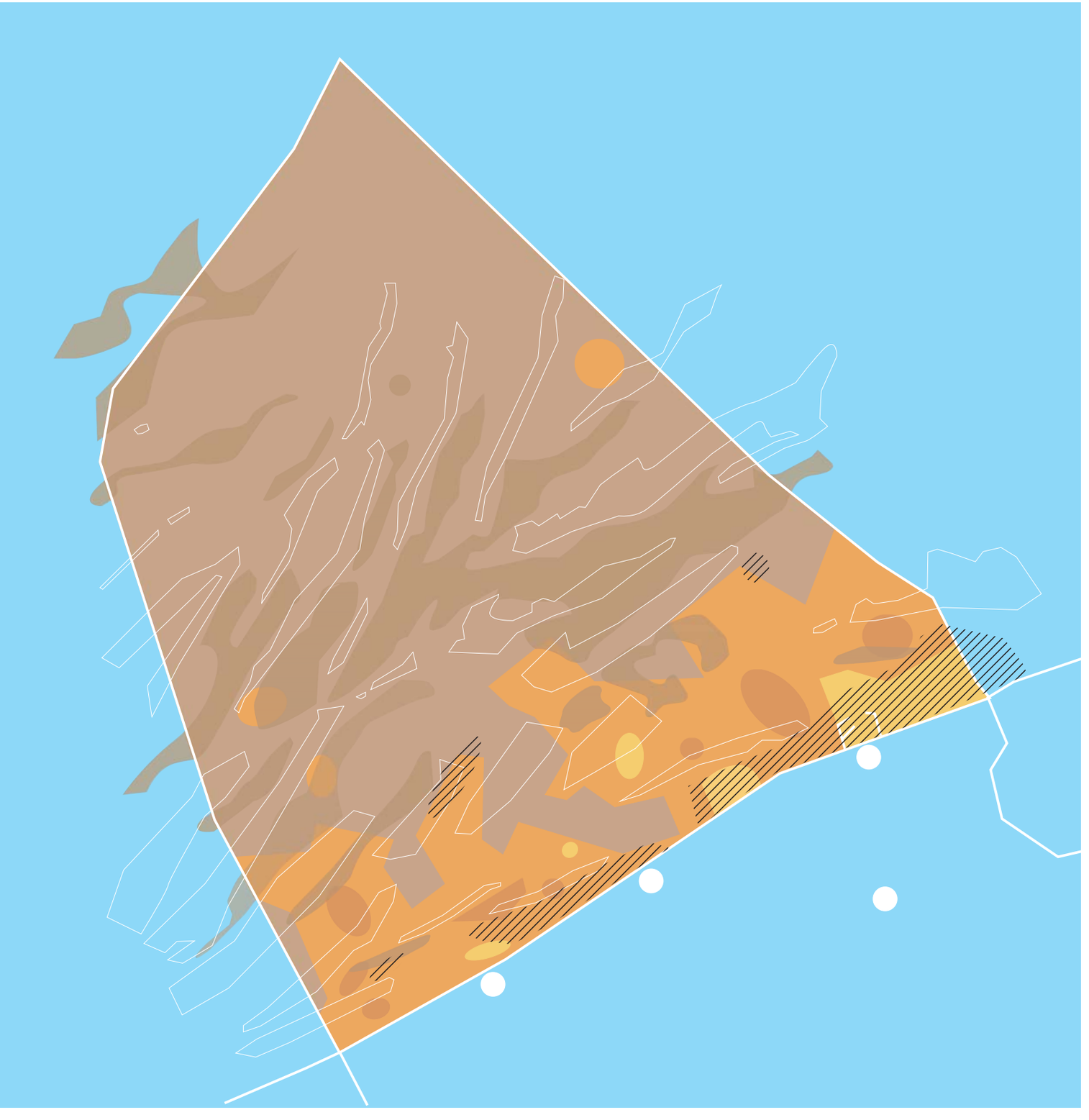
- the banks located farthest from the coast, the 'Hinder Banks' (Bligh Bank, Oosthinder, Noordhinder, Westhinder and Fairy Bank) are oriented north-northeast/south-southwest.

Sandbanks can reach a height of 30 metres with peaks located only a couple of metres under the surface in places. They are 15 to 25 kilometres long and 3 to 6 kilometres wide. There is a deeper channel between every two banks, with a width of 4 to 6 kilometres.

The lateral flanks of most sandbanks are covered with a dune structure (also called 'sand waves'). Fairly high dune formations can especially be found at the northern tips of the Flemish Banks and in the northern part of the region around the Hinder Banks. These dunes are subject to currents and may therefore shift (downwards along the slope or sideways along the flank of the sandbank) or change in height (varies mostly around an equilibrium point).

In general it can be stated that the morphology of the sandbanks remains relatively constant, whereas the position of the 'sand waves' can change considerably (1). Closer to the coast the sandbanks generally do not feature dunes.


***Structure map of the groups of sandbanks***



# COMPOSITION OF THE SEABED AND THE UNDERGROUND (2,3)

The substrate in the BPNS consists of strata of different ages. The basic stratum (the London-Brabant Massif) dates from the Palaeozoic. A limestone stratum deposited on this layer, followed by a Palaeogene overburden, and the surface of the seabed consists of Pleistocene / Holocene sediments.

***Median grain size of the sand fraction on the surface of the seabed (structure map)***

- medium to coarse sand (> 250 µm)
- fine sand (125-250 µm)
- very fine sand (63-125 µm)
- thin Pleistocene/Holocene layer (less than 2.5 m)
- large quantities of silt

## The Pleistocene / Holocene strata

The Pleistocene / Holocene deposits consist of material not yet consolidated. This means that they are partially subject to tidal currents (refer to relief - sandbanks). The thickness, composition and grain size of the quaternary strata nevertheless depend to a large extent on their location in the complex sandbank system.

In the many channels between the sandbanks the Pleistocene / Holocene stratum of the BPNS is frequently less than 2.5 metres thick. This thin layer is characterised by a relatively large gravel proportion.

As most of the sandbanks and dunes completely consist of Pleistocene / Holocene deposits, the Pleistocene / Holocene strata near the sandbanks are thicker and vary from 20 to 50 metres. The Pleistocene / Holocene strata are also somewhat thicker in the coastal zone and in the north of the BPNS.

A remarkable fact is the presence of a thick Pleistocene / Holocene stratum just off the coast of Ostend (the so-called 'sepia put'). Another deep 'pit' of Pleistocene / Holocene deposits can be found in the very north of the BPNS.

Near the coast the sand is relatively fine (grain size from 125 to 250 $\mu$m). In some places off the coast the sand can even be described as very fine (63 - 125 $\mu$m). This is the case in the vicinity of the port of Zeebrugge, off the coast of Knokke-Heist, De Haan and Wenduine and to a lesser extent also near Nieuwpoort. There are more local zones with very fine sand (about 5 kilometres off the coast of Middelkerke and about 10 kilometres off the coast of Ostend-Bredene).

There are also some zones close to the coast where the sand is somewhat coarser. The largest zone with coarse sand can be found near Ostend - Middelkerke.

In many coastal areas the sand contains large amounts of silt. This is the case at the east coast from De Haan to Knokke and from Ostend to Middelkerke. In addition a relatively high silt content can also be found to the north of the Trapegeer Bank, at the southern side of the Kwinte Bank and to the south-east of the Akkaert Bank.

From about 15 kilometres off the coast the major part of the BPNS is covered with medium to coarse sand (over 250 $\mu$m). Finer sand has also been found in three zones farther from the coast.

The sandbanks may consist of different Pleistocene / Holocene strata (e.g. Thornton Bank), but it is equally possible that the entire sandbank consists of only one type of Pleistocene / Holocene deposit (e.g. the Goote Bank). Most bank crest consist of coarse sand with large quantities of shells. On the flanks, finer to clayey sand can be found.

*The sandy floor in the coastal area of the BPNS extends onto land, where beaches with fine sand and dune formations are found.*

# CURRENTS (2)

The sea currents have a major impact on the marine environment.

Currents can move parts of the Pleistocene / Holocene sediments on the seabed as well as pollutant substances in the water column and drive them towards other zones via the sediments (this manifests itself best in the case of oil pollution at sea). Furthermore the strength of the current determines the spread of benthic communities.

***Conceptual representations of the main directions of the sea currents in the BPNS, on the basis of a 2-D sand transport model (sand transport over the seabed)***

In the BPNS the direction of the sea currents changes constantly during the course of a tidal cycle. However, a few main directions can be distinguished on the basis of a 2-D sand transport model (this model shows the daily quantity and direction of sand transport).

It is clear that sand near the coast is moved in east-northeastern direction, parallel to the coast. Off the port of Zeebrugge the sand is forced in very different directions by the groynes protecting the port channel against the currents.

Further from the coast a clear current in south-southwestern direction can be observed. This current runs more or less parallel to the Flemish and Hinder banks. Near the Bligh Bank and to the north of the Thornton Bank very complex currents occur: in one tidal cycle currents can be observed that are entirely opposite to the main current.

Where the individual sandbanks are concerned, the general conclusion is that currents at both sides of the sandbanks flow in opposite directions: if water at the northern side of the bank tends to flow to the east, the current at the southern side of the bank will tend to move in a westerly direction.

# THE NATURAL SEA

## NATURAL VALUES IN THE BPNS


# ECOLOGICAL VALUATION OF THE BPNS

Within the scope of spatial planning at sea it is recommended to gain a good insight into the ecologically valuable zones of the BPNS. The University of Gent (Marine Biology Section) gave the initial impetus to such an 'ecological valuation map' of the BPNS (1).

The ecological value was assessed by means of the macrobenthos communities living in the upper strata of the seabed. The macrobenthos is generally seen as a parameter for the health of the environment as these communities are very sensitive to pollution and disturbance of their living environment.

***Primary ecological value of the BPNS (structure map)***

low ecological value

ecological value

high ecological value

In addition they represent a major food source for animals higher in the food chain and thus determine the natural values of the water column (fish and mammals) and the air (birds).

The following parameters were used to evaluate the ecological value of a specific zone:

- the rarity of species. A species is considered rare if it is found in less than 2% of the samples;
- the rarity of communities;
- the structural diversity of the macrobenthos;
- the functional role of the macrobenthos. Especially the importance of macrobenthos as a food source for seabirds was studied;
- the importance of the macrobenthos as a community structuring factor;
- the functional diversity of the macrobenthos.

Each criterion was given a specific weight. Following this study, a visual presentation was made of the ecological value of the studied areas.

However, this map should be considered a first attempt, as this study was limited to the macrobenthos, did not cover the entire BPNS and did not include some significant criteria such as habitat diversity, distribution of food sources for specific fish species, the pollution level of the areas, the vulnerability of the species to pollutants or to physical disturbance, the vulnerability of the habitat, the replaceability of the species / communities and the replaceability of the habitat.

The value of areas for macrobenthos is determined by the speed of the current and the force of the waves. In general it can be stated that these populations prefer relatively stable areas. For this reason we can make some general conclusions on the basis of the results of the measurements and the demands of the macrobenthos populations on the environment:

- The channels between the sandbanks are dynamic areas, given the higher speed of the current compared to the sandbanks. Consequently, these channels are often less valuable areas. This is for example the case for the Flemish and the Hinder Banks.
- The crests of the sandbanks are generally dynamic due to the higher force of the waves. In case of wide banks these areas are less valuable as well.
- The flanks of most sandbanks are less dynamic and therefore most valuable. In the case of the Zeeland Banks the flanks and channels are smoother and wider, which makes this a very valuable area.
- The coastal area, and in particular the shallow western coastal banks, is very valuable. The eastern part is very dynamic due to dredging activities and erosion and therefore much less valuable.

Currently new biological valuation maps are being developed for the BPNS that will include both the macrobenthos and the hyperbenthos (benthos living just above the seabed surface), bottom fish and seabirds (2).

| | 'nursery' zone | spawning ground |
|---|---|---|
| herring | |  |
| cod |  |  |
| mackerel |  | |
| plaice |  |  |
| sprat |  |  |
| sole |  |  |
| lemon dab |  |  |
| whiting | |  |
| sand lance |  |  |

***Function of the BPNS as a 'nursery' zone and spawning area for different fish species (3)***

 the entire BPNS is important to this species

 the black part of the BPNS is important to this species

# FAUNA AND FLORA OF THE BPNS

The North Sea has an abundant richness of fauna and flora. The different habitat types, from the very dynamic shallow coastal zones to the deep waters with a varied bottom structure, harbour many species and communities.

The BPNS features for example a number of rich fishing grounds with a large diversity of fish species. The BPNS functions as a 'nursery' and spawning ground for different fish species. As a 'nursery' zone the entire BPNS is important for species such as mackerel, cod and sprat. Other species such as sole and plaice also use parts of the BPNS as nursery. As a spawning ground the BPNS is important for sole, plaice, sprat and sand lance. Smaller parts of the BPNS also serve as spawning ground for lemon dab, herring, cod and whiting. At European level the BPNS is of medium importance both as nursery zone and as spawning ground (3).

In addition the southern North Sea, of which the BPNS is a part, is the natural distribution area of some sea mammal species such as the porpoise (a small dolphin species), the common seal and the grey seal.

Every year various new foreign animal and plant species settle in the North Sea. They are called "exotics". These species are, either consciously or not, introduced from all over the world through aquaculture and ship trading (on the hull or in the ballast water of ships).

It is difficult to locate the ecologically valuable areas for 'higher' fish and plant species in the BPNS. Measuring data is lacking, many species are mobile and adjust to the environmental factors and the importance of a zone differs from species to species.

***Fauna of the BPNS:***
***smallspotted catshark (Scyliorhinus canicula): the smallest and most common shark species of the BPNS (above)***
***ruddy turnstone (Arenaria interpres) (above right)***
***and the common seal (Phoca vitulina)***


# Occurrence of bird species above the BPNS

The Institute for Nature Conservation has been collecting data on the distribution of bird species above the BPNS for quite some time.
The distribution maps of two major bird species, the red-throated diver (Gavia stellata) and the great crested grebe (Podiceps cristatus), are represented on opposite page. Both species are sensitive to disturbance, and the coastal zone, especially the western part with the Flemish Banks, is of great importance for them.

***Important locations for birds in the BPNS and the north of West Flanders (structure map)***

**Important locations for birds (5):**

areas with important breeding, staging and /or sleeping grounds

nesting ground

**(Proposed) protected locations for birds:**

Bird Directive Areas

Ramsar Areas
(in the BPNS: Coastal Banks - the Zwin)

proposed Habitat Directive Area

The coastal zone off Zeebrugge is also important for the great crested grebe, for which the entire Belgian coast is of international importance as a wintering area. Especially when the inland waterways are covered with ice there are large amounts of grebes to be found in the nearest coastal zone (up to 10km off the coast) (4).

On the basis of a recent study of the Institute for Nature Conservation (6) four bird species occurring in the BPNS qualify for protection under the Birds Directive (7), namely the sandwich tern, the common tern, the great crested grebe and the little gull, all mainly occurring in zones near the coast:

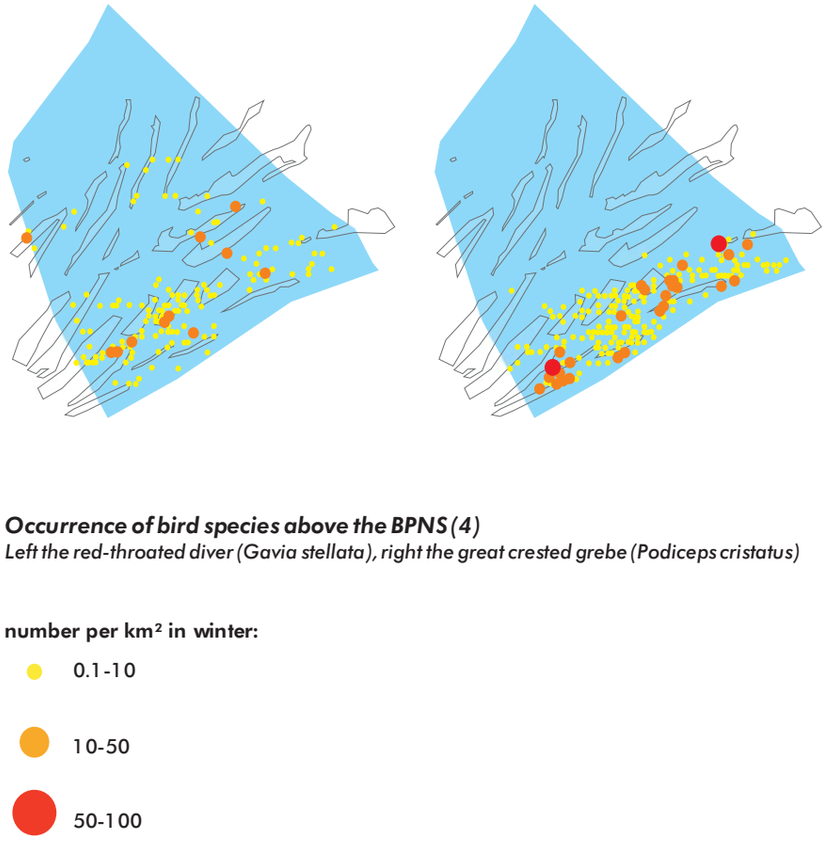
- Zeebrugge and the immediate vicinity (including the Bay of Heist): especially important as breeding ground for the tern and the common tern (April to August);
- shallow sandbanks between Ostend and the French border: major winter concentrations of e.g. the great crested grebe;
- farther away from the coast (Flemish Banks): important wintering area for the little gull and other species;
- Hinder and Zeeland Banks: important wintering area for the little gull and other species;
- the Vlakte van de Raan: important area for the great crested grebe.

## Shallow sandbanks as valuable habitats for seabirds and other communities

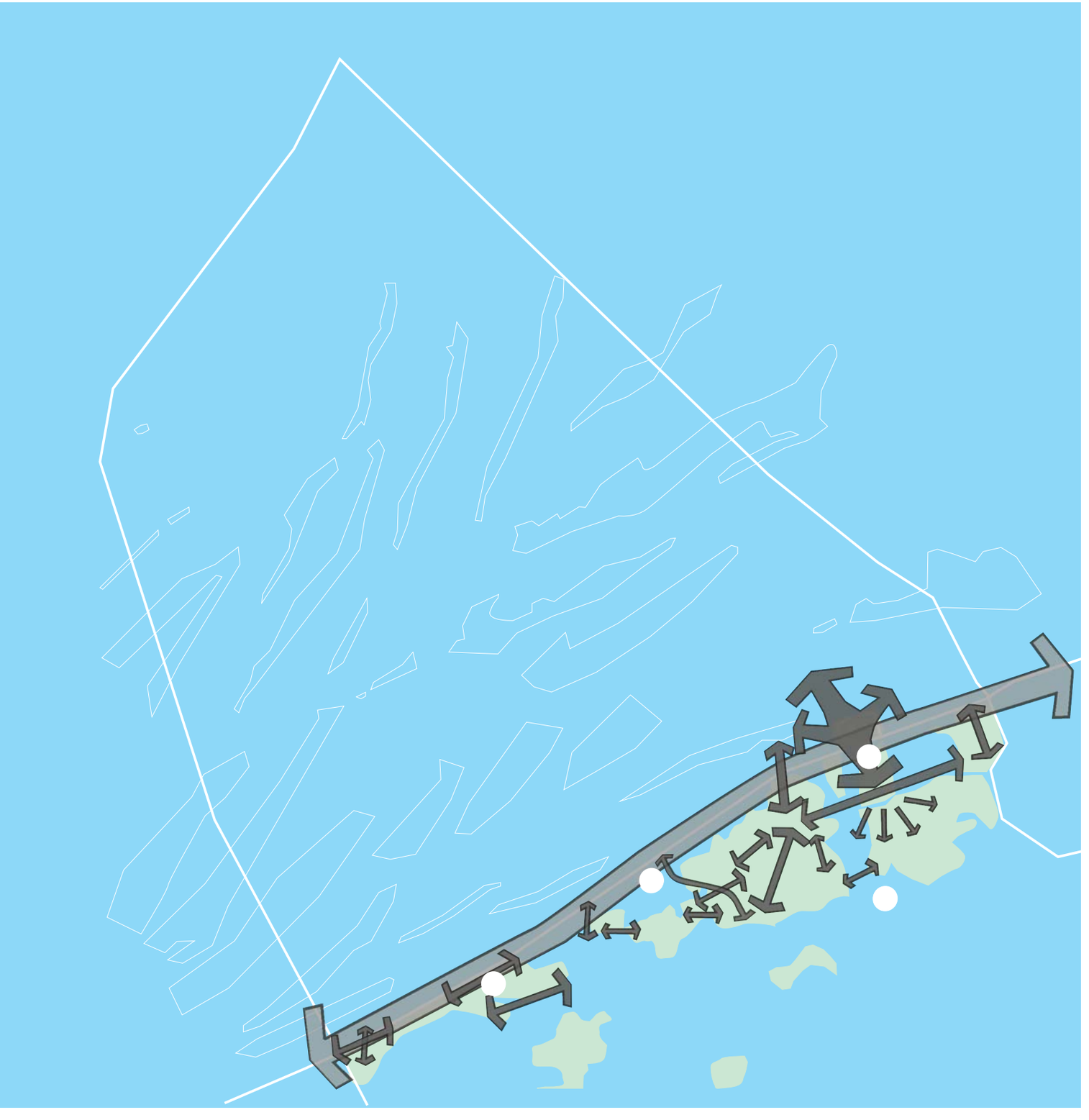
Especially the shallow western coastal banks are of particular importance to the seabirds. These banks serve as wintering areas for different seabird species including the common scoter, the guillemot, the auk and the gannet. Part of this area is even protected under the Ramsar Treaty (8).

At low tide these sandbanks are only 6 metres deep. On the map on page 47 all sandbanks located at a maximum depth of 6 metres are coloured dark green. On the basis of the depth criterion (maximum 6 metres) all these places may qualify for Ramsar classification.

Sandbanks at limited depth (maximum 20 metres) are also important for other species and communities. These areas are preferentially included in the NATURA-2000 network within the scope of the European Habitat Directive (9). A major part of the BPNS qualifies for inclusion in this NATURA-2000 network: both the dark green and the light green areas on page 47 (10).




***Occurrence of bird species above the BPNS (4)***
*Left the red-throated diver (Gavia stellata), right the great crested grebe (Podiceps cristatus)*



## Relation with the mainland (5)

The marine environment cannot be disassociated from the mainland, as numerous birds regularly move from the sandbanks to the mainland and vice versa. There are also a large number of important bird areas on the mainland in the immediate vicinity of the North Sea, including:

- the West coast (from De Panne to Westende);
- the coastal polders of Ostend-Bruges-Zeebrugge (especially the north-eastern part);
- the Port of Zeebrugge (both outer and inner port);
- the coastal polders of Brugge-Damme-Lapscheure;
- the coastal polders of the Zwin region;
- IJzer-Handzame valley and the area surrounding Lampernisse;
- the polders of Sint-Laureins and the surrounding area.

***Most important (known) bird migratory routes above the Belgian coast (5) (structure map)***

seasonal migration

sleeping and foraging migration

Large parts of these zones are designated Birds or Habitat Directive areas and have an important function as foraging, sleeping and / or breeding areas.

## Bird routes from and to the mainland

Seasonal migration takes place parallel to and in the proximity of the coastal belt, both over water and over land. The migratory route is part of the East Atlantic Flyway. This is a meeting and foraging place on a worldwide scale.

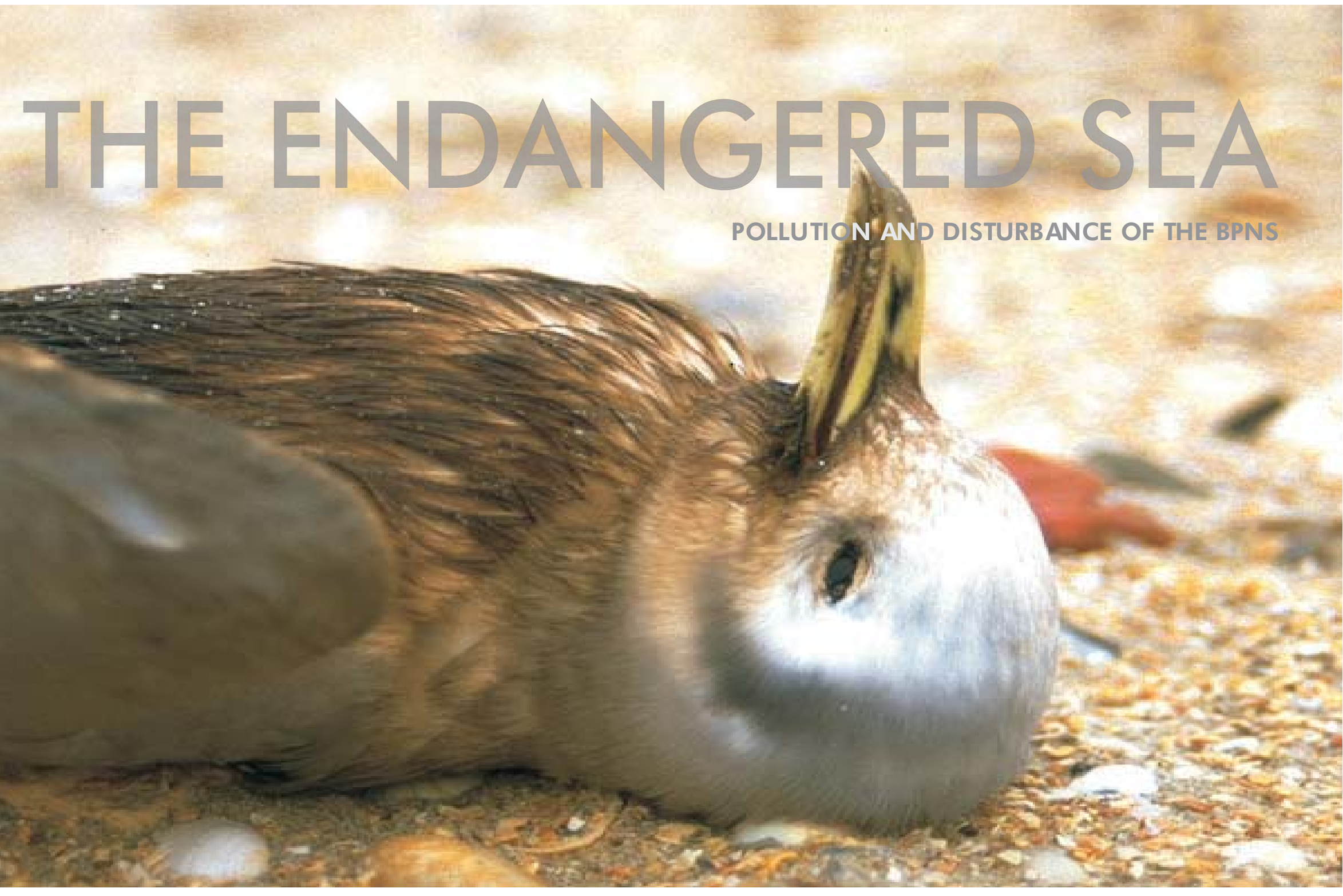
As regards foraging migration the birds fly from and to the different areas that are important to them (see the preceding paragraph). The largest number of movements is observed near the port of Zeebrugge, from where the birds migrate to the nearby staging areas. Movements from the mainland to the sea (and vice versa) occur near De Panne, Nieuwpoort, Middelkerke, Bredene and Blankenberge, the port of Zeebrugge and the Zwin area.

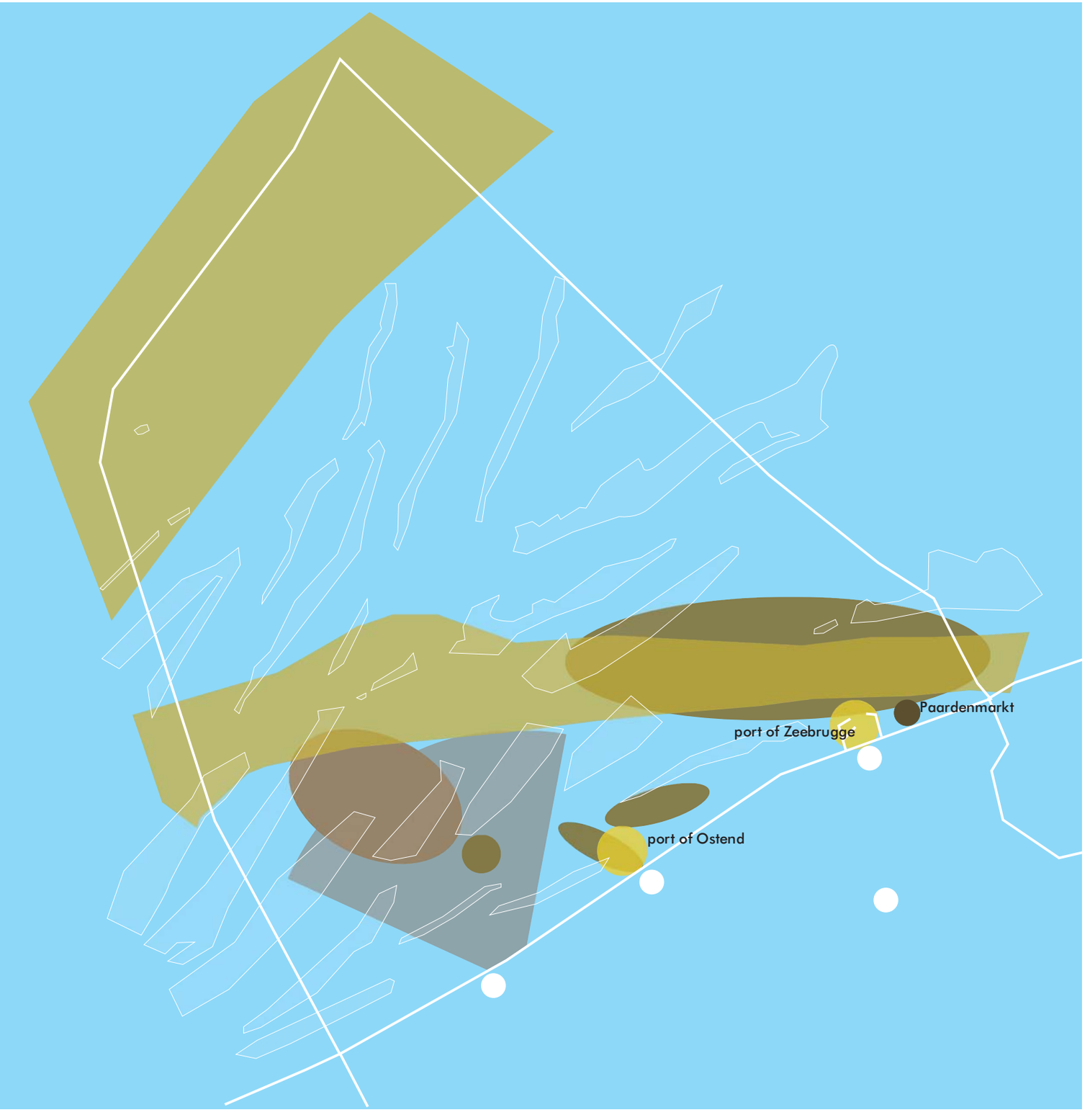
During the sleeping migration, the birds follow more or less the same routes as for the foraging migration.


***Important zones according to the Habitat Directive and the Ramsar Treaty (10)***

# THE ENDANGERED SEA

## POLLUTION AND DISTURBANCE OF THE BPNS






# POLLUTION AND DISTURBANCE OF THE BPNS

Bottom sediments and matter in suspension are a major component of the ecosystem of the North Sea. Silt or fine-grained sediments are a medium by means of which numerous absorbed contaminants can move from the rivers to the coast and from the coastal waters to the open sea/ocean.

The natural environment on the seabed is considerably influenced by the different activities in and on the North Sea. As the seabed is of major importance for different ecosystems in the North Sea, any external activity giving cause to - even minor - changes in the seabed can have severe and sometimes lasting effects on the marine environment.

***Pollution and disturbance of the BPNS***

- former war munitions dumpsite
- pollution in the port
- pollution and disturbance caused by dredging (dredging and/or dumping)
- pollution caused by shipping
- possible pollution caused by leaching after military practice
- pollution caused by intensive sand and gravel extraction up to 2004

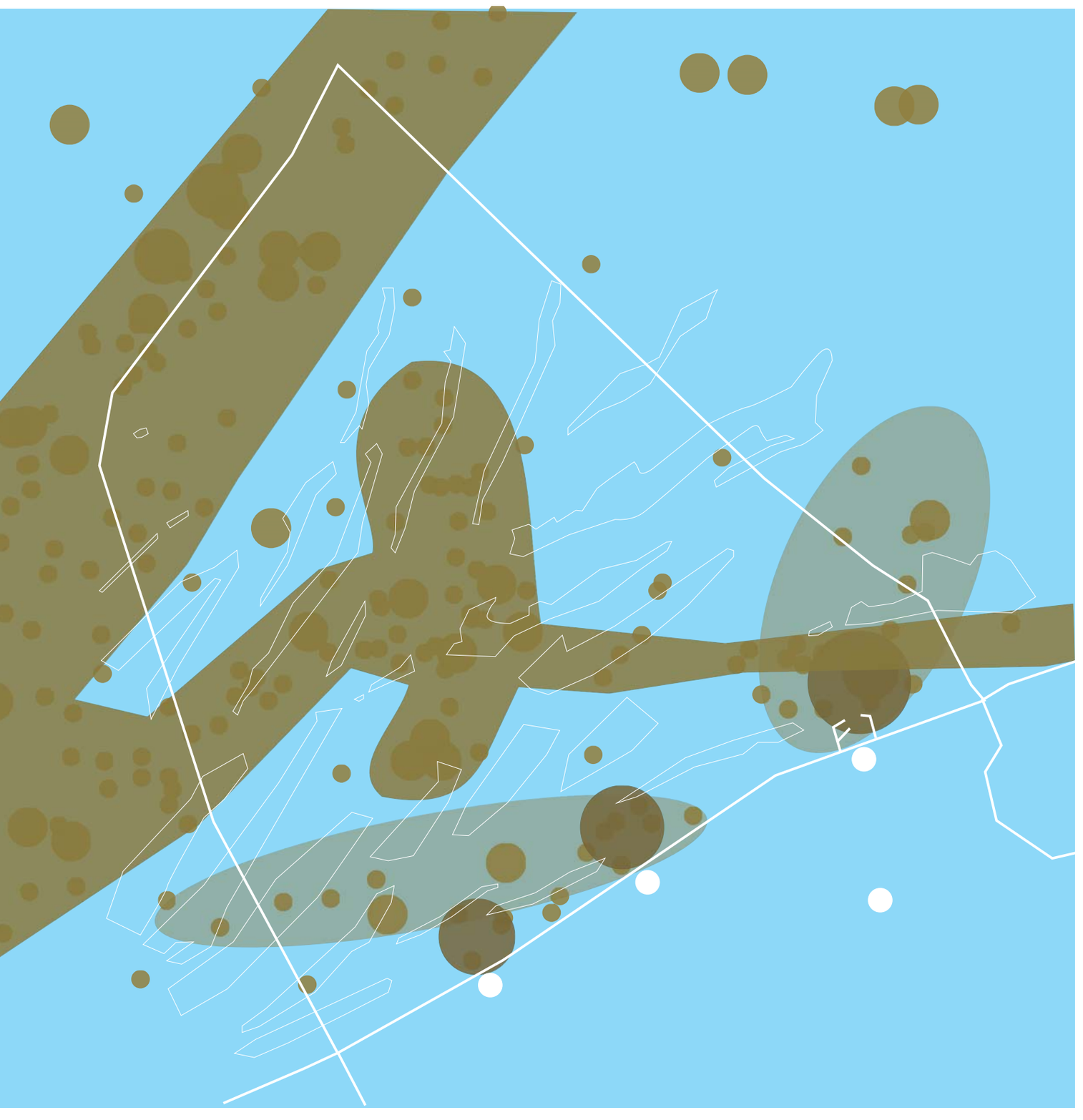
Sand and gravel extraction, dredging activities and the dumping of dredged materials can have the most detrimental effect on the ecological quality of the seabed. During extraction and dredging activities the life of all organisms present in the upper 10 cm stratum is severely disturbed and in some places all biological life disappears temporarily. Dumping of dredged materials leads to disturbance and even suffocation of the communities. Intensive beam trawling also disturbs the seabed and the communities living there. 97 % of the present-day Flemish fishing fleet use beam trawls that essentially plough the bottom of the North Sea.

Shipwrecks create disturbances of the seabed as they introduce hard substrates into the physical system of the North Sea which chiefly consists of sand. However, shipwrecks also have a considerable ecological value as 'rocky' habitats. Samplings on the wreck of the Birkenfels for example led to the discovery of 70 different species, which represents a larger biodiversity of benthic fauna than elsewhere in the BPNS (1,2). In addition shipwrecks can also serve as a refuge for several fish species. As the North Sea is a long-standing busy shipping area it is not surprising that numerous shipwrecks can be found on the bottom of the BPNS. Some wrecks not only have an ecological but an archaeological value as well.

Near Heist there is a small zone where the Belgian army dumped German war munitions after the First World War. This zone is called 'de Paardenmarkt' and is located about 1 kilometre off the coast of Duinbergen (Knokke-Heist). About 35,000 tonnes of war munitions were probably dumped here, of which 100 to 500 tonnes are toxic or may produce toxic effects. The short-term risk of pollution caused by the Paardenmarkt is considered relatively low as the munitions are covered by a layer of sand. However, the safety risk to retrieve these munitions from the water is rather large. For the time being, the Belgian government therefore does not take the initiative to dig up the munitions and bring them on land (3).
A marine zone located off the army base in Lombardsijde is used for military shooting practice. The munitions landing in the water are not removed and can in the long term, after leaching, result in chemical contamination.

***Shipwrecks in the BPNS***
*Sites of the localised ship wrecks in the BPNS (structure map of the locations).*

*On this one can clearly see the large shipping lane towards Zeebrugge and the estuary of the Western Scheldt (towards the ports of Vlissingen, Terneuzen, Gent and Antwerp). In addition one can observe a bigger concentration of wrecks (visualised by dark dots) off the ports of Zeebrugge and Ostend and in the entire coastal zone. Spread out over the entire BPNS several solitary wrecks can be found (visualised by stars).*



## Oil pollution and influx of pollutants from the mainland

The water quality in the North Sea is not very good generally speaking, partially because of the influx of pollutants from the mainland. The quality of the seawater is mainly influenced by the following factors:

- oil pollution: because of the busy shipping routes the risk of pollution in the BPNS is relatively high. In the 1991-2003 period MUMM (Management Unit of the North Sea Mathematical Models) observed 538 cases of oil dumping, excluding accidents, for a total estimated amount of 460 $m^3$. In 2003 the total volume amounted to about 30 $m^3$ (4).

***Water pollution:***
***Areas at sea frequently affected by oil pollution, in overlay with observations of oil pollution in the time span between 1996 and 2002 (4)***

- area frequently affected by oil pollution
- area less frequently affected by oil pollution
- port (frequent oil pollution)
- observations of oil pollution in the time span between 1996 and 2002 (size of dot in accordance with relative size of the oil slick)

Most oil is dumped near the Westhinder anchoring area (refer to page 76-77), in the ports and the shipping routes. In recent years, however, oil was also more frequently dumped in ecologically significant and sensitive areas such as the sandbanks near the coast;

- pollution from the mainland: various pollutants (PCBs, nutrients, heavy metals, oil...) end up in the seawater through the estuaries of rivers, the atmosphere and ports. The currents and seasonal differences make it very hard to predict where the largest concentrations of hazardous substances will be found. In addition also the mechanisms contributing to the accumulation of these substances in organisms are less well known. Only a small number of clear trends can be observed.
  However, the analysis of mussel meat shows that the quantity of heavy metals (mainly mercury) and PCBs is steadily decreasing due to a decreased influx of heavy metals through rivers (as a result of measures taken on the mainland) and during the dumping of dredging materials. It is safe to assume that the water quality of the coastal waters has improved compared to ten years ago.

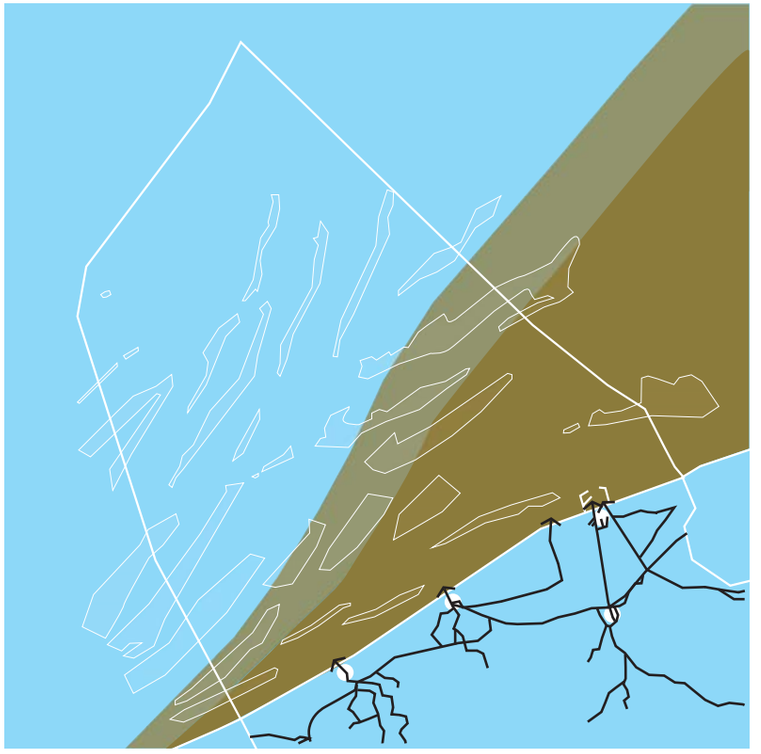
River water, as a natural source of supply, is nonetheless polluted with nitrogen compounds and phosphates originating from non natural sources, such as (untreated) sewage water and agricultural fertilizers. Via the atmosphere, nitrogen compounds and phosphates originating from the combustion of fossil fuels in traffic, shipping, households and industry also end up in the sea. They have a considerable impact on the North Sea ecosystems.
In addition enrichment with nitrates and phosphates can promote algae growth and such growth can be recognised by foam formation on the water. This may affect tourism as tourists or holiday-makers have the impression that the water is 'dirty' (5). However, algae growth is a natural phenomenon in certain periods.

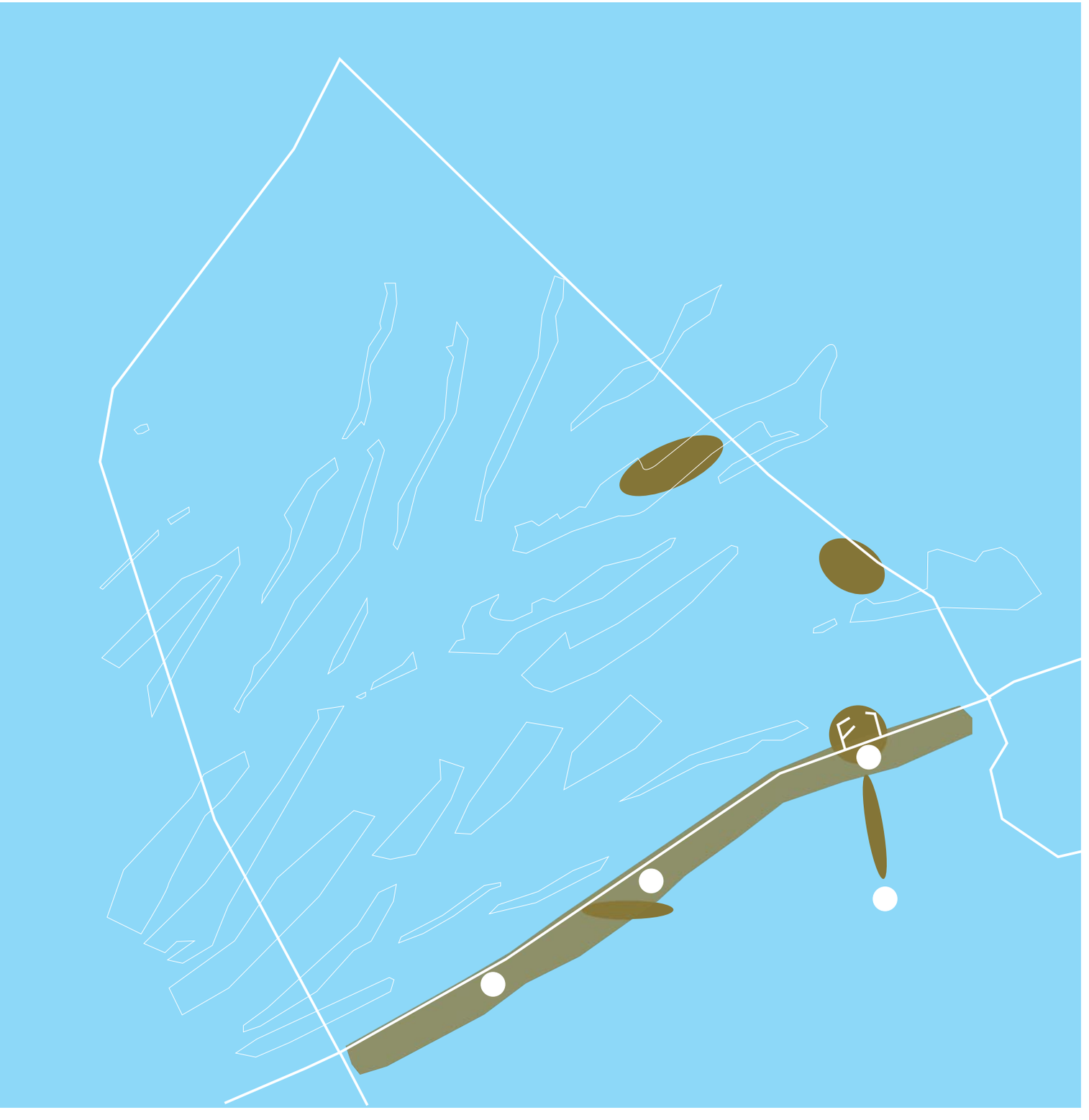
## Historical dumping site of industrial waste

From the 1960's through to the 1980's industrial waste has been dumped in the North Sea. It mainly concerns liquid waste originating from the titanium dioxide industry. This waste was lightly contaminated but had a high acidity. The objective was to achieve a maximal dispersion of waste materials in the seawater so as to optimally use its neutralising capacity. There is no certainty as to whether or not this industrial waste polluted the BPNS.

A licence to dump became obligatory as late as in 1978. Eventually dumping waste in the BPNS was completely forbidden in 1989. The former dumping zone is a large triangular area the base of which is located about 30-35 kilometres off the coast and the top of which is located about 23 kilometres farther.

***Pollution and disturbance of the water column***
*Land borne pollution of the water column in the BPNS*





## Disturbance of seabirds

One can mention two sources of aerial disturbance of seabirds:

- air traffic: every day several airplanes take off at the airport of Ostend. The airport traffic is likely to increase in the future. Its impact on the natural values however is limited, certainly on those over the BPNS since aircrafts reach a considerable high altitude when flying over the BPNS. The remaining air traffic over the BPNS (recreational, military and surveillance off the BPNS) has no noticeable impact on the bird populations present, due to its small size;

***Disturbance of seabirds***
***Possible (future) obstacles for seabirds in the BPNS (and the coastal area)***
***(structure map)***

area with (planned) wind parks

abstraction of the 'Atlantic Wall' (urbanized coastal area as a potential obstacle)

- wind parks: at present no wind farms have been constructed in the BPNS. In the near future the construction of a wind park on the Thornton bank will be initiated. The permits issued to allow the construction of a wind park on the Vlakte van de Raan, were suspended. Wind farms can have a major influence on the migratory route of the bird populations. In the event of a collision these windmills can be lethal to birds as well as affect their flight route. At present there already are windmills on the eastern longitudinal groyne in Zeebrugge. Every year a number of birds fall victim to these windmills but their number is negligible in comparison to the size of the entire population.


BUILDI

# NG THE NORTH SEA

## FIXED INFRASTRUCTURE IN THE BPNS


# CABLES AND PIPELINES

In the BPNS there are 27 telecommunication cables and 3 gas pipelines, accounting for a total length of 1,077 km (914 km cables and 163 km gas pipelines). Only 16 of the 27 cables are still used today. No oil pipelines are located in the BPNS.

## pipelines

The following three gas pipelines run through the BPNS:

- the Interconnector, running from the British village of Bacton to the port of Zeebrugge. The Interconnector was brought into use in 1998 and supplies gas originating from the Leman gas field on the British continental shelf. It is

***Cables and pipelines in the BPNS***

pipelines

cables

cables in disuse

configured to transport gas in two directions. The annual supply capacity to Belgium amounts to 20 billion $m^3$. The annual supply capacity to Great Britain will be increased to about 23.5 billion $m^3$ by the end of 2006 as Great Britain is expected to become a net importer of gas. Russian gas will account for a substantial share of the gas imports;

- the Zeepipe, connecting the Sleipner area in Norway with the Distrigaz terminal in Zeebrugge, is the oldest pipeline and was brought into use in 1993. The Zeepipe has an annual capacity of about 13 billion $m^3$;

- the Franpipe or Norfra, connecting the Norwegian Draupner E platform with the French port of Dunkirk, only passes the BPNS and does not connect to any Belgian ports. The Franpipe has been operational since 1998 and has an annual capacity of 15 billion $m^3$.

The pipelines have a diameter of about 1 metre. They are trenched into the seabed at a depth of 70 centimetres to 2 metres and are subsequently covered with a protective gravel layer.

## cables

The telecommunication cables in the BPNS are usually trenched into the seabed at a depth of 60 to 90 centimetres. There are two types of cables: coax cables and glass-fibre cables. The coax cables were laid between 1950 and 1988 and only one is still used today. Since its introduction in the 1980s the glass-fibre cable has been the only one used. The number of (glass-fibre) telecommunication cables will in all likelihood increase considerably in the future.

Electricity cables cannot be found in the BPNS yet, but if a wind park is constructed in the North Sea, this type of cable will be required to transport the electricity that is generated to the mainland.

***Right:***
***Structure maps of cables and pipelines in the BPNS***

*Top: all cables and pipelines*
*Bottom: the main bundles*

A number of measures are recommended to protect the cables and gas pipelines. These measures are further discussed in the text below. Cables and pipelines exclude certain activities and they cannot be installed everywhere.

## INCOMPATIBLE ZONES [The laying of cables and gas pipelines is legally not allowed] (1)

The laying of cables and gas pipelines is not allowed in the following zones. Furthermore, a safety zone of 250 metres for communication cables and 1,000 metres for gas pipelines applies outside these zones:

- dredging material dumping sites;
- the Paardenmarkt as a former munitions dumping site;
- anchoring areas.

Cables and pipelines are not legally prohibited in areas where detonation of mines occurs, but their placement in these zones is not recommended.

## INCOMPATIBLE ZONES [safety measures are appropriate to protect the cables and pipelines] (1)

- dredging areas

Usually, pipelines and cables are first buried at a certain depth and covered with sand or gravel afterwards. In dredging zones, the cables and pipelines are buried deeper.

## COMPATIBILITY WITH OTHER ACTIVITIES

*In the outport of Zeebrugge the gas from the pipeline Zeepipe is piped towards the LNG terminal.*

## INCOMPATIBLE ACTIVITIES (1)

A safety zone of 250 metres on both sides of the communication cables and of 1,000 metres on both sides of the gas pipelines is maintained for sand and gravel extraction.

A safety zone of 50 metres on both sides of the communication cables and of 500 metres on both sides of the gas pipelines is maintained for the construction of additional cables, pipelines, wind farms and platforms.
These distances do not apply to crossings of cables and pipelines and a smaller distance is also allowed for starting and arrival points. However, a larger distance of 1, 000 metres is generally observed between two distinct pipelines.

Beam trawl fisheries can damage cables and pipelines when they are not buried deep enough.

## IMPACT ON THE ENVIRONMENT

The laying of cables and pipelines disturbs the marine environment due to the dislocation of sediments, the creation of turbid sand clouds and the disturbance of fauna, benthos and fish.

However, the effects of the installation of cables are relatively small and temporary according to the EIA (Environmental Impact Assessment) of the C-Power wind park. Once the cables and pipelines are in place there will be only minor (or even no) effects on the environment. Pipeline leaks may temporarily disturb the ecosystem, but electrical or magnetic radiation from the cables would have more permanent effects on the ecosystem (2).

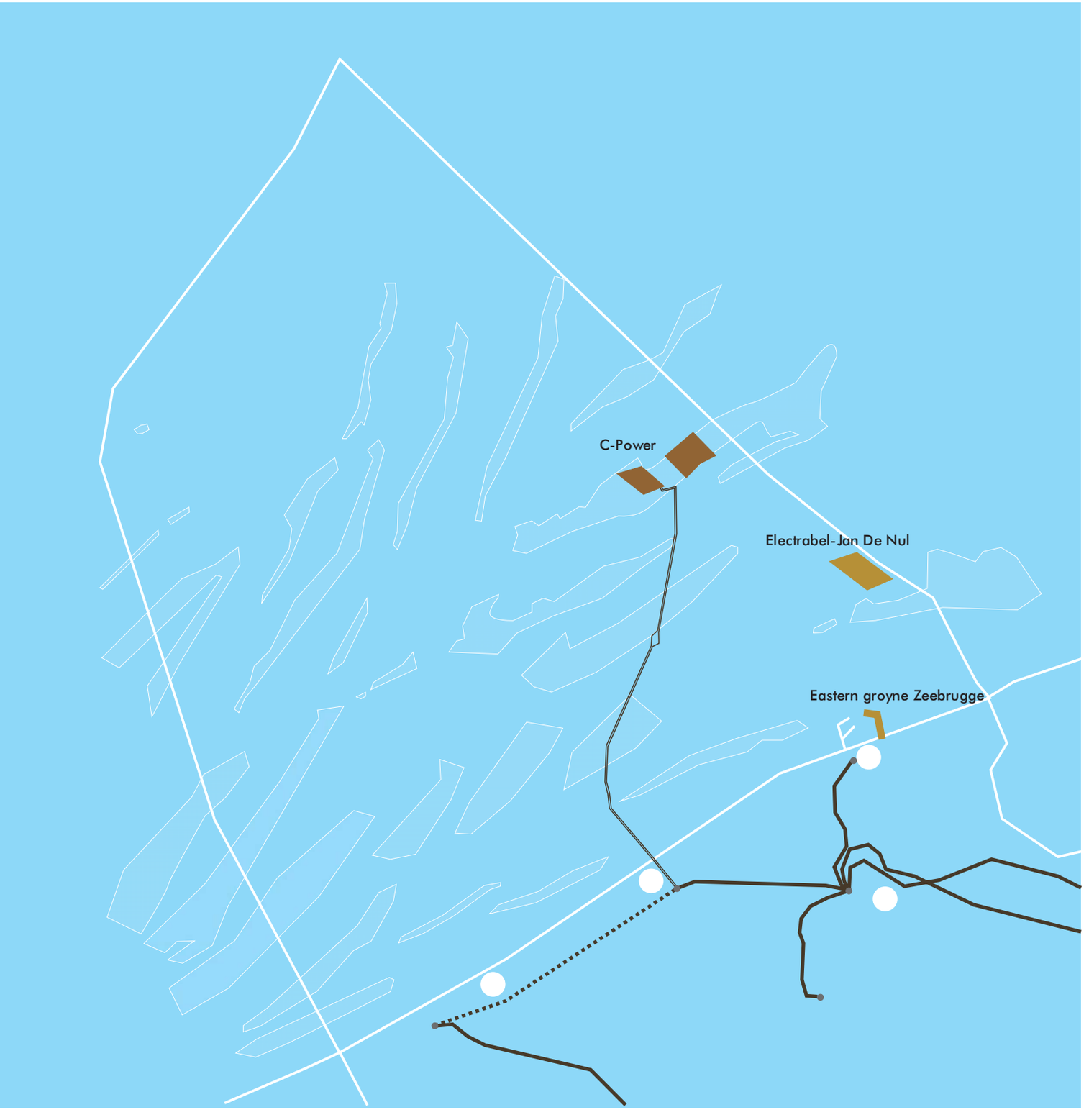
## LEGAL ASPECTS

Several permits are required for the installation of cables and pipelines including:

- a permit to lay cables/pipelines in the sea, to be obtained from the Ministry of Economic Affairs;
- permission or a permit from the Minister responsible for the marine environment to dig trenches and dump trench material on the seabed, on the basis of an environmental impact assessment pursuant to the Law on the Protection of the Marine Environment (art. 25.1 (ii) and art. 28 regarding the EIA);
- a planning permit for the cables/pipelines on the mainland (from the low-water mark), to be applied from the Flemish Region (AROHM);
- a permit for the connection of the electricity cables to the power grid;
- official approval of the route of the pipeline by the King pursuant to the Exclusive Economic Zone Act.

## ENVIRONMENTAL REQUIREMENTS

There are no specific environmental requirements, which means that cables and pipelines can in principle be laid anywhere (provided the above safety measures are observed ). Cables and pipelines are preferably laid and bundled in accordance with the natural relief lines. However, cables and pipelines are also trenched into sandbanks.




# WIND PARKS

At the moment no offshore wind parks have been constructed in the BPNS.

On the eastern groyne of the port of Zeebrugge 23 wind turbines are operated with an overall annual power generation of 10,300 mWh, consisting of 21 200kW turbines, one 400kW turbine and one 600kW turbine. The first turbines were brought into operation in 1986.

***(Planned) wind parks in the BPNS***

- wind park at eastern groyne Zeebrugge
- planned wind park Electrabel - Jan de Nul I (suspended)
- planned wind park (+ electricity cable) C-Power II
- high-voltage cable on land
- planned high-voltage cable on land

Since 2001 several applications have been submitted for offshore and near-shore wind parks in Belgium.

N.V. C-Power currently has the necessary permits to construct a wind park on the Thornton bank, about 27 kilometres off the coast. The Seanergy project (TV Electrabel - company Jan De Nul) also obtained the necessary domain concession and environmental permit to construct a wind park on the Vlakte van de Raan, but the implementation of the project is currently suspended due to legal proceedings before the Council of State.

## C-Power II

The approved wind park on the Thornton bank consists of two different zones with a total surface area slightly less than 14 km² (excluding the safety zones). The western zone will feature 24 wind turbines, the eastern zone 36. The entire park will comprise 60 wind turbines with an overall capacity of 216 Megawatt or an annual energy production of about 0.7 tWh (2, 3). A transformer platform is also planned for the western zone. Two electricity cables will be laid, more or less parallel to one another, between the installations and the mainland.

## Seanergy

The Seanergy project is situated on the Vlakte van de Raan about 12.5 km off the coast. The planned wind park consists of 50 turbines and covers an area of 5.8 km², excluding the safety zones. In addition, two meteorological towers, a transformer platform and an electricity cable will be installed to transport the power to the mainland.

## Monitoring

Pursuant to the Law on the Protection of the Marine Environment the environmental permit for offshore wind parks includes a condition that a continuous monitoring programme is prepared to monitor the effects on the marine environment. The concession and permit furthermore require the concessionaire to disassemble his installations at his own expense and to restore the marine environment to its original state if the wind parks are no longer in use. For this purpose the concessionaire is obliged to build up an adequate financial reserve.

## Wind energy plans

It is a policy objective to generate 6% of the energy consumption from renewable sources by 2010 (4). This means that Belgium has to generate approximately 4.8 kWh of energy from renewable sources in 2010 (3). Currently 2% of the overall energy consumption is already produced from renewable sources (3). If the remaining 4% of the objective is to be obtained completely from wind energy at sea this would mean that not taking into account possible technological improvement about 100 km² needs to be reserved for wind parks at sea (2).

Sustainable energy can also be naturally obtained from wind parks on land or from other sustainable sources (solar energy, bio-energy).

In a policy document the Thornton bank has been designated as most appropriate location for off-shore wind parks in the BPNS. The area covers about 270 km² with a potential of approximately 2,5 GW (5).

There are activities that are not perfectly compatible with wind parks and certain areas are considered less appropriate because of their natural values or for social reasons.

## INCOMPATIBLE ACTIVITIES

- shipping. An offshore wind park cannot be constructed in or in the immediate vicinity of recognised shipping routes. The construction and maintenance of the farm will result in additional shipping traffic, which may result in a limited disruption of other shipping traffic. In addition there is a certain risk of collisions, the significance of which depends on the location of the park. The collision risk for the wind park on the Thornton bank is estimated at one accident per 200 years (2);

- sand and gravel extraction. Sand and gravel extraction is not possible in the vicinity of wind parks. The planned wind park on the Thornton bank is located to the east of sand extraction control zone 1 A;

- fishing. Fishing in the vicinity of wind parks is not allowed. Beam trawling will no longer be possible in parts of the channels of the Thornton bank and shrimp fishing on the crest will be prohibited as well. The fishing industry will also experience a certain degree of nuisance during the construction stage;

- military practice and dredging activities are also impossible in (the immediate vicinity of) wind parks.

### COMPATIBILITY WITH OTHER ACTIVITIES

Wind parks constructed too close to the coast can be considered a visual disturbance to the landscape of the North Sea. This may affect tourism but this is very hard to predict.

The construction of a wind park may also result in temporary noise nuisance. The wind park can also be dangerous for divers as currents may change.

### IMPACT ON TOURISM

## COMPATIBLE ACTIVITIES

- tourism: wind parks may offer new possibilities for divers (specific fauna and flora) and for pleasure cruising;

- aquaculture: wind parks may also offer new aquaculture possibilities: wind parks are suitable for oyster and mussel cultivation and it is also possible to free cultivated fish species in the parks;

- fishing: wind parks may have a 'shelter function' for fish, so that they develop into rich fishing grounds.

Wind parks constitute new habitats for rocky coast fauna and flora (sea anemones, mussels, crabs, lobster and seaweed). The parks may in due time become biologically rich areas on account of the fishing ban and may subsequently develop into new fish spawning grounds or fish 'nurseries'.

On the other hand, sediment and current changes near the foundations of wind turbines may result in disruption of the food or larvae transport and of the morphology of the spawning grounds. The installation of wind turbines in fish migration routes may also affect the species. At this moment it is hard to predict the ecological profit or loss. It is certain that the benthos and the sediment will be temporarily disrupted during the construction phase. There is a risk of accidents with birds (disorientation or collision) (6) and of noise and vibration nuisance for fish and sea mammals.

## LEGAL ASPECTS

The construction of a wind park can only start once the property developer has obtained the necessary permits, including:

- a domain concession;
- an environmental permit for the construction and operation of the park; and
- a permit for the construction and operation of submarine electricity cables.

The environmental permit procedure requires the applicant to draw up an environmental impact report (EIR). On the basis of this EIR the Management Unit of the North Sea Mathematical Models (MUMM) draws up an environmental impact assessment (EIA). The MUMM can order additional studies and research and recommend additional conditions to the competent Minister (7). The environmental permit procedure furthermore requires a public inquiry. During 45 days a public consultation round is organised. If the wind park may also have an impact on neighbouring countries, consultation rounds are also launched in the countries concerned.

Finally the federal Minister responsible for the Marine Environment decides on the permit application. The process from the submission of the application to the eventual decision of the Minister takes 6 to 8 months.

Applications for the granting of domain concessions are submitted to the CREG (Commission for the Regulation of Electricity and Gas), which advises the Energy Minister (or Secretary). The domain concession is valid for a maximum of 30 years (7).

A domain concession only becomes valid when an environmental permit has been granted for the project as well.

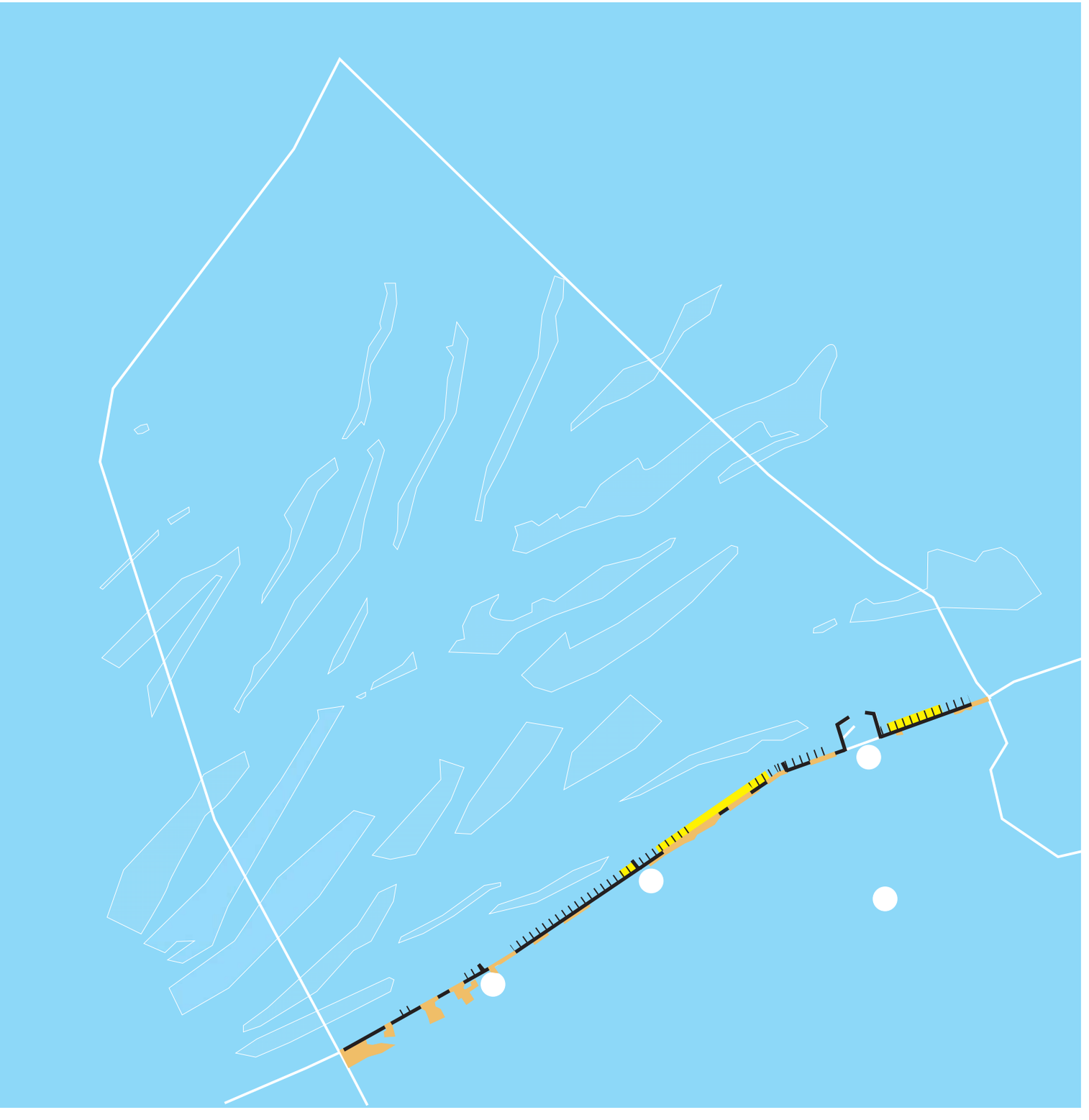
The permits for the cables (at sea, planning permit for the cables on the mainland and permit for the connection to the power grid) have to be applied for separately (refer to 'cables and pipelines').

The competent authority for wind parks in the 'Flemish' part of the North Sea (landwards from the mean low low-water mark or baseline) is the Flemish government.

## IMPACT ON THE ENVIRONMENT

## ENVIRONMENTAL REQUIREMENTS

- there are no specific subsoil requirements, but there are 'suitable' and 'less suitable' zones. Clay or clayey sand is the most preferable, while tertiary strata of stone, mixed strata and mud or fine sand are the least preferable (5);
- the maximum ideal water depth is about 30 metres (5). The more shallow, the lower the investment costs;
- inclination of the subsoil: the subsoil should be as level as possible. If the subsoil is too steep this will result in additional construction difficulties;
- optimal wind conditions: in the first 20 kilometres off the coast the wind speed increases as the distance to the coast increases. After these first 20 kilometres the wind speed still increases but to a lesser degree (5);
- there are no known hydrologic limitations;
- distance to the coast: there are in principle no technical limitations as regards distance to the coast. In the present situation the maximum distance is about 40 kilometres for the wind park to be economically profitable (5).



# COASTAL DEFENCE

The main objective of coastal defence on the Belgian coast is to protect the hinterland against natural processes such as erosion and flooding. A secondary function of coastal defence is nature conservation (conservation of ecologically valuable dunes). Coastal defence may also be implemented with a view to tourism.

Various methods are used:

- soft coastal defence includes beach nourishment, beach reinforcement by means of nets, Marram grass...
- hard coastal defence includes dykes and groynes. Ports also contribute to coastal defence, but that is not their primary function.

***Coastal defence in the BPNS***

- soft coastal defence (large quantities of sand)
- dunes
- breakwaters
- dykes
- port constructions (piers, groynes,...)

## Soft coastal defence

Beach nourishment is the most frequently used method of soft coastal defence along the Belgian coast. According to this method a 10m wide sand plateau is placed against a dyke (about 7 metres above the mean low-water mark). The plateau gradually slopes down to the lower part of the beach.

Other less frequently applied techniques are:

- dune foot nourishment;
- foreshore nourishment: sand is supplied under the low-water mark (i.e. under water) so as to stabilise the eroding beach;
- tourist beach reprofiling (mostly in combination with beach nourishment): the sand is redistributed over the beach without adding new sand;
- placement of common osiers or Marram grass on the beach or dunes. The placement encourages sand deposition and ensures that the sand is held in place.

Since 1968 Belgian beaches are frequently nourished, particularly between Heist and Het Zwin and to a lesser extent between Bredene and De Haan. Other beaches are barely eroding and thus require little beach nourishment.

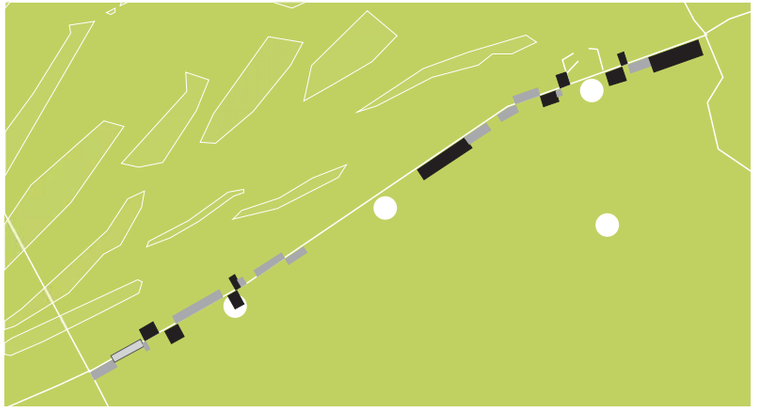
Beach nourishment is a natural way to protect the coast. Normal coastal processes are not hindered and a more varied landscape can develop.

Beach nourishment is mainly done with dredged sea sand. If the sea sand is dredged in port channels or in other possibly contaminated areas the quality of the sand has to be checked first. If necessary the sand can be treated before it is dumped on the beach. Sand originating from other beaches can also be used.

In any case, the sand has to be as coarse as possible to make the beach more stable. However, this is not always the most appropriate type of sand from an ecological point of view. Other factors play a role in the selection of the sand as well (characteristics of the original beach, currents, ecological and tourist value...). In general, preference is given to a result that resembles the original situation as much as possible and to a beach profile that is as natural as possible.

In recent years soft coastal defence has been preferred to hard coastal defence, for instance in the beach zones of Ostend and Knokke-Heist.

Coastal defence works are mostly carried out in the off-season so as not to disturb tourism and recreation. They are not possible in the winter period either due to the weather conditions. The ideal period is from September till November.




***Coastal defence in the BPNS: Evolution of the Belgian coastline (8)***

## Hard coastal defence

Almost the entire Belgian coast is equipped with hard coastal defence. Four types of hard coastal defence can be distinguished (9):

- breakwaters;
- dykes and dune foot reinforcements;
- groynes and seawalls;
- piers.

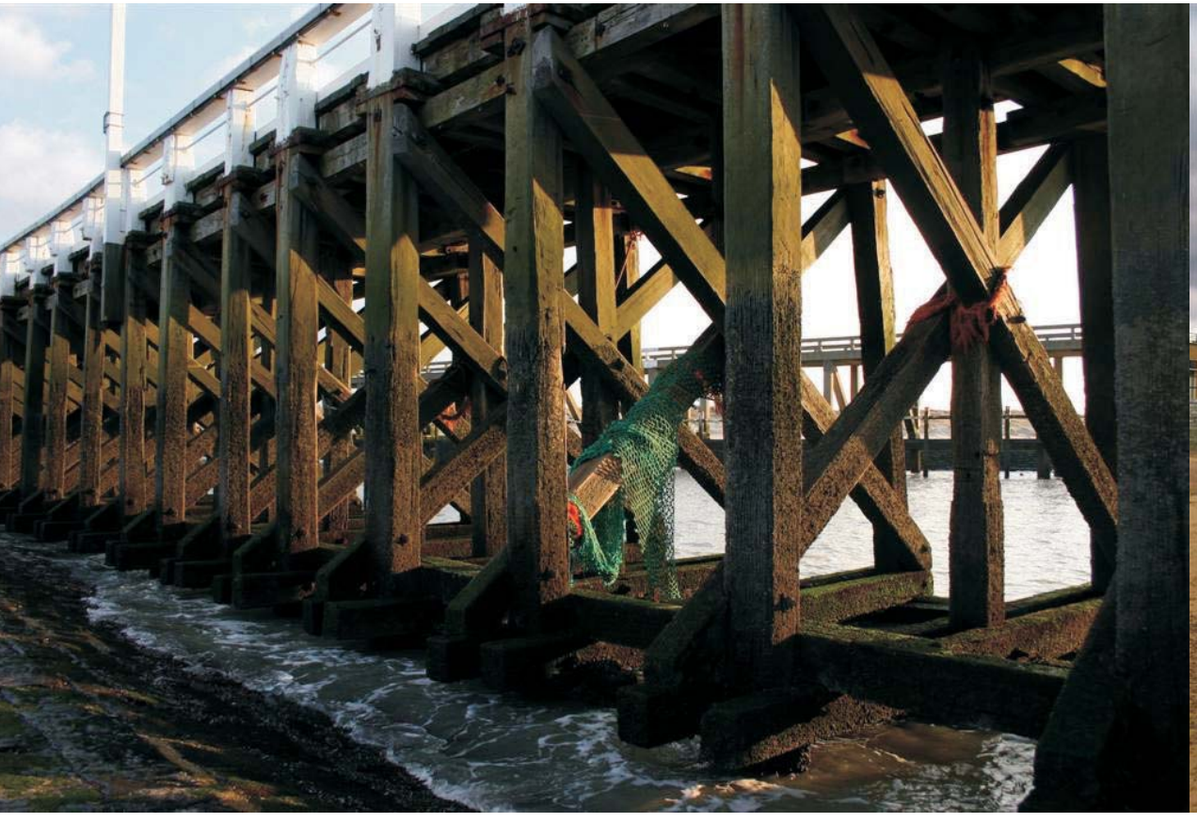
Other hard structures along the Belgian coast include bunker remains near the Belgian-French border.

Groynes and seawalls can be found in the ports of Nieuwpoort, Ostend, Blankenberge and Zeebrugge. Only the port of Zeebrugge has groynes oriented towards the sea. Seawalls mostly consist of concrete or bluestone blocks and are sometimes fixed with asphalt.

Breakwaters can be found almost everywhere. They protect the beach against erosion. They are long, narrow elements oriented towards the sea. On the mainland they often end near a dune foot reinforcement or a dyke. Some breakwaters are almost completely covered with sand (e.g. Knokke), some are also built less far in the sea (e.g. Koksijde, Zeebrugge, large part of De Haan: up to halfway the tidal zone). On the 'dry' part of the beach breakwaters mainly consist of waste granulates held together by concrete or natural stone blocks filled with cement and formerly covered with asphalt. In the wet part breakwaters consist of arbitrarily stacked blocks protected by pieces of zinc. In the Netherlands breakwaters mainly consist of wooden posts. In Belgium this technique can only be found in Knokke-Heist.
Between Westende and Bredene and between Wenduine and Knokke there is an almost uninterrupted series of breakwaters. There are no breakwaters in De Panne, Oostduinkerke, De Haan and near the Zwin area. Short breakwaters such as in Koksijde, Zeebrugge and a large part of De Haan are not built anymore because of their poor protection against erosion and limited ecological value.

Dykes can be found at many places along the Belgian coast. Most dykes consist of clay covered with concrete, natural stone, asphalt or another material. The technique of dune foot reinforcement is used in the nature reserve 'De Westhoek' in De Panne. The reinforcement consists of gabions, pieces of zinc or rubble material covered under a thick layer of sand.

Piers serve to protect port channels and can therefore be found in Nieuwpoort, Ostend and Blankenberge. Wooden and concrete piers can be found.



***Hard coastal defence***
*Left page - from top to bottom: breakwater, breakwaters and dyke, pier and seawall, pier.*
*This page: pier (left) and pier, dyke and breakwater (right).*

## INCOMPATIBLE ZONES

beach reserves: coastal defence works in beach reserves need to be planned and carried out with the greatest caution and are only possible when there is a significant safety risk.

## INCOMPATIBLE ACTIVITIES

- military activities: no coastal defence works can be carried out during military activities.
- shipping traffic: certain coastal defence works (especially in the vicinity of ports) can disturb the shipping traffic.
- tourism and recreation: beach recreation is impossible during coastal defence works. The spatial conflict is limited as most are carried out in the off-season. Certain hard coastal defence elements can also create risks for tourists (e.g. danger of slipping).

## COMPATIBILITY WITH OTHER ACTIVITIES

## COMPATIBLE ACTIVITIES [possible multiple use]

- dredging works and sand and gravel extraction: dredged material (mostly originating from shipping routes) and extracted sand can be used for beach nourishment.
- shipping traffic: buoys, groynes and the like contribute to the discernability of shipping routes and ports.
- tourism and recreation: once the coastal defence works are completed new tourism and recreation possibilities arise (beach fishing from the hard coastal defence, usually 'more scenic' landscape, wider beaches...).

Certain coastal defence works can have positive effects on ecologically valuable areas. For instance, soft coastal defence protects dunes against erosion, and hard coastal defence constitutes a rocky substrate on which specific species can develop (mussels, oysters, seaweed, crustaceans, anemones…). In general, the ecological value of the breakwaters increases in proportion to their length, height and number of microhabitats (10).

From another point of view, the creation of new habitats could also be perceived negatively. After all, rocky environments are not a part of the original sandy environment of the Belgian coast.

There are other possible negative effects. Benthos dies if it is covered with new sand and cannot return to the surface. If the supplied sand has a composition that differs from that of the original sand this may affect the benthos as well and have a short-term impact on the number of birds and fish in the environment (birds and fish feed on benthos). Coastal defence works can also temporarily disturb benthos and birds (11, 12).

The impact on nature and the environment is generally seen as relatively small (slightly negative to even positive in some cases). In recent years more attention has been paid to environmentally friendly ecological solutions, including more soft coastal defence or the lowering of the dune foot reinforcement in the nature reserve 'De Westhoek' in De Panne, which gave cause to the creation of sea inlets.

## IMPACT ON THE ENVIRONMENT

Coastal defence can in principle be constructed wherever it is needed. There are no limitations as regards the quantity of sand that can be supplied. However, certain municipalities impose a number of conditions, for example a prohibition to change the dune relief.

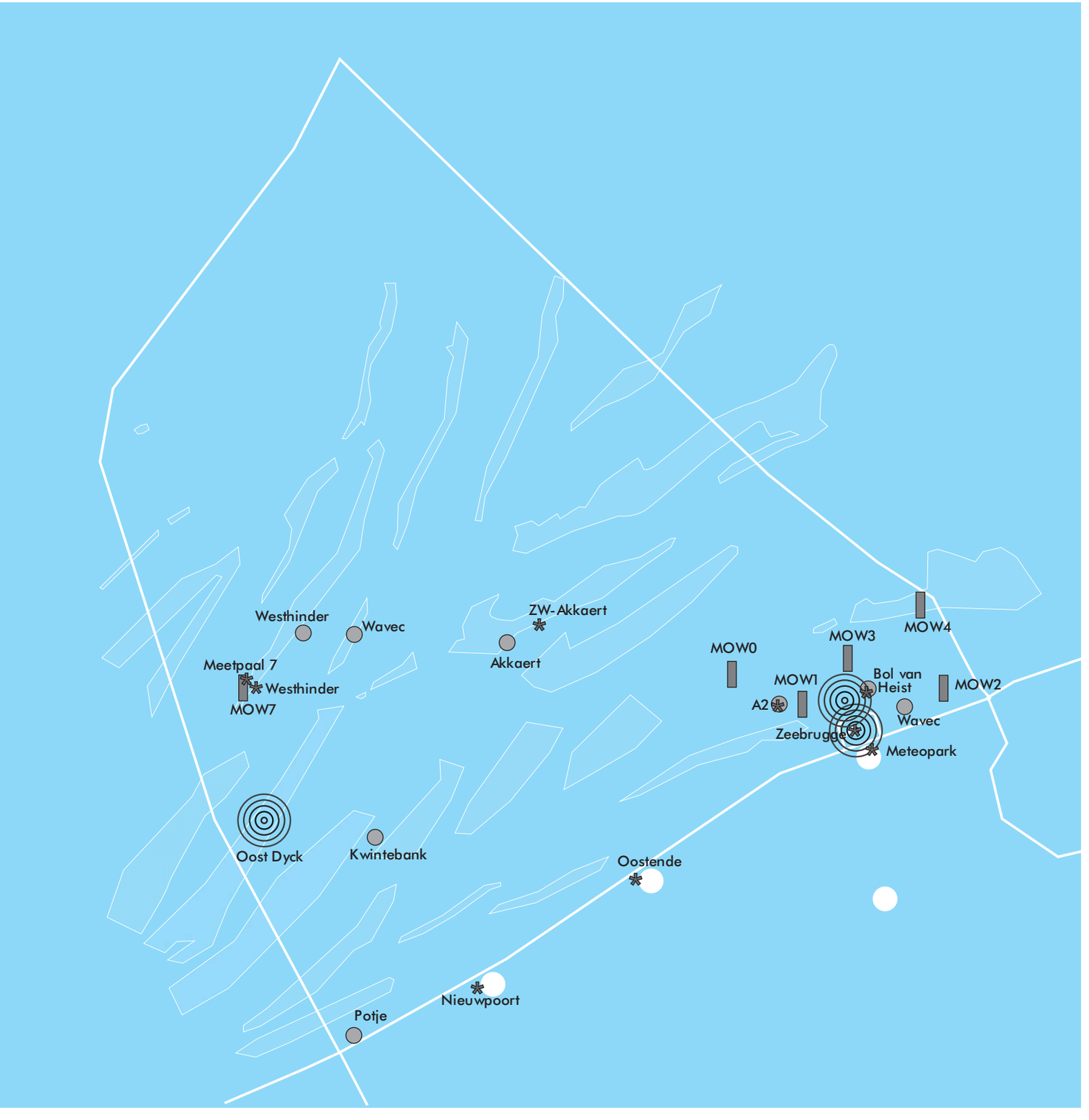
An urban development permit is required for coastal defence works on the landside, to which an environmental impact report (EIR) has to be added (13). A special concession or permit is required for constructions in beach reserves.

The dune decree stipulates that any construction in dune areas is forbidden unless the works are carried out with a view to environmental protection or coastal defence.

Hard coastal defence works fall under the authority of the Ministry of the Flemish community, the Environment and Infrastructure department (LIN), Coastal division of the Waterways and Marine Affairs Administration.

In the dunes and on the beach reserve of the Bay of Heist coastal defence works cannot be carried out during the breeding season (15 April to 15 September).

## LEGAL ASPECTS




# TOWERS AND PLATFORMS

The BPNS features a network of small, pointed structures, the most important of which are towers and buoys. The buoys indicate the location of certain shipping routes (refer to the chapter on shipping traffic). The towers comprise a single radar tower located on the Oost Dyck sandbank and 6 meteorological towers. The latter (indicated on the map as MOW) provide a monthly weather review, have a specific individual name and are located at fixed coordinates.

***Radar, survey and monitoring in the BPNS (8)***

survey platform / towers

Wavec / Waverider

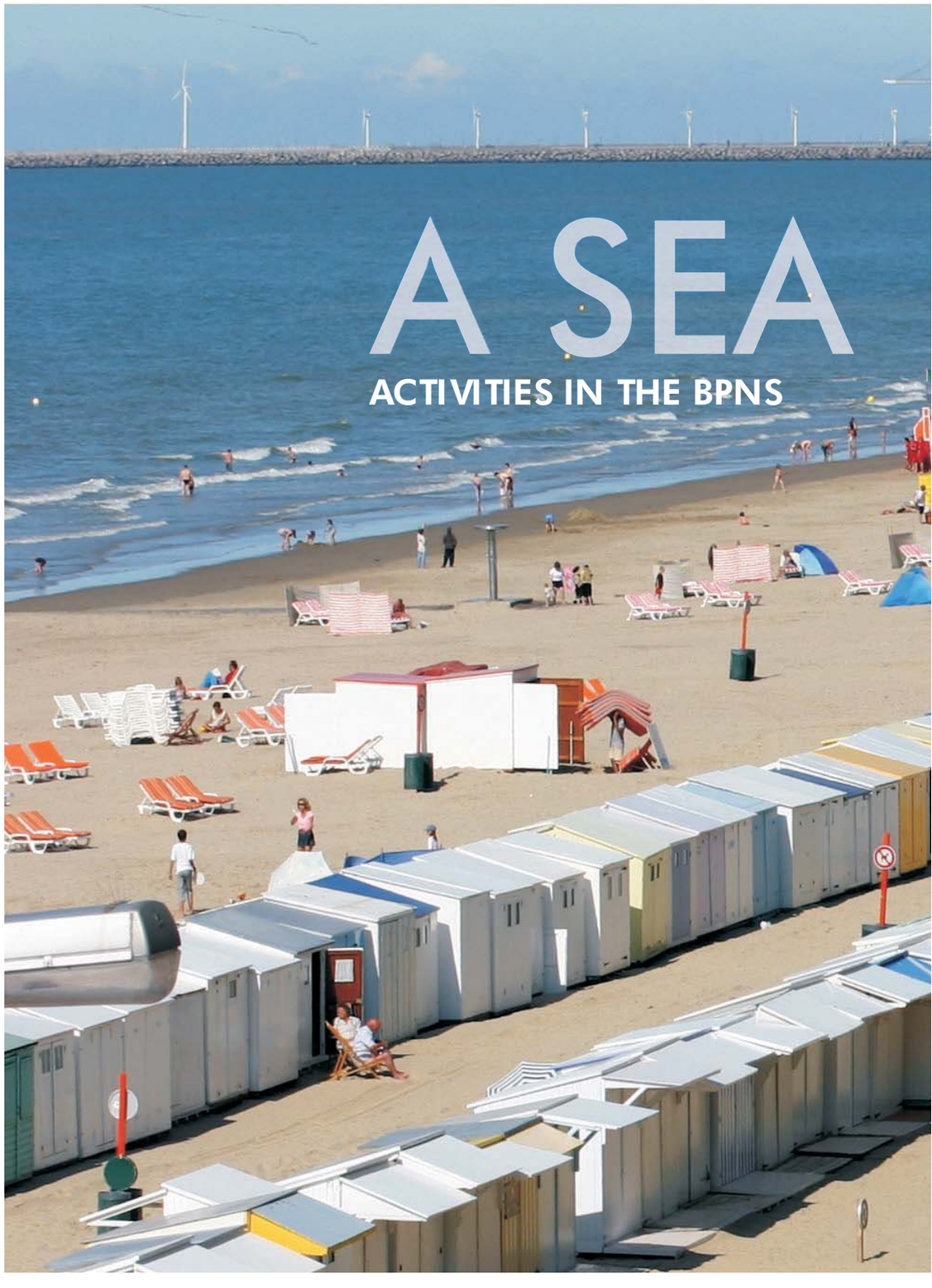
survey point

radar tower

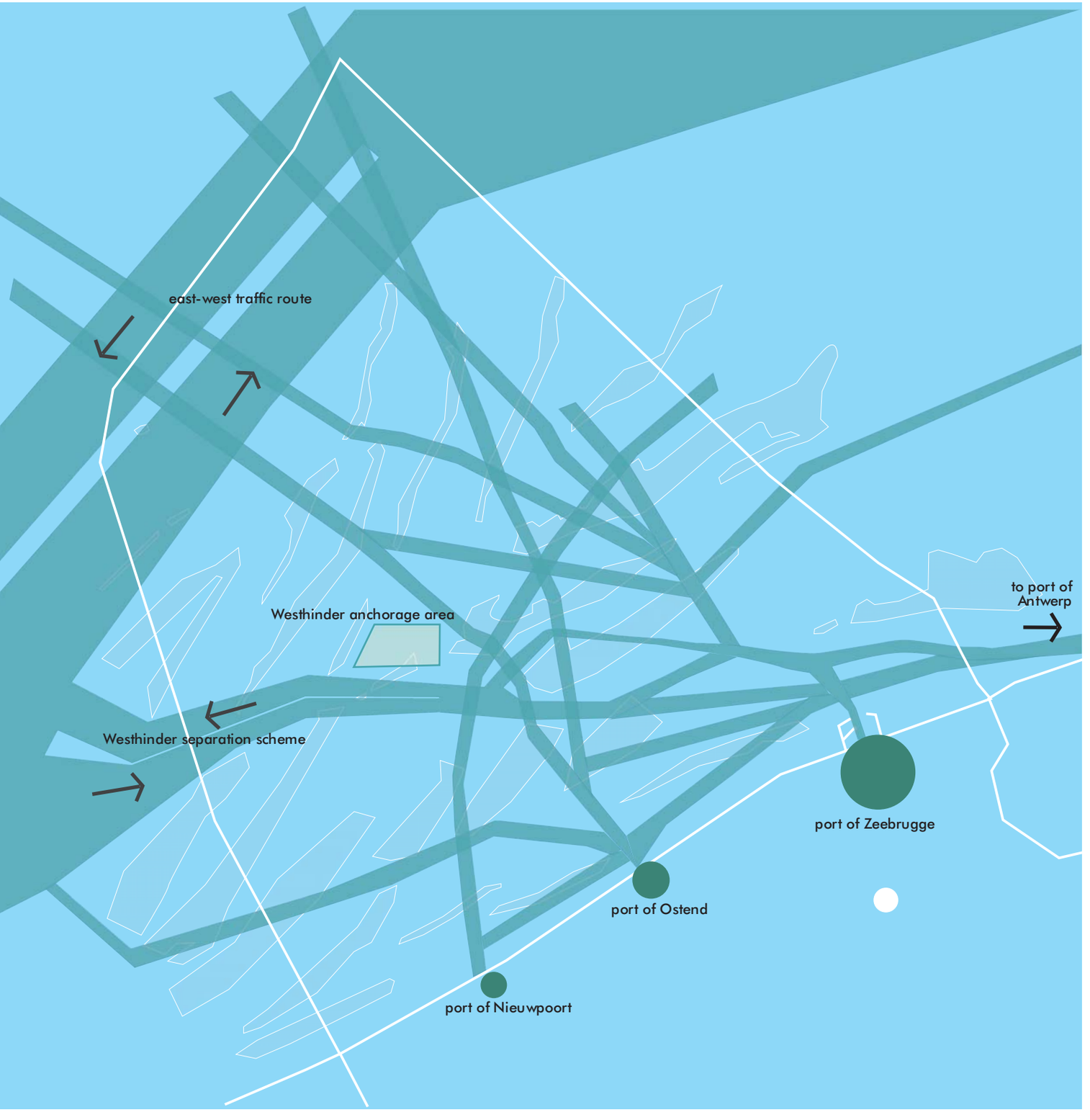
The competent authority for the installation and maintenance of the towers is the Waterways and Maritime Affairs Administration within the Environment and Infrastructure Department of the Ministry of the Flemish Community.

The presence of these fixed structures naturally hinders a number of other users in the performance of their functions. But in general it can be said that the impact on the marine environment and other users is minimal.

***Right:***
***Radar tower on the Oost Dyck bank and buoys in the BPNS***


A SEA
ACTIVITIES IN THE BPNS


OF PEOPLE




# SHIPPING INDUSTRY

The North Sea is considered one of the busiest sea areas in the world. Every year over 420,000 shipping movements are registered in the North Sea, and this number does not even include fishing and recreational vessels. The majority of these movements takes place in the southern part of the North Sea.

In order to limit the number of collisions and crashes a number of so called traffic separation systems and routes were determined by the International Maritime Organisation (IMO). Ships belonging to a certain category must follow these 'highways at sea'.

***Shipping industry in the BPNS***

- international traffic separation routes
- shipping routes
- anchorage area
- ports

The shipping routes in the BPNS and the surrounding area can be subdivided into 3 major categories (1 ):

- Category I: the 'east-west traffic route' with ships from or to European ports in the southern part of the North Sea. These ships enter or leave the North Sea through the English Channel and the Straight of Dover. This route is part of the traffic separation scheme, in which opposite traffic flows are separated. A small part of the outgoing traffic of the traffic separation scheme can be located in the northern part of the BPNS. All incoming traffic in the traffic separation scheme passes the BPNS. There is a high collision risk in this area.

- Category II: the 'Westhinder separation scheme' is used by ships moving to and from Belgian ports and ports in the Western Scheldt. It comprises a western and southern lane and in the north (near Dunkirk) the scheme comes in contact with the east-west traffic route. The lanes are indicated by buoys. There is also a high collision risk in this area. The Westhinder anchorage site (within the BPNS) is also part of this Westhinder traffic separation scheme and is reserved as a refuge for ships that encounter difficulties during storms or as a result of accidents or incidents on board. At the Westhinder anchorage site ships longer than 80 meters or with a hazardous cargo have to wait for a pilot to enter the Western Scheldt or the harbour of Zeebrugge.

- Category III: all other shipping routes are for ships not bound to specific shipping routes: these are ships with a length under 80m that do not have to be piloted. Therefore these ships can use the entire BPNS. Their freedom of movement is only limited by the rules of good seamanship (water depth, dangers of collisions, etc) and by areas where shipping is not allowed. The shipping traffic between the Belgian ports and Great Britain, for example, crosses the traffic separation scheme every day. But this category also includes coasters, supply ships, research ships, dredgers, tugs, fishing and recreational vessels. These vessels mainly occur in the area south of the traffic separation scheme.


***Shipping intensities in the BPNS***

low shipping intensity
(up to 1.735 ships/year/km²)

average shipping intensity
(up to 4.264 ships/year/km²)

high shipping intensity
(up to 50.784 ships/year/km²)

ports
(size of symbol in accordance with importance for shipping)

## INCOMPATIBLE ZONES

- concession zones for sand and gravel extraction;
- areas with shipwrecks: wrecks that are located in shallow water need to be salvaged or towed away so as to avoid collisions;
- location of cables and pipelines: cables and pipelines may be damaged if ships need to drop anchor in case of emergencies;
- dredged material dumpsites: the sea bottom may rise as a result of dredged material dumpings. This may obstruct shipping traffic. In practice dredged material is not dumped in shipping lanes;
- wind parks: wind parks need to be located at a sufficient distance from the shipping lanes to avoid collisions;
- the Paardenmarkt: shipping traffic is not allowed in the Paardenmarkt area, as this area is a former munitions dumpsite.

## COMPATIBLE ACTIVITIES

- dredging the shipping lanes;
- recreational shipping.

## COMPATIBILITY WITH OTHER ACTIVITIES

## INCOMPATIBLE ACTIVITIES

- sand and gravel extraction: the ships used for extraction are stationary and constitute obstacles for shipping traffic;
- military practice: during military practice all shipping traffic is temporarily forbidden in the relevant zones. For this reason, military practice is never organised in the traffic separation systems;
- fishing: fishing vessels are considered obstacles for shipping traffic in the traffic separation schemes and other shipping routes. Although fishing is allowed in the traffic separation scheme it is forbidden to obstruct sea traffic.

Intensive shipping traffic disturbs certain sensitive bird species in their wintering areas. This mainly concerns disturbances resulting from coastal shipping (category III) near ecologically valuable sandbanks.

All kinds of chemicals may end up in the sea as a result of shipping traffic, such as tributyltin, copper and zinc. These substances are used to prevent algae growth on the hull.

Operational dumping from ships (oil, chemicals resulting from rinsing the holds, bilge water and fuel sludge) may also pose a threat to certain species, including seabirds. The main threat, however, is oil pollution resulting from shipping accidents. This threat affects seabird species as well as coastal fauna and flora.

In addition, ship ballast water may introduce exotic organisms in the BPNS that can pose a threat to the local species of the BPNS, especially in coastal waters.

## IMPACT ON THE ENVIRONMENT

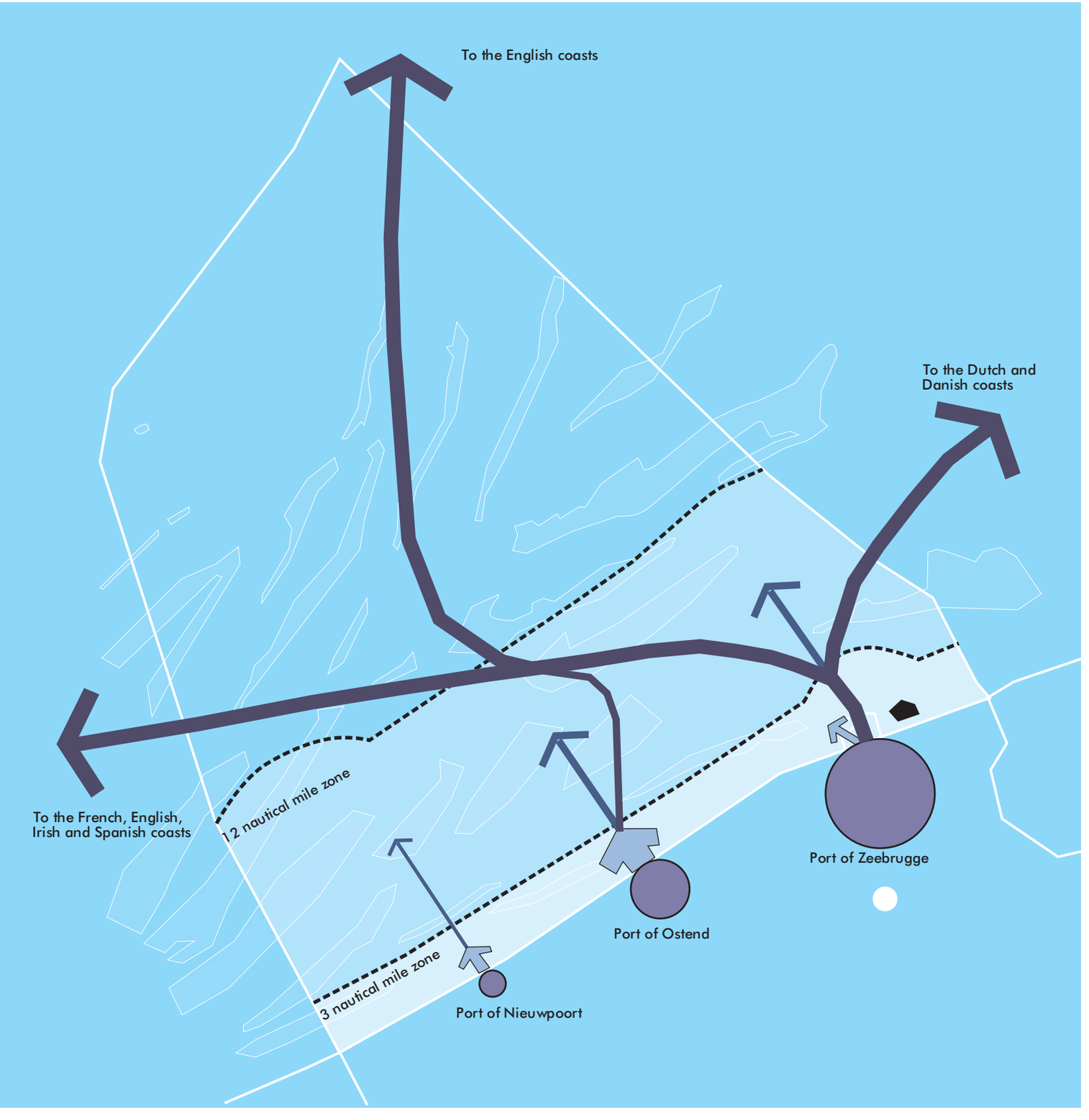
Traffic separation schemes, shipping routes and traffic rules were determined pursuant to international treaties and approved by the IMO (International Maritime Organisation).

Ships following an international traffic separation scheme always have right of way. Obstruction of shipping traffic in traffic separation schemes by vessels during fishing activities is forbidden.


## LEGAL ASPECTS

In view of shipping traffic it is important that shipping lanes are free of obstacles. The main criteria are depth and manoeuvrability. If the lane is insufficiently deep it needs to be dredged. In addition all obstacles need to be removed. Wrecks have to be salvaged or moved and other users have to make way for sea-going vessels.

## ENVIRONMENTAL REQUIREMENTS




# OFFSHORE FISHING

Belgium has the smallest offshore fishing fleet of the entire European Union. The share of Belgian offshore fishing in the overall European fishing industry amounts to less than 1%.

There are three Belgian fishing ports: Nieuwpoort, Ostend and Zeebrugge. About the entire fleet (97%) is engaged in beam trawling (trawl nets).

Most larger vessels do not fish in the BPNS but generally fish off the British and Irish coast (zones between 6 and 12 miles), in the French or Danish coastal waters or in the Bay of Biscay. Belgian fishing vessels have 'unlimited' fishing rights in the Dutch zone up to 12 miles.

***Offshore fishing in the BPNS structure map***

- large segment of the fishing fleet*
- medium segment of the fishing fleet*
- small segment of the fishing fleet*
- fishing port (size of symbol in accordance with importance for fishing based on fish landings by Belgian fleet)
- Paardenmarkt (former war munitions dumpsite): fishing is forbidden

* Categorization of the fishing fleet: refer to legal aspects

## Belgian fleet in the BPNS

Nieuwpoort is the smallest Belgian fishing port. In 2003 fishing vessels called at the port of Nieuwpoort 478 times with an overall supply of 296 tonnes. Especially small coastal fishing vessels called at the port. Supplies by container and by foreign vessels amount to zero.

In 2003 Belgian fishing vessels called at the fishing port of Ostend 2,002 times in total. The majority of the calls consisted of small fishing vessels, but medium-sized and larger vessels also brought their catches to shore in Ostend. In 2003 the supply from Belgian vessels in Ostend amounted to 6,184 tonnes, 40% of which was by container. The number of calls by and the supply from foreign vessels is rather limited (13 vessels in 2003).

In 2003 1,130 calls were registered in the port of Zeebrugge, the majority of which were made by larger ships. In 2003 the supply from Belgian vessels amounted to 13,627 tonnes, 40% of which was by container. Like in the port of Ostend, the number of calls by foreign vessels is limited (2).

## Foreign fleet in the BPNS

Within the Belgian Exclusive Economic Zone (EEZ) the principle of equal access to fishing areas for all EU-member states applies, except for Spain, Portugal and Finland that have restricted access for non-quota fish species. The territorial sea (12 miles zone) is reserved for Belgian fishing vessels, with Dutch and French fishing vessels having limited access: Dutch fishing vessels can fish on all fish species between 0-12 miles, whereas the 0-3 miles zone is reserved for coastal fisheries. Between 3-12 miles the French vessels can only fish for herring.

The only vessels allowed in the zone between 0 and 12 miles are trawlers with a maximum engine power of 221 kW (small and medium-sized vessels) (3).

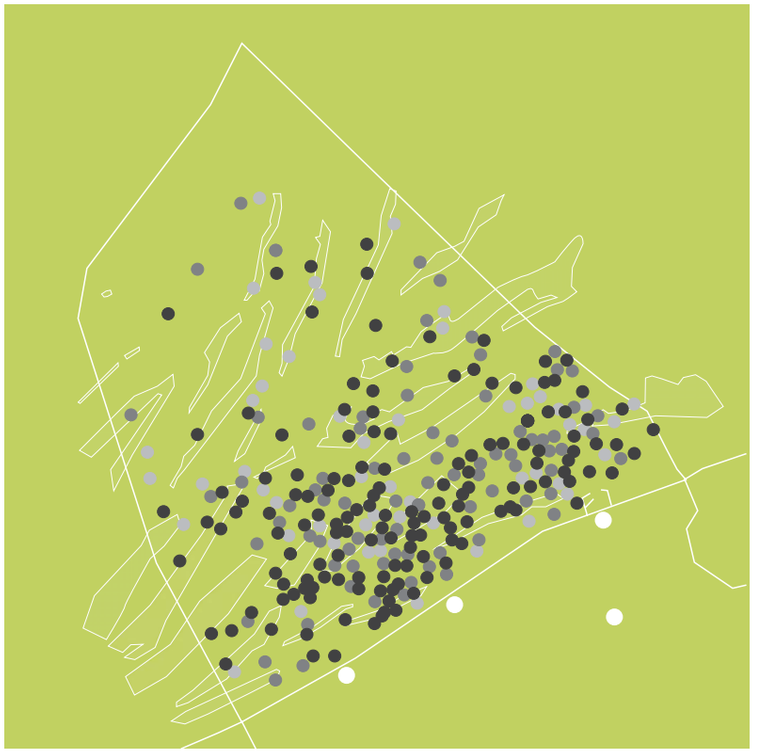
Access to the 3-mile zone for fishing purposes is limited to vessels with a maximum tonnage of 70 GT (small fishing vessels) (4).

## Recreational fishing

The recreational fishing branch mainly fishes for the same fish species as the professional fishing branch. However, the volume of recreational fishing is not known.

The fishing and angling vessels sail up to 6 miles from the coast in winter (October to March) and up to the Gootebank in summer (April to September).

Recreational fisheries are poorly regulated and control is almost nonexistent.



***Fishing intensities in the BPNS***
*Observations of shipping vessel movements (data source: Institute for Nature Conservation)*

high intensity

medium intensity

low intensity

## INCOMPATIBLE ZONES

fishing is forbidden in:
- the Paardenmarkt (former war munitions dumpsite);
- wind parks.

fishing can experience problems in:
- areas with shipwrecks;
- former industrial waste dumpsites;
- dredged material dumpsites.

## INCOMPATIBLE ACTIVITIES

- sand and gravel extraction;
- military practice;
- dredging and dumping activities;
- recreational fishing;
- shipping traffic.

## COMPATIBLE ZONES

- areas with shipwrecks;
- wind parks;
- marine protected areas.

Fishing near wrecks, offshore wind farms and marine protected areas may become more attractive because these zones can serve as refuges for fishes.

## COMPATIBILITY WITH OTHER ACTIVITIES

## ENVIRONMENTAL REQUIREMENTS

Rich, unpolluted fishing grounds are required for a good, large and healthy catch. However, it is difficult to say that a fishing ground is rich or poor in fish as there are no concrete measuring results available. All fishing grounds within the 20-mile zone are actually considered rich in fish. The entire zone is valuable, either as a fishing or as a spawning ground.

On the basis of counts and the positions of fishing vessels it is possible to obtain an idea of the location of a number of major fishing grounds (refer to the map on page 81 and to the data on spawning grounds and nurseries in the water column of the BPNS, page 42).

The nature of the fishing ground as well as other criteria, including the distance to the fishing port, the legislation as regards maximum engine power, the right of way of other users in the BPNS (such as the shipping lanes) and disturbing activities such as military use will determine where most of the fishing will be done.

Fishing in the BPNS is for the most part done with trawl nets (beam trawling). The trawls constantly turn over the upper strata of the seabed. This method seriously affects the benthos, sediment and fish stock (disturbance of life on the seabed, turbid sand plumes, elimination...).
In addition, overfishing has been a problem for many years; catch quotas can only partially solve this problem as their observance is insufficiently checked.

Fishing influences seabirds both positively (temporary increase of feeding possibilities) and negatively (noise hindrance for sensitive seabirds, in the case of crustacean fishing: reduction of food supply).

Marine mammals can get entangled in the fishing nets.

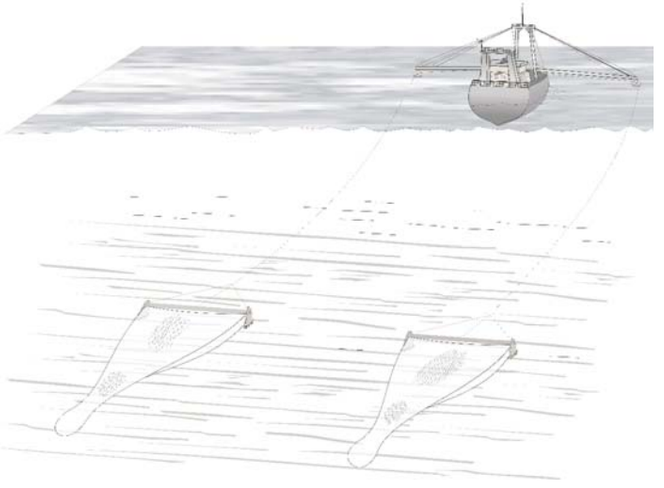
The Belgian maritime zones are measured from the baseline and determine what kind of fishing vessels are legally allowed (3,4):

- within the Belgian 3-mile zone: only fishing vessels up to 221 kW and up to 70 gross tonnage are allowed. This implies that only fishing vessels from the small segment are allowed to fish in the 3-miles zone. These vessels usually do not stay at sea for more than 24 hours;
- within the 12-mile zone: only trawlers up to 221 kW are allowed. This implies that both fishing vessels from the small and medium category can fish in the zone between the 3 and 12 miles border. Vessels from the medium category have a gross tonnage larger than 70;
- outside the 12-mile zone: all fishing vessels are allowed. This implies that the large category of the fishing fleet can only fish outside the 12 mile zone. These are vessels with a capacity above 221 kW (300 HP) and more than 70 gross tonnage. These vessels usually stay at sea for about 10 days.

The fishing industry is bound by catch quotas per fish species. These quotas are imposed by the European Union on the different member states. The quotas determine how many fish of a specific species can be caught. In addition the fishing industry is also bound by effort restrictions, such as the days-at-sea restrictions. The latter restrictions imply that every type of fishing vessel can only spend a certain number of days at sea, specified in advance, for fishing purposes.

For reasons of safety it is forbidden to fish in the Paardenmarkt area (presence of war munitions).
Recreational fishing is barely regulated by law. Five municipalities have adopted their own regulations (indication of zones where and periods when fishing is allowed, maximum number of nets per fisherman...). However, a recreational fishing permit is not required anywhere. Each person can only fish a maximum daily amount of fish (e.g. 15 kg of cod, 5 kg of bass) and undersized fish have to be thrown back into the sea, but these regulations are hardly ever enforced.

## IMPACT ON THE ENVIRONMENT



***Beam trawling***
***© Departement Zeevisserij, Ostend***

## LEGAL ASPECTS

*Mussel cultivation (Common blue mussel) near Wissant, in the north of France. These mussels are grown according to the so-called 'bouchot' method, a technique which is mainly applied in France: the mussels are cultivated on ropes twisted around long, erect oak stakes. Cultivation according to the bouchot method produces about 55,000 tonnes a year.*

# AQUACULTURE (5,6)

## cultivation on the mainland, release at sea

At the moment there are no fishing farms at sea. Since 1998, however, a few essentially scientific experiments have been conducted with turbot and sole farms on the mainland. These fish species were released into the sea after the cultivation period. Three out of four experimental releases took place near the western part of the Stroom Bank (in the vicinity of Nieuwpoort - Westende). At the time of the releases this zone was temporarily closed for fishing for the purpose of the experimental examination. The fourth release (sole) took place in 2001 in the port channel of Ostend.

After their release the fish were monitored. It appeared that the turbot juveniles remained in the coastal zone during the first months after their release (July-August period), especially in the vicinity of the Thornton Bank and the Oostdijck and Bergues Bank. From October-November onwards the fish migrated northward towards deeper water. In the spring, part of the fish returned to less deep coastal water while another part appeared in the British channel.

## cultivation on the open sea

An experimental project has recently been launched to cultivate shellfish (mussels) on the open sea. The initial (1999) location selected for the project was a zone north of the Buiten Ratel. The zone was closed for all shipping and fishing activities, but this ban was very frequently disregarded, as a result of which a major part of the aquaculture was destroyed. For this reason the decision was taken to move the zone to the area of the 'D1 buoy', north of the Noordpas and close to an embranchment of the Smal Bank. This zone (0.09 km²) is not suitable for fishing and shipping traffic is forbidden (there is a shipwreck and the water is too shallow). The zone thus appeared to be more suitable for aquaculture. In 2001, however, 19 out of 20 hanging installations were destroyed by passing ships. Nevertheless, the results obtained with the remaining cultures were very positive year after year (rapid growth, no barnacles, very high density).

Aquaculture on the open sea is a rather innovative concept as previous European aquaculture experiments always took place in naturally protected bays or in closed inlets.

The Belgian aquaculture on the open sea is currently still in its testing phase. Soon it will become clear whether aquaculture on a larger scale can be economically viable.

## INCOMPATIBLE ACTIVITIES

- fishing;
- shipping traffic;

Sea-going or fishing vessels can destroy the aquaculture.

## INCOMPATIBLE ZONES

- anchorage areas;
- military zones;
- international shipping routes;
- dredged material dumpsites.

## COMPATIBLE ZONES

- wind parks: wind parks offer interesting aquaculture possibilities. The area closed for fishing can be used as a place to release different fish species. In addition the combination of a wind park with mussel cultivation is possible as well. As wind parks are closed for shipping traffic there is no danger that the aquaculture will be damaged. The water quality in the vicinity of the park, however, has to meet the strict demands for shellfish cultivation. The artificial reefs (foundations of the wind turbines) may also attract larger and commercially interesting predator fish (sea eel, cod, bass...). Lobsters and cephalopods may also thrive in the vicinity of wind parks.

## COMPATIBILITY WITH OTHER ACTIVITIES

## COMPATIBLE ACTIVITIES

- fishing.

Aquaculture in combination with wind parks can offer interesting possibilities to cultivate commercially interesting or new fish species.

- no strong currents and storms;
- good quality of the seawater and the surrounding phytoplankton (as few heavy metals and PCBs as possible).

In the last decade the quality of the seawater has improved considerably. The quality of the Belgian mussels has been monitored since 1971. The quantities of PCBs and heavy metals continue to decrease. Belgian inland waterways are not interesting because of their relatively high bacteriological pollution. Consumption of polluted mussels can result in intoxication of the consumer.

## ENVIRONMENTAL REQUIREMENTS


# DREDGING ACTIVITIES

Dredging activities can be subdivided into two activities: the actual dredging and the dumping of dredged material.

## the actual dredging

Dredging is necessary to keep the Belgian seaports accessible. Many ports, in particular the port of Zeebrugge, experience intense sedimentation of liquid mud at high tide. Since the navigable depth needs to be 1 5m TAW ('tweede algemene waterpassing') minimally, dredging is required along the coast, in the Western Scheldt and in the ports themselves (Zeebrugge, Ostend, Nieuwpoort and Blankenberge) throughout the year. The dredging mainly concerns maintenance dredging.

***Dredging and dumping of dredged material in the BPNS***

**Dredged areas:**

ports (size of symbol in accordance with dredging intensity)

channels

**Dredged material dumping sites:**

occasionally used sites

most intensely used sites (S1 and 'Bruggen en Wegen Zeebrugge Oost')

Dredging activities are carried out by different dredger types, such as stationary or self-propelling dredgers, bucket chain or pump dredgers. The navigational depth is monitored by means of daily measurements of the depth and density.

Three companies dredge about 9 to 10 million tonnes of dry matter every year. Over half of this volume is dredged in the port of Zeebrugge and the shipping lane to Zeebrugge.

## the dumping of dredged material

The greater part of the dredged material is dumped back into the sea or the Western Scheldt. The BPNS has seven legally approved dumpsites:

- the dumpsites located near the ports are 'Bruggen en Wegen Zeebrugge Oost', 'Bruggen en Wegen Oostende' and 'Nieuwpoort';
- dumpsites 'S1', 'S2', 'S3' and 'R4' are located further off the coast (north of the shipping lanes to the Western Scheldt and Zeebrugge).

It is not possible to univocally identify the best dumpsite. The cheapest solution is to dump the material at the dumpsite located the closest to the dredging site. The risk of this solution is that the dredged and dumped material may end up in the original shipping lane or port again because of the currents.

The most frequently used dumpsites are 'S1' and 'Bruggen en Wegen Zeebrugge Oost'. Most of the dredged material sinks rapidly to the bottom as one mass.

## INCOMPATIBLE ZONES

- zones with cables and/or pipelines: it is legally forbidden to lay cables or pipelines near dumpsites. A minimum safety distance of 250 metres from cables and 1,000 metres from pipelines is applied. Cables and pipelines can be laid in the actual dredging zones but are generally dug in deeper by way of precaution;
- wind parks: dredging and dumping activities are not possible in the immediate vicinity of wind parks.

## INCOMPATIBLE ACTIVITIES

- military practice: dredging and dumping activities are forbidden during military exercises;
- fishing: fishing is not possible at times when dredging and dumping activities take place.

COMPATIBILITY WITH OTHER ACTIVITIES

## COMPATIBLE ZONES [possible multiple use]

Zones where sand or gravel is extracted. The dumped dredged material is not suitable for the building industry (concrete). However, the dredged material from zone S1 is intended for land reclamation from the sea (also refer to 'sand and gravel extraction': control zone 3). Other dredged material (from the shipping lanes) is used for beach nourishment.

## IMPACT ON THE ENVIRONMENT

The impact of dredging activities on the environment cannot be mapped easily. Dredging has positive, neutral as well as negative effects.

Dredging can positively influence fish species as a result of the increase of the oxygen level in the water column. However, turbid sand clouds resulting from dredging activities can destroy eggs located on the seabed. It is therefore recommended not to dredge or dump dredged material near spawning grounds.

The dumping of dredged material is in most cases not a major source of pollution as dredged material is only transported to another place in the sea. Material dredged in the ports, however, may be more problematic as this dredged material is often heavily polluted. Furthermore, the benthos may change as a result of the dumping of dredged material (7, 8).

## LEGAL ASPECTS

The Ministry of the Flemish Community (Waterways and Marine Affairs Administration) is responsible for the maintenance dredging activities, which are carried out by three private companies.

The federal government (department of the Environment), on the other hand, is responsible for monitoring the effects of the dumped dredged material.

Dredged material cannot be dumped at any given location. It is only possible in the seven legally approved dumpsites. Dredging is in principle possible at any given location, but will only be done at places where it is necessary.


# SAND AND GRAVEL EXTRACTION

The demand for sand and gravel extracted from the sea is on the increase as sand quarries on the mainland are gradually becoming depleted. In addition, sea sand is very pure and homogeneous, which offers a major quality advantage. Sand and gravel are used in:

- the building industry where they are required to make concrete;
- beach nourishment to counter erosion of the Belgian coast resulting from waves and currents;
- land reclamation from the sea, e.g. for the expansion of the port of Zeebrugge.

A total of 19 sand and gravel extraction ships operate in the BPNS. Each ship can transport 760 $m^3$ to 13,700 $m^3$ of sand or gravel. The sand or gravel is mostly sucked up by a flexible suction pipe and transported to the hold.

***Sand and gravel extraction in the BPNS (situation since 2004)***

control and exploration zones

rotation system:
closed until February 2006

limitations: no extraction
in March, April and May

## situation prior to October 2004

Prior to October 2004 sand and gravel extraction took place in two major concession zones:

- the first zone was located near the Thornton and the Goote Bank. This zone was mainly used by the Ministry of Public Works. Since 2000 private companies have also been allowed in this zone;
- the second zone was situated near the Oostdijck, Buiten Ratel and Kwinte Bank.

About 95% of the extractions took place on the Kwinte Bank, and more especially on a very small part of the bank. The extractions resulted in a local 4-metre deep depression near the north-western and central part of the sandbank. On 15 February 2003 a three-year ban on sand and gravel extraction was imposed for this site.

## current situation

The concession zones were modified in 2004. Nowadays there are three 'control zones' and one 'exploration zone'. These zones have officially been in force since October 2004.

- Control zone 1 comprises two sectors: sector 1a on the Thornton Bank and sector 1b on the Goote Bank. Sand and gravel extraction is not allowed in sector 1b from March to May (fish breeding season);
- Control zone 2 is subdivided into three sectors: sector 2a and 2b are located on the Kwinte Bank, sector 2c on the Buiten Ratel and Oostdijck. This control zone is characterised by a rotation system: sand or gravel extraction is possible in a maximum of two zones at the same time for a period of three years. This gives the sandbank in the third sector three years to recover in a natural manner. After three years another sector is given the opportunity to recover. As sector 2b on the Kwinte Bank was used the most in the past, it is the first sector to be closed for three years. This means that sand and gravel extraction will only be possible in sectors 2a and 2c until 15 February 2006;
- Control zone 3 is situated at a dredged material dumpsite (also refer to 'dredging activities'). Hence, this is a kind of 'recycling zone' located close to the coast. The objective of this control zone is to reduce the pressure on natural sandbanks;
- the government and concessionaires will investigate the possibilities of mainly gravel extraction in the exploration zone (near the Hinder Banks).

At the moment there are 11 active concessions.

Each sandbank has its own characteristics:

- Control zone 2:
  - the Oostdijck: fine and yellow sand suitable for brickwork and pointing;
  - Buiten Ratel: suitable for road building;
  - Kwinte Bank: mainly coarse sand of very high quality;
- the sand quality in control zone 3 ('recycling zone') is rather low. The sand from this zone can only be used for land reclamation from the sea and is not suitable for the production of concrete or for beach nourishment.


***Sand and gravel extraction in the BPNS***
*Situation prior to 2004. About 95% of the extraction took place at the Kwinte Bank (dark area on the map).*

## INCOMPATIBLE ZONES

- safety zone of 250m around cables and 1,000m around pipelines;
- anchorages;
- main shipping lanes;
- wind parks.

## INCOMPATIBLE ACTIVITIES

- military practice: sand and gravel extraction is forbidden during military practice;
- fishing: fishing is impossible when sand or gravel is extracted.

## COMPATIBLE ZONES [possible multiple use]

Dredged material dumpsites. Dredged material, whether or not dumped, is not suitable for the building industry (concrete). However, dredged material from control zone 3 is intended for land reclamation from the sea (also refer to 'dredging activities').

## COMPATIBILITY WITH OTHER ACTIVITIES

## ENVIRONMENTAL REQUIREMENTS

The preferred grain size of the extracted sand ranges between 125 and 500 $\mu$m (fine to medium). Sand to be used for concrete ideally has a grain size between 300 and 500 $\mu$m (medium coarse sand of high quality) and a calcium level under 30% (9).

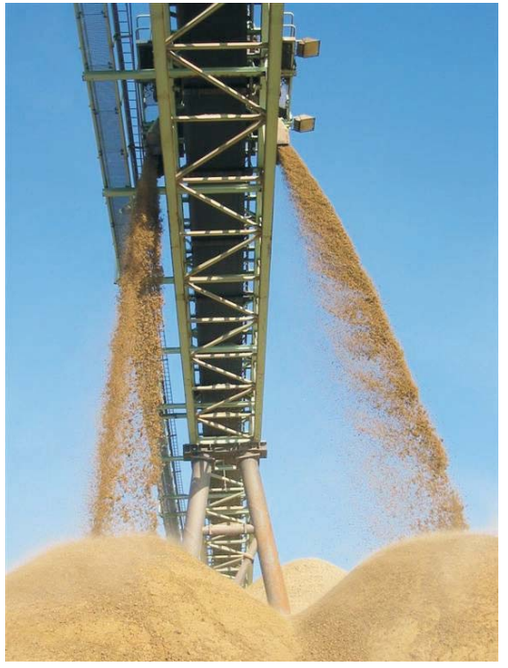
The major consequences of sand and gravel extraction on the sea bottom are (7, 10):

- substrate removal (the actual extraction);
- modification of the seabed topography;
- development of temporary turbid sand clouds that may extend over several kilometres. These clouds consist of sand and silt in suspension as a result of the dumping of water from the holds of the ships;
- intensive sand and gravel extractions, like those that took place at the Kwinte Bank until recently, may result in the development of deep depressions in the sandbanks.

As the benthos is disturbed by the changes in the sea bottom (local density and diversity reduction) fish species, crustaceans, marine mammals and birds will to some extent be affected as well since benthic organisms serve as food for higher organisms. Turbid sand clouds can destroy eggs on the seabed. Sand and gravel extraction near spawning grounds is therefore not recommended.

In addition, the shipping traffic to the extraction sites can disturb certain sensitive bird species in their wintering areas.

## IMPACT ON THE ENVIRONMENT



## LEGAL ASPECTS

Since 2004 the sand and gravel extraction conditions and restrictions have been tightened. The concession zones have changed and the north-western and central part of the Kwinte Bank is closed for extraction until 15 February 2006 (see above). In addition, there is a maximum quota of 15,000,000 $m^3$ to be spread over a period of five years.

Permits are issued by the federal Ministry of Public Enterprises, SMEs, the Self-employed and Energy at the advice of the Flemish Department of the Environment (MUMM) and the Flemish Department of Agriculture (Fisheries division).

Observance of the permit conditions is monitored by means of a 'black box' (automatic registration system) in the vessels.

The concessionaires pay a contribution of 0.35 €/$m^3$ for low quality sand, 0.54 €/$m^3$ for standard quality sand and 1.14 €/$m^3$ for gravel. These contributions are used to examine the consequences of sand and gravel extraction on the seabed and the marine environment.


# MILITARY USE

The BPNS is also the setting of frequent military activities and practice including:

- shooting practice from the mainland to the sea;
- shooting practice at sea at floating targets;
- detonation practice and detonation of mines found;
- mine installation, finding and sweeping practice;
- extensive mine practice by different NATO member states.

In addition, amphibious, rescue and flying practice is organised in the area as well.

***Military practice in the BPNS***

low intensity of military use
(max. 10 days/year)

higher intensity of military use
(78 days in 2001)

## the various military activities

The legally determined coordinates of the zones within which the military activities take place are changed every year (11). These changes, however, are limited to some minor differences.

**shooting practice from the mainland to the sea**

This kind of practice takes place on the beach in the vicinity of Nieuwpoort-Lombardsijde. The practice zone is divided into three sectors: K (small), M (medium-sized) and G (large), depending on the weapons used during practice. After practice, ammunitions are not removed from the sea bottom. Ammunition clips falling on the beach, however, are removed.
The annual number of effective practice days amounts to 85-95 days. The medium-sized sector (M) is used most often (78 practice days were organised in this sector in 2001). In the other sectors the maximum number of annual practice days is 10.

**shooting practice at sea at floating targets**

The practice zone is an irregular pentagon in the vicinity of the Oosthinder and the Bligh Bank. The ships are located in the southern part of the pentagon and aim at targets situated in the northern part of the pentagon.
The shooting practice is organised only very rarely (maximum 5 times a year).

**detonations and detonation practice**

Since 2001 detonation practice has been organised in a circular area near the Thornton Bank and the Goote Bank. The mines used during detonation practice are 'practice mines' (cassette tapes simulating mines). The practice may be both defensive and offensive. The practice mines are always removed after practice.
It is also possible - but this happens only very rarely - that real war mines are found by ships, fishermen or dredgers. These mines can also be detonated in this zone (other places are also possible but only in case of emergencies).
On average there are no more than ten practice days a year with an overall number of 15 to 20 detonations. There is no data available on the number of detonations of real war mines.

**mine installation, finding and sweeping practice**

Two (more or less) rectangular practice zones are situated in the BPNS. The first zone (NB-01) is located near the Westhinder Bank and is used as a deep-water zone while the second one (NBH-10) is located near the Wenduine Bank and is used for simulations in shallow water.
It is necessary to sail outside these zones for certain manoeuvres or under certain weather conditions. Therefore, the practice zones can if necessary be extended to the circular detonation zone (for the NB-01 zone) and to a zone between the Wenduine Bank and the port of Ostend (for NBH-10 zone).
Both zones are only used very rarely.

**extensive mine practice by different NATO member states**

There is no fixed zone for this type of practice, but the NATO always announces the location in advance. The NBH-10 zone (Wenduine Bank) is one of the possible practice zones. This kind of large-scale international mine practice is organised in the BPNS once every two years.

During practice the practice zone or sector is closed for all other activities. Practice days are therefore announced in the 'Navigational Warnings' (11).

## INCOMPATIBLE ACTIVITIES

All shipping traffic, fishing, sand and gravel extraction, dumping of dredged material, dredging activities, recreation/tourism, exploration of shipwrecks, building of coastal defences...:
All these activities cannot take place in the practice zone or sector at the time of practice.
In this respect the beach zone near Nieuwpoort-Lombardsijde is not accessible during shooting practice in the direction of the sea (85-95 days a year). However, military practice can be interrupted shortly to allow people to reach the other side of the beach.
The influence on sand and gravel extraction is limited as the concession areas only overlap with zones and sectors used to a lesser extent for military practice (maximum 10 days a year).
The practice zones are also located outside the major shipping routes.


### COMPATIBILITY WITH OTHER ACTIVITIES

- ammunition that is left behind may damage fishing nets towed over the sea floor.
- the detonation of war mines can damage cables and pipelines. It is therefore recommended not to lay cables or pipelines in the detonation zone.

## INCOMPATIBLE ZONES

Military practice is not possible in zones with wind parks and in the immediate vicinity of wind parks.

Military practice can only be executed during good weather conditions and when there are no strong sea currents.

### ENVIRONMENTAL REQUIREMENTS

The limitations applicable in marine protected areas (MPAs) and marine reserves are not automatically applicable to military activities. However, the military officers in charge of the operations are expected to take all necessary measures to avoid damage or nuisance to the marine environment without compromising the necessary military activities.

Mine and submarine locating practice, which includes the use of sonars (zones NB-01 and NBH-10), may possibly affect marine mammals and fish. Other military activities involving explosions may also disturb marine animals, but this impact is probably minimal because of the temporary character. Birds can be startled by the shooting practice and the explosions.

Ammunition landing on the sea bottom during practice is not removed. This may affect the local ecosystem ('leaks' of copper and lead from the ammunition). The effect of this leaching originating from military practice is probably inferior to the leaching resulting from other activities, but may nevertheless have a local influence.

The shooting practice from the mainland to the sea takes place in the vicinity of the nature reserve 'De Ijzermonding' near the Ramsar area and the Habitat area of the Flemish Coastal Banks. Its negative impact can partially be reduced by a good timing (for example, no shooting practice during the breeding season).

The sailing to and from the practice areas does not have notable effects on the environment. Military ships sail at a considerably lower speed than commercial ships (12, 13).

## IMPACT ON THE ENVIRONMENT

Military practice has to be announced 'in an appropriate manner' so that other users of the sea know in time that they cannot enter the practice sector during practice.

Only the shooting practice from the mainland to the sea is subject to restrictions: this type of practice is forbidden during the summer holidays (15 June until the first week of September) and during weekends. Other military activities are legally allowed throughout the year, but are organised only very rarely.

The conditions for allowing activities at sea (concessions, permits, EIR obligations, permanent monitoring) that apply to a broad range of activities are not directly applicable to military activities. The military officers in charge have to give their permission but are expected to take all necessary measures to avoid damage or nuisance to the marine environment.

Nuclear weapon tests in the BPNS have been forbidden since 1966. It has also been forbidden since 1973 to leave strategic weapons of mass destruction or nuclear weapons at sea beyond 12 miles offshore and since 1999 this ban has been extended to the entire BPNS.

## LEGAL ASPECTS


# TOURISM AND RECREATION

The Belgian coast attracts numerous tourists and holiday makers.

As a matter of fact, the coast is perfectly suited for recreational activities (14): rather wide beaches compared to other North Sea coasts that consist of mainly fine sand and that constitute an uninterrupted accessible whole along the entire coast. The beach gradient from shallow to deep water is quite low and there are quite large waves. Finally hotel and catering industry near the beach are highly developed and there is a relatively large number of breakwaters and piers.

***Tourism and recreation in the Belgian coastal area***
***(structure map)***

- low tourist pressure
- average tourist pressure
- important seaside resort (high tourist pressure)
- marina

## tourist pressure

Thanks to the many possibilities it offers as a nearby recreation area and in spite of its limited length of 65 km the Belgian North Sea coast attracts numerous tourists and holiday makers. In 2003 no less than 12.6 million nights were booked by 2.1 million tourists, spent in hotels, camp sites, holiday centres, rented houses... (15). The coast is furthermore visited by 20 million day-trippers on a yearly basis (2002), of whom 75% visit between the period of April to September (16). The number of second residences not rented to tourists is not included in these figures.

Almost the entire Belgian coast is characterised by a high tourist pressure (refer to graph on this page) (17, 18, 19), but Knokke-Heist, Ostend and Blankenberge are the busiest seaside resorts. Koksijde, Nieuwpoort, De Haan, De Panne and Middelkerke also attract numerous tourists. The tourist pressure is the lowest in Bredene and Zeebrugge.

## sub-areas (14,17,19,20)

### the west coast

A major part of the west coast (from De Panne to Westende) features very wide, hard beaches without breakwaters. Due to the permanent wind and the nearly uninterrupted stretches of sand the west coast is the perfect location for sand sailing. The west coast is also characterised by considerable shrimping and fishing activities from the shore (Oostduinkerke). Nieuwpoort boasts the largest marina of the Belgian coast. With over 1,800 berths it is one of the largest marinas in Europe. Nieuwpoort also has a small fishing port and a fish auction hall.

### Ostend

Ostend is a seaside resort that attracts many tourists and holiday makers due to the easy connections to the hinterland, both by road and by rail. Ostend boasts several marinas. Ostend features an important fishing port and is the only seaport with a "Vistrap", where fresh fish is sold directly to the consumers by the fishermen.

### Bredene-Blankenberge

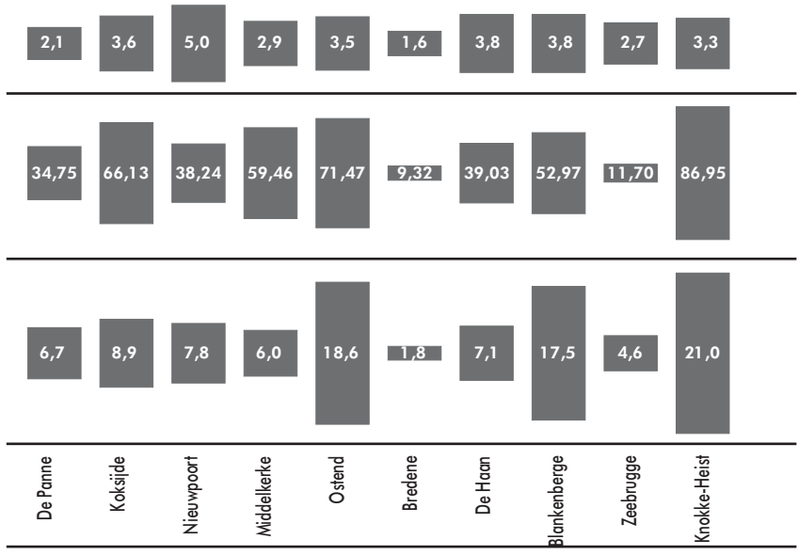
The coast in the vicinity of Bredene, De Haan up to Blankenberge is characterised by various less visited resorts and one very busy seaside resort (Blankenberge). Blankenberge also features a marina.

### Zeebrugge

Zeebrugge is a somewhat strange combination of a small seaside resort and a large seaport. The beach is relatively small, but the port also harbours a small marina. Zeebrugge furthermore features an important fishing port and fish auction hall, but unlike Ostend fish is not sold directly to the tourists.

### Knokke-Heist

Knokke-Heist also attracts many tourists thanks to its fashionable character and the trendy shopping streets. Surfing is a frequent activity in Knokke-Heist, both on the beach (parasailing and speed sailing) and on the water.




***Tourist pressure at different Belgian coastal locations (17,18,19)***

*Above: Tourist pressure on the beaches (17). One of the parameters used was the number of beach constructions. The figures give a relative estimate of the tourist pressure on the beaches, with 1 being a low pressure, 3 an intermediate pressure and 5 a strong pressure.*

*In the middle: Impact of tourism based on the number of overnight stays in commercial accommodations, the number of second homes and individual holiday home rentals, the number of day tourists and the number of registered paid employees in the tourism and recreational sector (18).*

*Below: Number of day trips in Belgian coastal locations in 2002 (19).*
*The figures show the relative share (%) of each coastal location.*

## INCOMPATIBLE ZONES

- wind parks (21 , 22). As no wind parks have been constructed off the Belgian coast, it is not yet possible to make a final assessment of the tourist impact of wind parks on the Belgian coast. It is, however, clear that wind parks influence the way people experience the coastal landscape. Much depends on the distance between the parks and the coast: the closer to the coast the larger the impact. Distance is hardly relevant if wind parks are situated 12 miles or more off the coast because of the limited visibility. The layout of the park is also important: according to MUMM only one fifth of the entire horizon may be occupied by all constructions together. It can in general be stated that a number of people feel very strongly against the development of wind turbines at sea. They claim they will avoid seaside resorts where a wind park is built that can be seen from the coast line. On the other hand, a wind park may also benefit tourism and develop into a tourist attraction including such things as boat trips to the park and an educational centre. Accordingly, it is possible that there will be both positive and negative effects on tourism;
- nature reserves. Tourism and recreation are subject to restrictions in certain nature reserves. It is not possible, for example, to build beach and dyke constructions in nature reserves without the permission and the approval of the advisory body for the reserve.

## COMPATIBILITY WITH OTHER ACTIVITIES

## COMPATIBLE ZONES [possible multiple use]

- coastal defence sites: once the coastal defence is realised these sites offer new recreational and tourism possibilities.
- nature reserves: although recreation and tourism may affect coastal fauna and flora, nature reserves also represent attractive zones for soft forms of tourism. Ecotourism may have a sensitising effect with regard to nature and the environment and may strengthen support for new nature reserves.

## INCOMPATIBLE ACTIVITIES

- military practice: tourists are not allowed in the practice zone during military exercises.
- creation of coastal defence: coastal defence (beach nourishment,...) is undertaken as much as possible out of season so as to prevent conflicts with the tourist sector.
- other recreational activities: fishing from the shore can be dangerous to swimmers, surfers, shrimp fishermen and anglers. If the nets are (illegally) dumped into the sea they may seriously damage the propellers of fishing or recreational vessels. Other recreational activities (kiting, sand sailing,...) may also disturb other tourists (e.g. sunbathers).

The high tourist pressure on the Belgian coast can have a negative impact on vulnerable natural areas. Recreational activities on the beach or at sea can disturb certain sensitive bird species in their resting, breeding or wintering places. This is for example the case in the vicinity of the Ramsar area (west coast), where many yachts leave the port of Nieuwpoort during the weekend. The Zwin area also suffers under the presence of a nearby holiday village. In addition, tourism causes a lot of trampling.

Tourism also indirectly affects the Zwin area: due to the sand supply to the beach of Knokke the coves of the Zwin area gradually silt up (also refer to 'coastal defence').

Recreational fishing with gill nets has the most negative impact. The risks are high: protected species may be caught, birds and marine mammals may get entangled in the nets and suffocate. The nets are often also cleaned carelessly, as a result of which the beach can get polluted. If the nets are left at sea (illegally), they can still be dangerous to fish and birds.

## IMPACT ON THE ENVIRONMENT

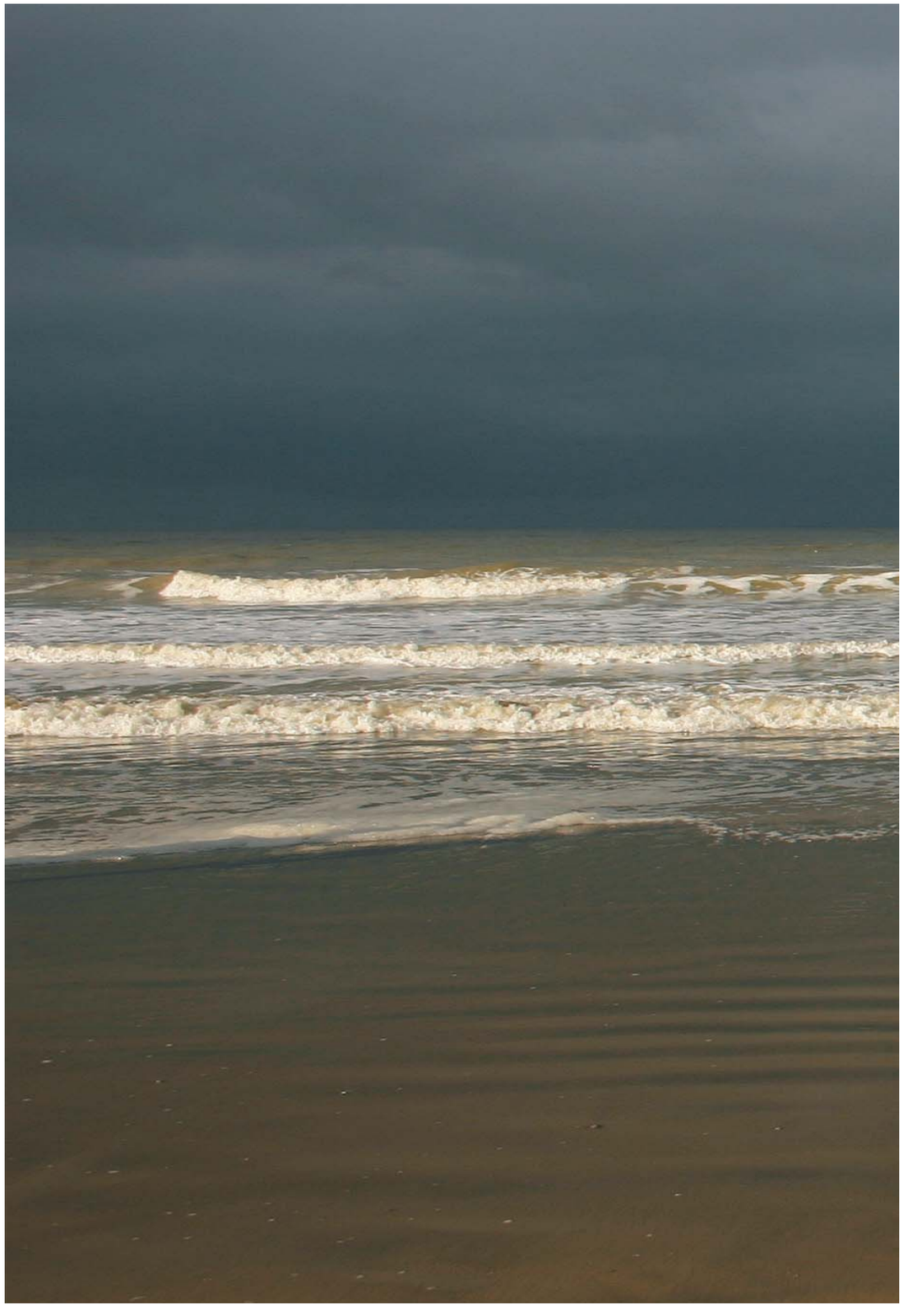
The beach is legally defined as the zone up to the low-water line. This is also the official border of the province of West Flanders and of the Flemish Region.

The Flemish government issues beach concessions to the coastal municipalities for various beach constructions (beach cubicles, hotel and catering industry, sports clubs,...) (23). These concessions are linked to specific beach management requirements.

Clubs or organisations wishing to organise activities on the beach or on the dyke have to apply to the Flemish government for a permit.

## LEGAL ASPECTS



# A FLOOD OF SPACE?

## SYNTHESIS OF THE EXISTING SPATIAL STRUCTURE OF THE BPNS


# A SEA OF CHAOS

The Romans regarded the Mediterranean Sea as their own property. Surrounded by only Roman provinces, the Mare Nostrum was the centre of their global empire. Later, the Spaniards and Portuguese also appropriated certain seas as their territory. In an attempt to break the Portuguese trade monopoly with the East Indies, the Dutchman Hugo Grotius introduced the Mare Liberum-doctrine in 1609.
He considered the sea to be free for all pioneers and explorers. The sea belonged to no one. The oceans became common and free but at the same time the doctrine allowed for an uncontrolled utilisation and exploitation of the seas. Everything was allowed.

Therefore the sea is completely different than land. On land, property is the basis of all forms of planning. At sea no right of ownership exists and users cannot really claim it. The illustration on this page shows a superimposed projection of all activities and infrastructures in the BPNS and illustrates this complexity.

Yet gradually people did appropriate certain parts of the seas. Several treaties gave territorial jurisdiction to coastal states. But because of the deeply rooted 'free seas' principle, the majority of the oceans can still be considered common property that belongs to no one.
Some spatial conflicts are inevitable due

***Map: Mare Liberum. Superimposed projection of all users of the BPNS.***

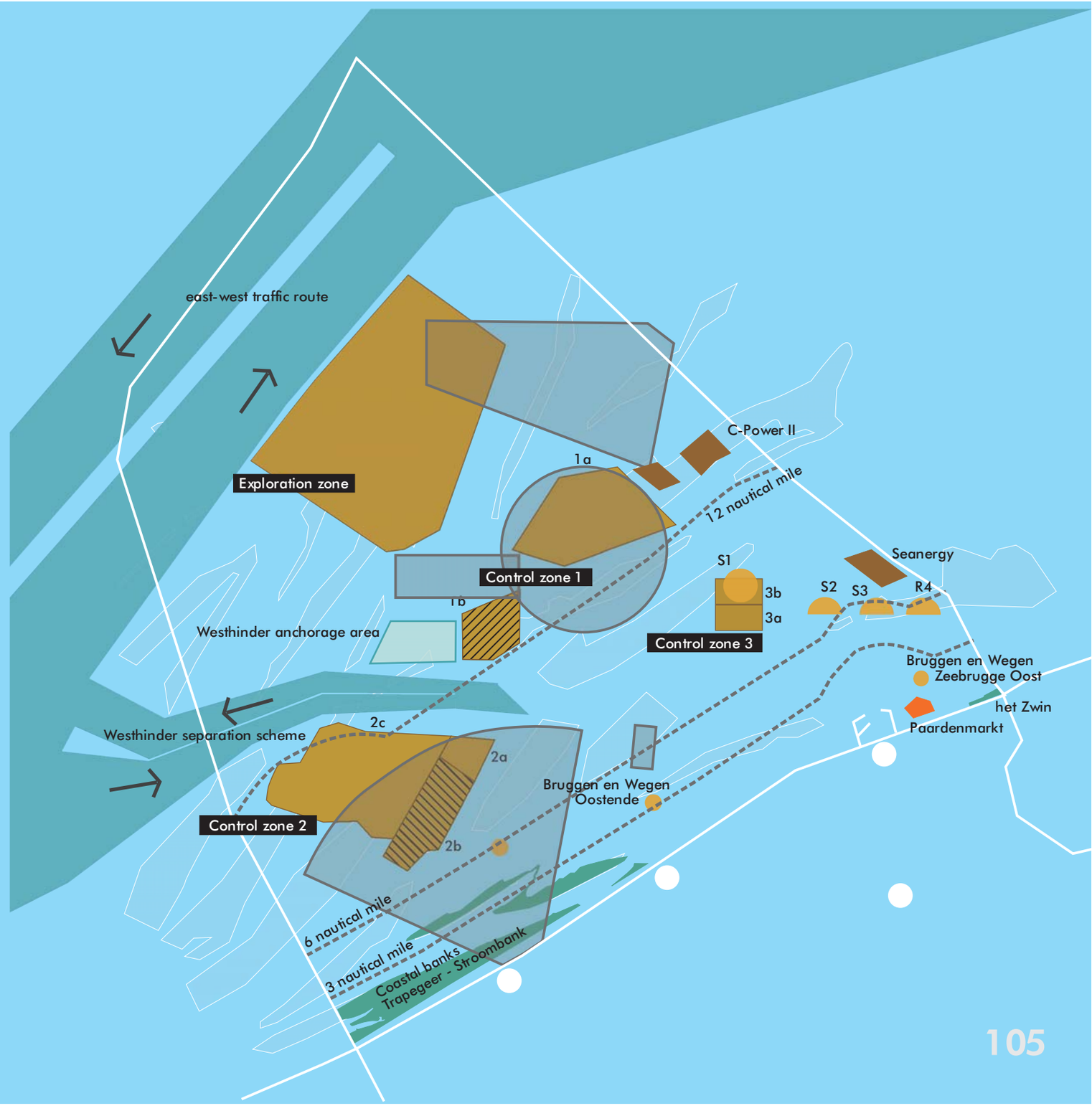
# THE REGULATED SEA

to the many activities that take place within the BPNS (also refer to the following pages). Several rules have been established to control some of these conflicts.

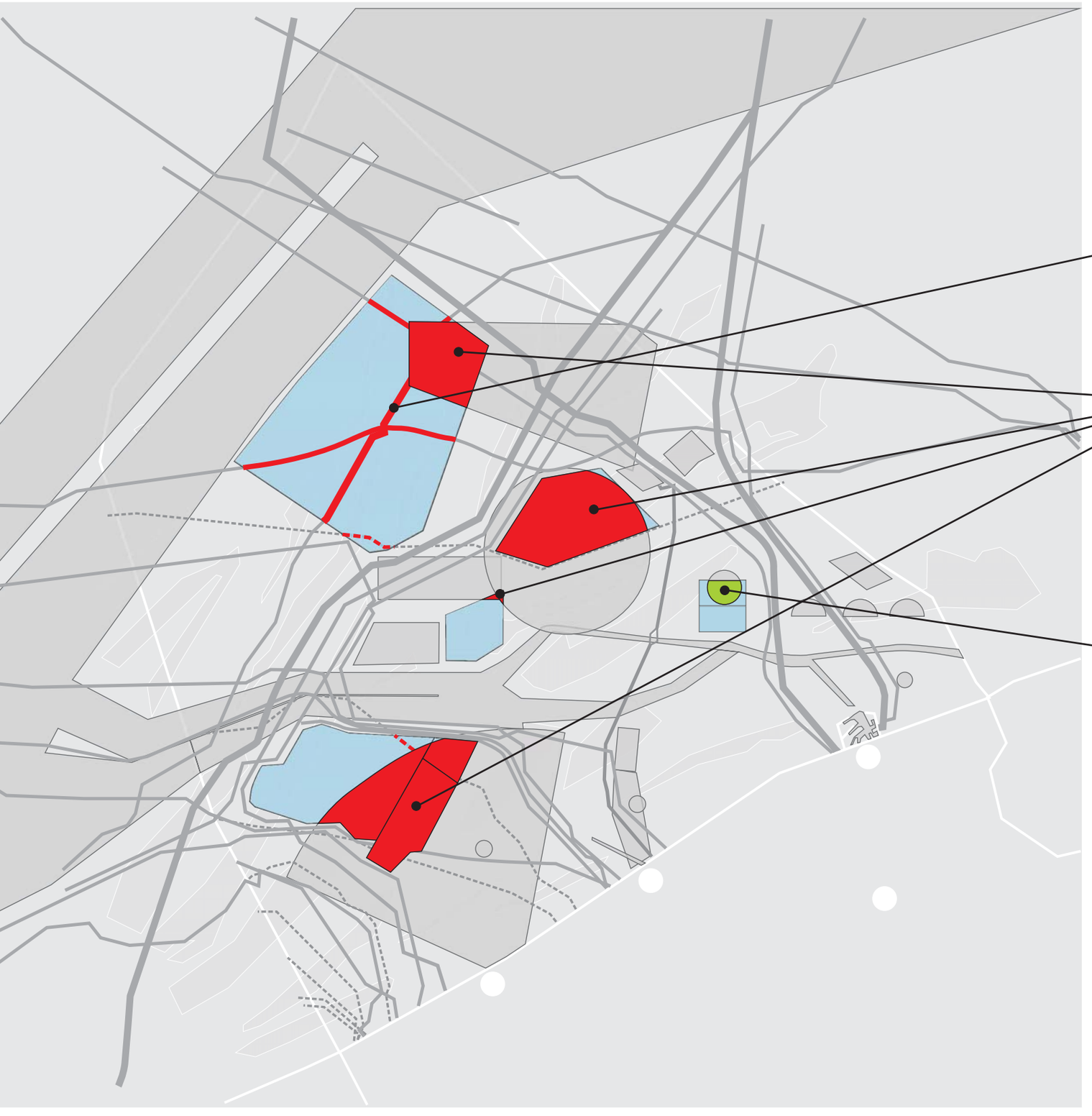
Natural values for example have received increasing attention during the last years and as a result marine protected areas have been delineated. The 'Zwin' and part of the coastal banks are protected under the Ramsar convention. Some dunes and beach areas are protected under the Habitats and / or Birds Directive and two beach reserves have been installed ('de Baai van Heist' and 'de IJzermonding). A rectangular shaped area off the Ramsar area (Flemish Banks Trapegeer-Stroombank) has also been proposed for integration in the Natura 2000-network (Habitats Directive). However, this area has not formally been designated.

In addition, international shipping routes, areas for military exercises, areas for the different categories of the beam trawl fisheries and dumping sites for dredging materials have been established (see map).

Existing rules and plans merely serve as a basis for a prohibition policy that regulates what is allowed and what is not. They have no structuring function but are limited to regulating the existing uses based on sectoral rules and zonations, concessions and juridical procedures.




***Map: the regulated sea. All zones with a juridical status in the BPNS.***



## CONFLICTS

**no sand and gravel extraction near**

wind parks

cables and pipelines

anchorage area

shipping lanes

**no sand and gravel extraction during**

military practice

**sand and gravel extraction could have negative impact on**

marine ecosystems and the environment

fisheries

## POSITIVE EFFECTS

extraction of dredged materials for land reclamation

***Map: The disputed sea. Spatial conflicts and positive effects between sand and gravel extraction and other users of the BPNS***

conflicts

positive effects

locations for sand and gravel extraction

other activities and infrastructures

# THE DISPUTED SEA

Conflicts often arise between different parties that claim the sea.

The development of other users is often regarded as a threat for own development. The fisheries sector for example considers all of the sea as fishing ground, resulting in many conflicts with other activities. Mainly new fixed infrastructures such as (offshore) wind farms are considered a threat for fishermen because they reduce the total available area for fishing, even if this zone was hardly used for fishing activities beforehand.

These conflicts frequently arise for each user of the BPNS. Known conflicts exist between sand and gravel extraction and fishing activities, shipping and military exercises (see map on the facing page). In addition, most activities have a considerable impact on the environment.

Fortunately, despite this conflict, for several users multiple use of space is possible within the BPNS. Fisheries for example may benefit from ship wrecks, marine protected areas, offshore wind farms or other areas where fishing is not possible. These areas possibly function as attractive refuges and resting-places for fishes as a result of which it might become interesting to fish nearby.

Multiple use of space is also possible for sand and gravel extraction: recently a new exploitation zone was set at a dumping site for dredging material. The dumped material can be used for land reclamation and beach nourishment.

It becomes clear from these examples that the sea is a place where different users can function at the same time at the same place; and this results either in conflicts or multiple use of space. A good plan for the BPNS would consist of an integral and long-term vision that tries to minimise conflicts while maximising the multiple use of space as much as possible. There is no future for a mere sectoral approach towards planning at sea!

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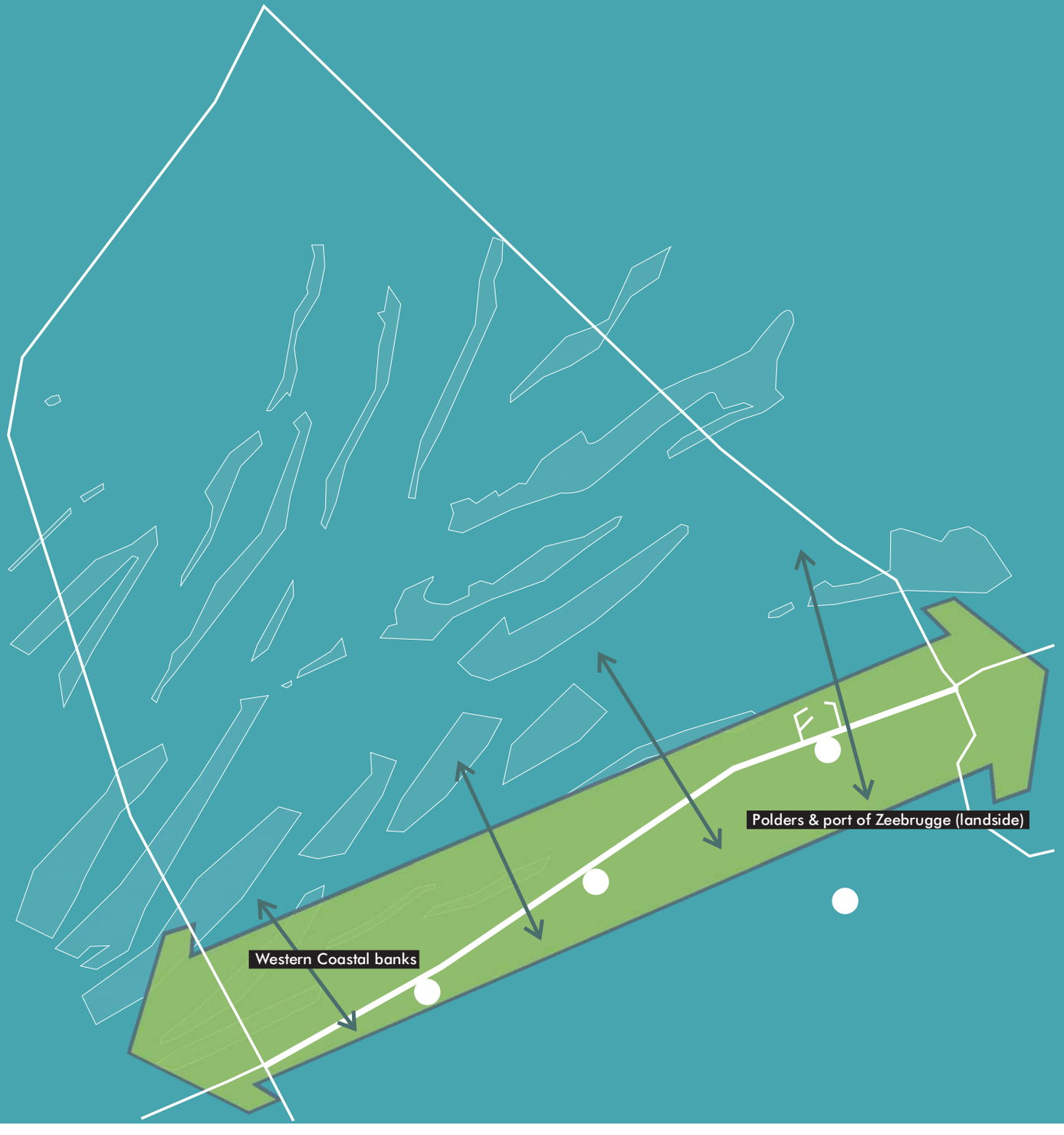



# NATURAL VALUES

Physical elements such as wind, water and sand reign at sea much more than they do on land. To this extent the physical elements have safeguarded biodiversity and seascape.

These natural values have, however, come increasingly under pressure because of the intensified use of the coast and the sea. The natural values of the BPNS are diverse, but they are also dependent on specific communities or populations. Though the biodiversity is enormous and spread throughout the BPNS, certain core areas can be identified as being of higher natural value. Two areas identified within the GAUFRE project include:

- a strip, about 10 kms wide and more or less parallel with the coastline. This strip is divided into a marine and terrestrial part. The marine part is widest in the western part of the BPNS. This part contains the most valuable coastal sand banks with large and rich benthic communities and their connected flora and fauna. In the eastern part, the marine

***Existing spatial structure:***
***Natural values in the BPNS***
***Structure map***

high natural values parallel to the coastal strip

natural relations between seaside and landside

strip is less wide as a consequence of the high dynamics around the port of Zeebrugge. The most valuable area on this side is therefore situated on land. These are the internationally well-known bird areas of the coastal polders, the Zwin and the hinterland of Zeebrugge. This coastal stretch also coincides with the wide strip being used as a migratory route for birds along northern and southern Europe;

- perpendicular to this coastal strip, several faunal movements interconnect the landside with the marine side. These patterns are mainly important for birds searching for feeding grounds or during migration to and from the British Isles, and fish migrating between the shallow coastal banks and the deeper sea.

More natural values also occur deeper at sea but these are less known and mainly connected with specific local habitats such as rocky formations that mainly consist of wrecks in the BPNS.

# THE COASTAL STRIP

The coastal strip, the landside bordering the BPNS, has a large impact on the BPNS and the sea also influences the coastal strip. Although the sea has an impact on the total length of the coastal strip, this strip can still be divided into a number of structurally distinct categories.

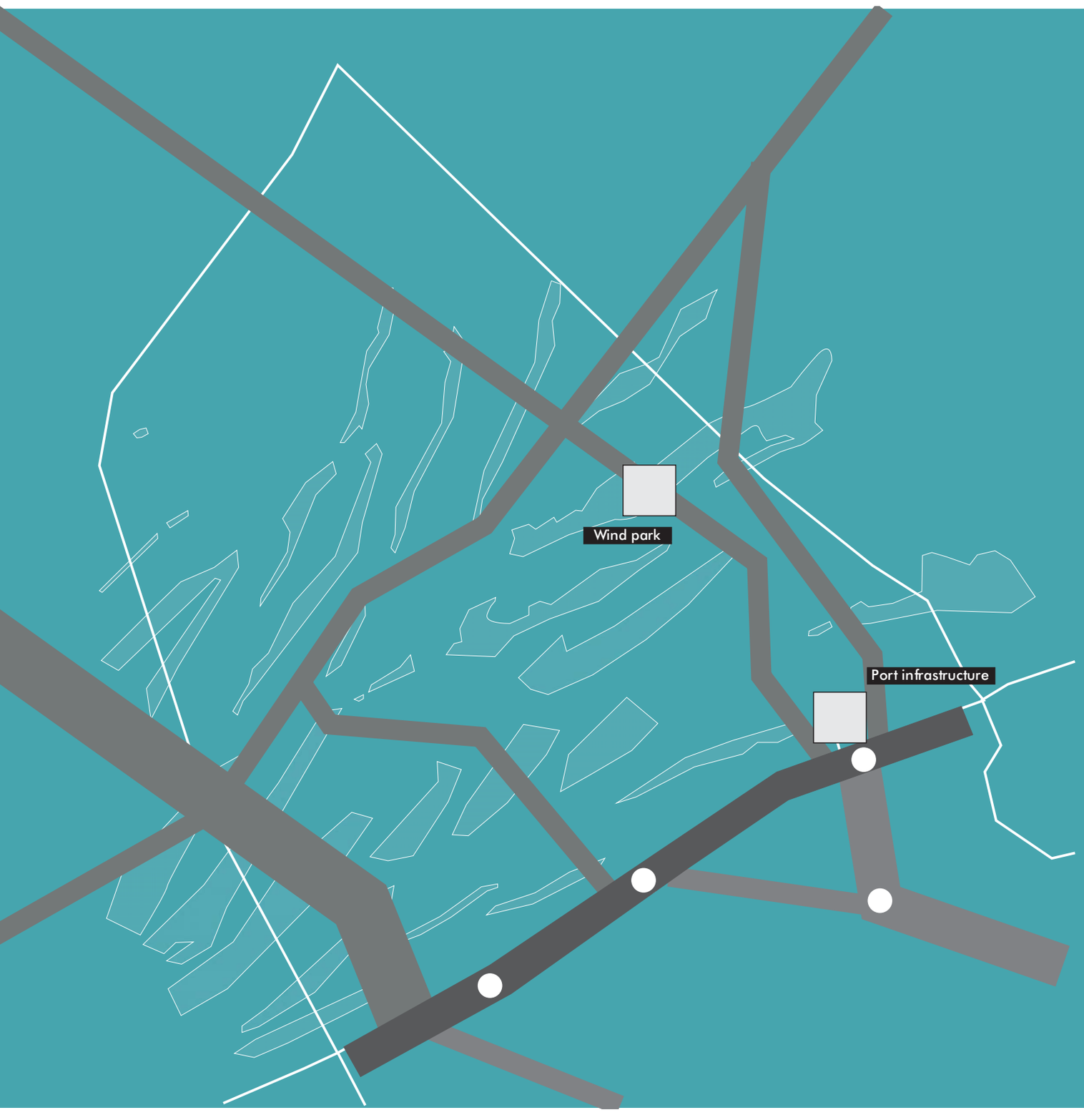
These categories are mainly based on different physical characteristics of the coastal strip, types of use and mechanisms for defence against the sea.


***Existing spatial structure of the Belgian coastal strip***
***Structure map***

- hard coastal defence zone
- dune zone
- port zone
- polders

These categories specifically include:

- the concrete coast: this type occurs in the area between Knokke and Heist and between Ostend and Nieuwpoort. The coastline is characterized by concrete structures such as dykes, high levels of construction, high pressure and almost completely depressed natural sea dynamics towards the land. An exception is the Zwin in Knokke;
- the port of Zeebrugge: this is an industrial landscape in which the link with the sea is purely based on shipping and port activities. The groynes are meant to protect incoming vessels against currents;
- the narrow dunes: the area between Blankenberge and Bredene has less hard infrastructure than the above categories. Although part of the coast is still comprised of dunes, natural dynamics between the sea and the dunes is limited. Furthermore, the dunes that are present are very narrow and immediately turn into a polder landscape or coastal forest;
- the broad dunes: the area between Nieuwpoort and De Panne contains a broad dune belt. Although intensive construction has heavily impacted the dune belt, natural dynamics are still present. A recent example of natural dynamics are the artificially introduced breakthroughs from the sea to the dunes (sea inlets or the so-called 'slufters');
- the polders: these occur behind the coastal strip.




# INFRASTRUCTURE

The BPNS has two types of fixed infrastructural systems. These can be characterised as exposed infrastructure and submerged infrastructure:

- exposed infrastructure consists of the port infrastructure (jetties and groynes) of Zeebrugge, coastal defence in general, survey and monitoring infrastructure, and the future wind turbine park on the Thorntonbank;
- submerged infrastructure is located on the seabed and mainly includes cables and pipelines. Although the layout of this type of infrastructure can appear chaotic, a certain structure can be identified in the shape of 'bundles':
  - perpendicular to the coastal strip: two bundles leave the groynes of the port of Zeebrugge. Each one of them consists of a communication cable run-

***Existing spatial structure of the fixed infrastructure in the BPNS***
***Structure map***

bundles of cables and pipelines

the coastal strip: urbanisation (roads, tramway, construction,etc) and coastal defence

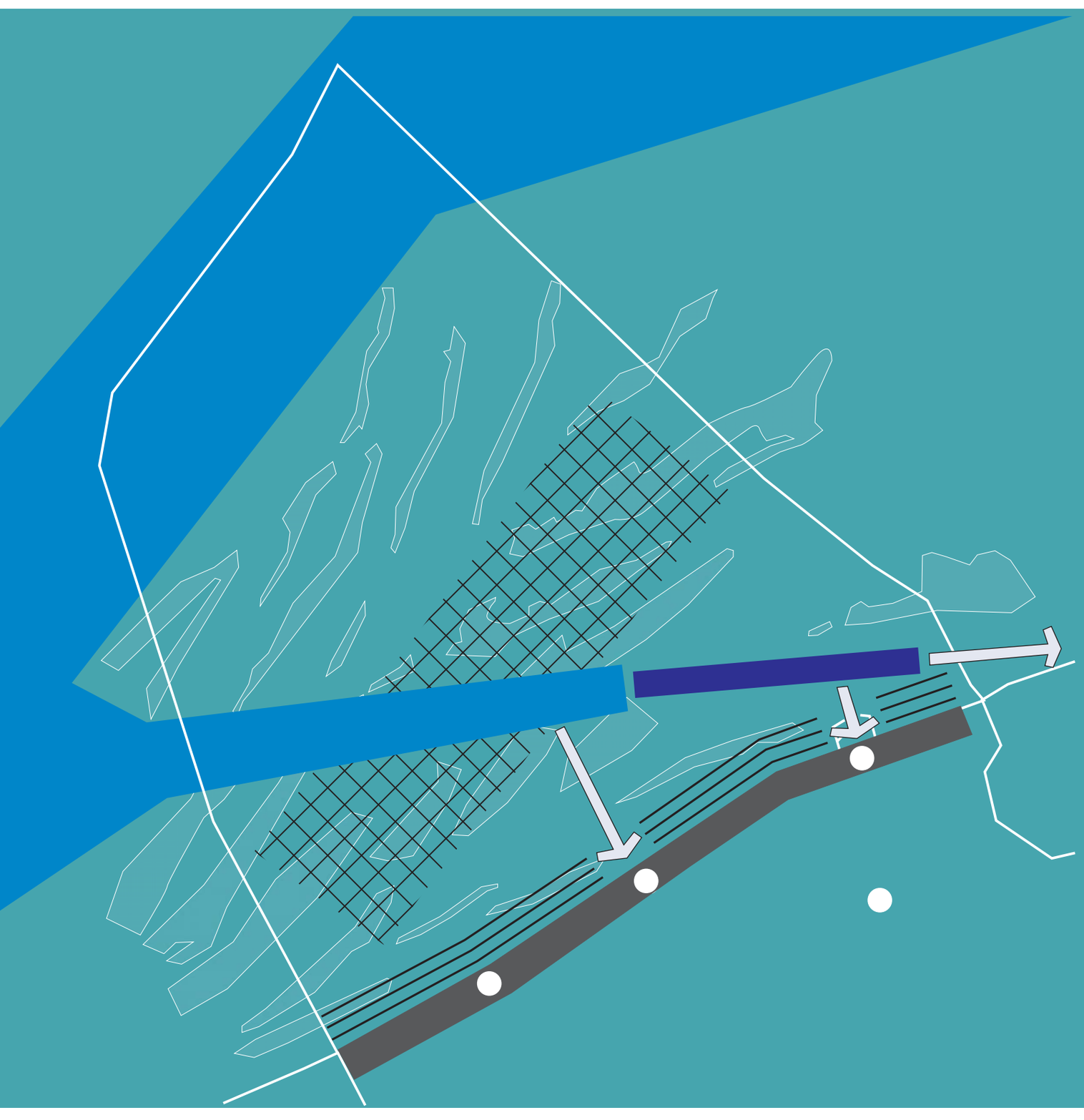
(planned) wind turbine park

ning parallel with a gas pipeline. A second bundle leaves from Ostend. Three cables run parallel in this bundle. Additionally many cables leave the area of De Panne-Koksijde-Oostduinkerke. The distance between these cables is larger and some of them are no longer in use;

- parallel to the coastal strip: several communication cables have been installed parallel to the Norfra-gas pipeline.

On the landward side, the entire coastal strip can be identified as one stretched infrastructural lane. Different infrastructure (cables, coastal defence, construction, roads, etc) is bundled parallel to the coastline. Accordingly, access routes are perpendicular to the coastline.

For energy network infrastructure (gas and high voltage) no connections are made along the coast, and there are only dead-end or passing connections towards the sea. Nevertheless, some dead-end cables are meant to be connected to sea cables of future wind turbine parks.



# DYNAMICS

The BPNS though being very small, is intensively used. Its dynamics both natural as well as human are very strong in this part of the North Sea.

Dynamics are another way to subdivide the BPNS into zones:

- the transit zone: its dynamics mainly consist of the shipping movements in the traffic separation schemes. This part of the North Sea is one of the busiest shipping lanes in the world;

***Existing spatial structure:***
***Dynamics in the BPNS***
***Structure map***

main shipping movements

coastal zone

activity zone

dredging zone

transit zone

- the dredging zone: the dynamics of this zone are even higher than those in the transit zone, being an extension of the transit zone. Permanent dredging activity needs to be carried out for safety reasons for international shipping. It is a continuous activity due to sand movements at sea, constant sedimentation from the Scheldt estuary and erosion from the groynes of the port of Zeebrugge. This dredging zone covers the direct access routes to the ports of Zeebrugge, Gent and Antwerp;
- the activity zone: this zone accommodates a rapidly increasing use of mobile and fixed activities. Almost all current uses and infrastructure within the BPNS are situated here. It is the area in which the different natural resources of the sea are being exploited, including wind energy, sand and gravel extraction, fisheries, etc. The part that is closest to the coast undergoes the heaviest exploitation due to the short distance to coastal ports;
- the coastal zone: the ports, coastal towns and the beach all impact the activities that take place in the 3 nautical miles zone along the coast. It is consequently a very intensely used area of the BPNS. This is not only limited to economic and recreational activities, but also includes high natural and ecological dynamics such as continuous coastal erosion.

# DEVELOPMENTS AND TRENDS

Besides current uses and the existing spatial structures within the BPNS, important trends can also be identified in the natural and societal development of the area.

These trends illustrate the challenges that a future North Sea policy would have to face and are therefore guidelines in formulating a spatial vision for the BPNS. The most important trends are discussed below.

## (over)exploitation of fish stocks

Coastal seas such as the North Sea are very productive areas. They deliver about 90% of the commercial fish catch in the world (2). Additionally, the demand for fish as a source of nutrition is constantly increasing. As a consequence, large parts of the most important fishing grounds are being overexploited. This of course raises questions about the sustainability of exploiting natural resources.

## climate change

The effects of future climate changes will heavily impact on densely populated coastal areas, such as those along the North Sea. The pressure on those areas from the water, as a consequence of the greenhouse effect will only increase in the years to come. Sea level rise for the North Sea is estimated to be between 20cm and 110cm (1). But the climate will also change due to changes in the North-Atlantic gulfstream. The consequent increase in the risk of inundation, coastal erosion, siltation, etc needs to be anticipated. All these effects will have a tremendous impact on the use of the North Sea and the coastal areas.

## pollution and degradation of natural structures

The quality of the marine environment is under a lot of pressure. The intense use and proximity to industrialised areas make the North Sea one of the most polluted areas in the world. Current and historical pollutants are a constant threat to the North Sea's vulnerable natural ecosystem. It is necessary to develop a system to protect the North Sea's ecological and physical assets. This protection is necessary not only to ensure preservation of the sea's natural value but also its importance as a productive and stocking area.

## (under)utilisation of diverse natural resources

The North Sea has an enormous potential, but only part of its natural resources are really being used. There are many additional resources that are under-utilised or which might be applied to further uses. It is presently thought that additional applications can be found in the pharmacology, biotechnology and the chemical industries.

Although the North Sea is presently restricted to gas and oil exploitation, new forms of energy exploitation are also becoming likely. New areas where energy may be increasingly exploited in the future include tidal power, sea currents and wind energy.

## increased spatial claims

While the demands for space on land increase, the amount of land available to meet that demand is decreasing. This has resulted in the wide areas of space at sea being increasingly sought after as an alternative location for uses and activities that previously took place on land. At the same time activities that have been traditionally based at sea are placing increasing demands on sea space. Although marine space appears unlimited, it is not, and it will soon be challenged by the same type of difficulties as those that are faced on land.

# 2 spatial vision for the BPNS

# THE NEED FOR A SPATIAL VISION

The surface of the BPNS is approximately 3600 km², which is approximately 1/9 of the surface of Belgium itself.

The BPNS gives the impression of being immense with an enormous potential for new uses.

Nevertheless, the current demand for space shows that the BPNS already has a high exploitation rate. The current need for space at sea is larger than generally thought. The sum of all potential demand for space at sea is around 2.6 times larger than the available space (if space allocations are based on current legislation and if this space would actually be completely used). Apparently, some activities do not occupy all their legally allocated space (both in time and space) and some activities or infrastructures can be perfectly combined without spatial or temporal conflicts (e.g. cables and pipelines versus shipping).

Nevertheless, future requirements for space will continue to increase. Several future plans (e.g. for offshore wind parks) illustrate this increasing demand for space within the BPNS.

This in turn increases pressure on current uses and existing (natural) systems. It is important to note that the need for space changes in two directions. The fixed activities (such as wind energy, cables and pipelines, coastal defence, port structures, aquaculture and land extension) are gaining importance (and spatial occupation) in comparison with the mobile uses at sea. The mobile uses (such as fisheries, shipping, military use, water recreation, sand and gravel extraction and dredging activities) do not increase their spatial occupation, but rather intensify their action in the zones they already occupy.

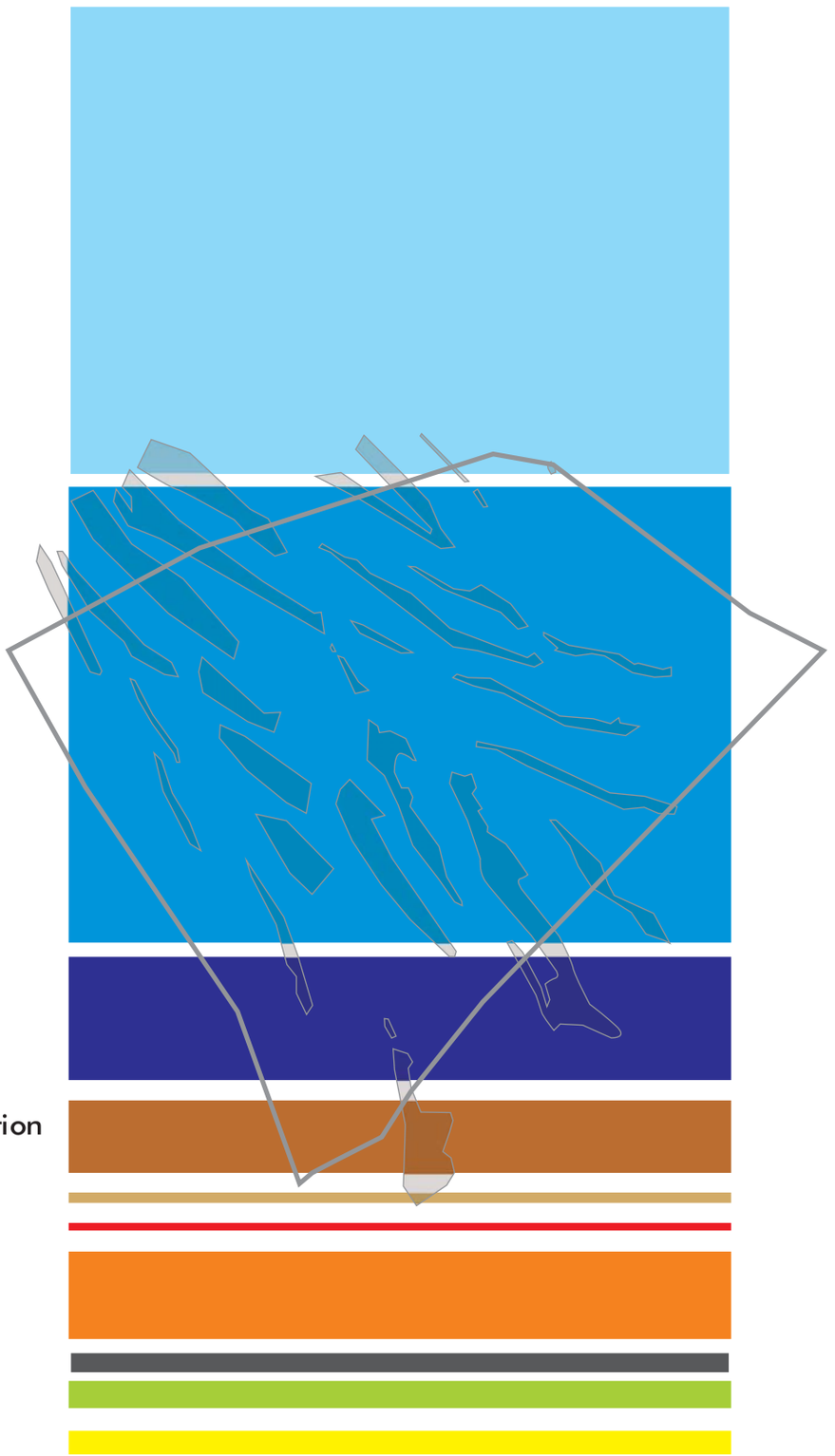
Space within the BPNS is limited and in most cases the use of space for one type of use restricts possibilities for other types of uses.

In simple terms, there is not enough space within the BPNS to accommodate all the claims for space. Accordingly, structuring and planning is required for the BPNS and choices will have to be made about space allocation.

It is important to acknowledge the sea's specific characteristics. The BPNS cannot just be seen as an extension of the land. The sea has a unique and typical structure and dynamics. It is not a 'waste' space for activities that can no longer take place on land. Therefore, each activity needs to be examined in terms of whether it can be performed more effectively on land or in an alternative form.

99 % fishing

97 % shipping
of which
20 % traffic separation



26 % military use

15 % sand and gravel extraction

1,2 % dredging and dumping

0,6 % wind parks

18 % cables and pipelines

0,1 % coastal defence

4 % nature conservation

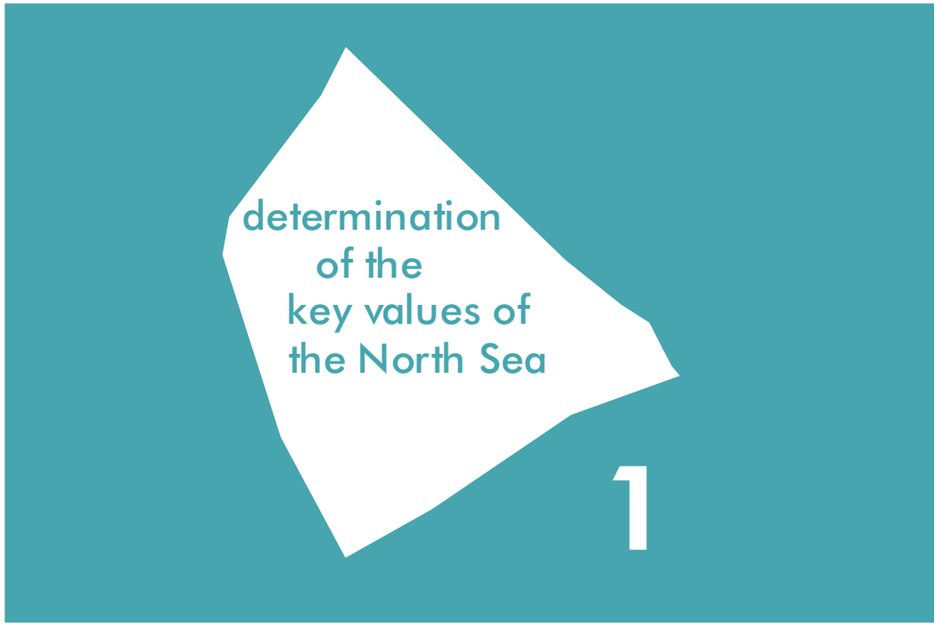
1,9 % coastal recreation

**264 %**
**TOTAL CLAIM FOR SPACE**
**(potential use of space based on legislation)**

The GAUFRE-project went further than mapping the current activities and functions of the Belgian part of the North Sea. Rather, the aim of the project was to outline concrete future possibilities for the BPNS. The future prospectives were drawn in order to inspire policymakers and end users to envisage alternative ways in which the BPNS might be spatially managed in the future.

In order to develop a concrete spatial plan for the BPNS, policymakers will be able to follow a four step program. This program will permit policymakers to produce a spatial plan for the future of the BPNS by simply formulating a few key values in the first step. Finally in the last step this spatial plan will be translated into an international policy context.

In this book the first two steps of the program are elaborated. The last two steps require a social balance between the different future visions, due to the fact that different users will give more weight to different dividing key values. Balancing the desires of the users was seen as a task for the government, therefore, the GAUFRE-project restricted itself to the first two steps leaving the last ones to be filled in by the authorities.




*Identification of the key values that determine each use within the North Sea (i.e. ecological, economic and social well-being)*

# FOUR STEPS TOWARDS A

development of various scenarios for the BPNS

2

*The different weight given to the key values and the scientific knowledge on public needs, environment and impacts will lead to a formulation of new scenarios for the future management of the BPNS. Visions, spatial planning strategies and preferential areas of use will be formulated within each of these scenarios*

drawing of the structure plan for the BPNS

3

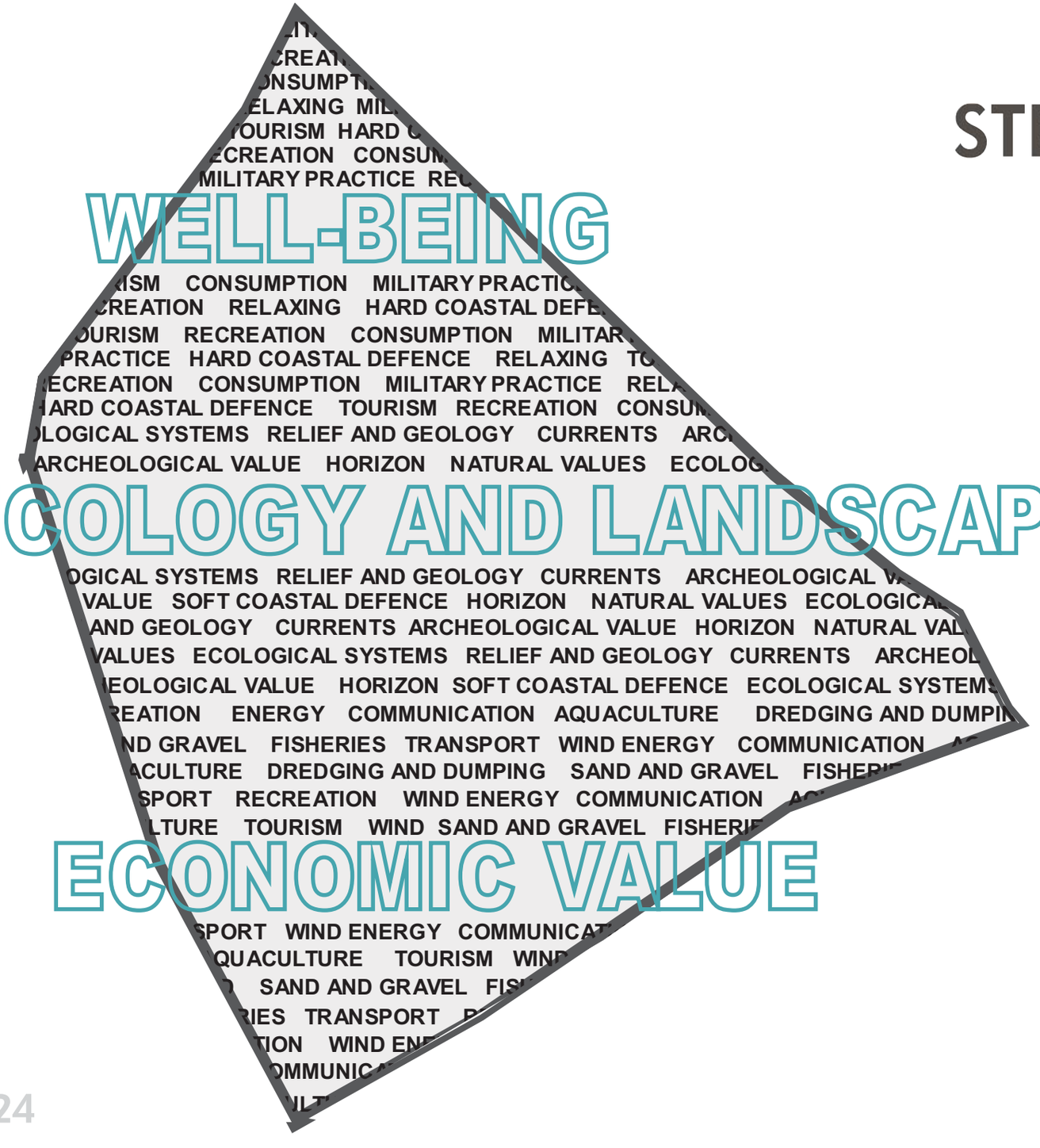
*Formulation of a single vision based on the different scenarios into one structure plan. This vision will form the foundation for the future management of the BPNS*

the transnational approach

4

*A structure plan for the BPNS can set an example within the international policy context. Ultimately, a combination of national structure plans may result in a vision for the whole North Sea*

# SPATIAL NORTH SEA POLICY




# STEP 1 THE KEY VALUES

The key values of the North Sea determine each use within the BPNS. Every activity in the BPNS can be correlated to these three key issues. The designation of marine protected areas for instance is correlated to the weight the policymakers put on the ecological and landscape value of the North Sea, and sand and gravel extraction would be linked to the importance of the economic value of the North Sea for the policymakers.

Every future intervention will be tested towards the key values. After all, a sound spatial policy for the BPNS starts from a well balanced social hierarchy of key values.

The three key values are: the value of well-being, ecological and landscape value, and economic value. It is evident that these same values will play a role in the spatial planning of the mainland.

# OF THE NORTH SEA

## WELL-BEING

The North Sea is an area for recreation. In particular, the coast is a place to relax, take holidays and get a breath of fresh air.

'Consumers of the sea' view it as a large, empty space in contrast with the density of the land.

The social value of the Belgian part of the North Sea is caused by its potential for consumption: the sea offers space, consumer goods and entertainment.

## ECOLOGY & LANDSCAPE

In Belgium, the North Sea is a scarce 'landscape' with a large ecological importance.

The North Sea has a highly diverse natural wealth formed through an ecological network of benthos, fish, marine mammals and birds.

Moreover, its natural wealth covers the entire ecosystem through the combination and interrelation of topography, currents, wind, etc. Examples include such things as sand banks, dunes, tidal areas and more specific habitats on hard coastal structures.

Furthermore this value concerns the landscape with its free horizon and the 'heritage' of this landscape, such as ship wrecks.

## ECONOMY

The BPNS is a very wealthy area, with resources and conditions that are unavailable on land.

The maximum extraction of these resources, or making use of these specific conditions provide a surplus value. For example: transforming wind into valuable energy, the extraction of sand and gravel, the catch of fish and the development of aquaculture.

In addition, the North Sea has an important role as transport area for both goods and passengers.

## Precautionary principle

The precautionary principle is based on international agreements, such as the OSPAR Convention (for the protection of the marine environment of the North East Atlantic, 1) and the Belgian Law for Protection of the Marine Environment (1999).

This basically provides that "preventive measures are to be taken when there are reasonable grounds for concern that substances or energy introduced, directly or indirectly, into the marine environment may bring about hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship between the inputs and the effects…".

## Principle of sustainability

The principle of 'sustainability' is based on the Bruntland Report which defines 'sustainable development' as: "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (2).

This principle has been translated in the Belgian Law for Protection of the Marine Environment (1999) as the principle of sustainable management of sea areas.

The Spatial Structure Plan Flanders (3) provides for sustainability as the guiding principle for land management. Analysis of the existing spatial structure of the North Sea revealed that uses on the BPNS are highly connected with the contiguous land parts. This means that sustainability must be implemented in the North Sea in the same way that it is implemented on land, so that the adverse effects of land use are not simply transferred to the sea. Stated more strongly, activities that are no longer welcome on land cannot simply be relocated to the sea.

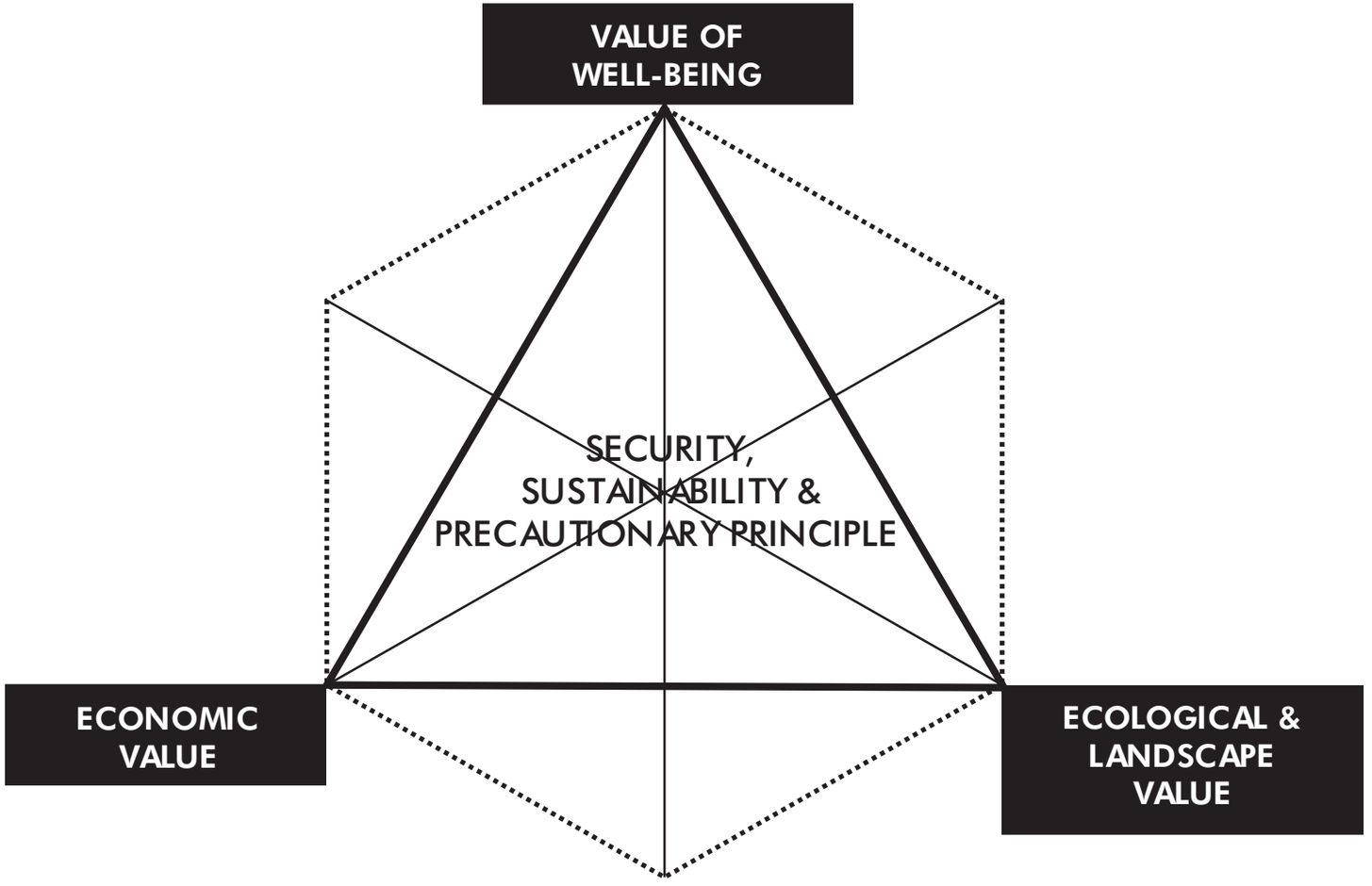
## Principle of security

The principle of security can be interpreted as protection on, of, but also against the sea.

This includes such things as: the protection of land against floods and the power of the sea; the protection of nature values against pollution, disruptions and destruction; the protection of shipping against disaster and collision and the protection of the territory against invaders (e.g. military, coast guard, etc.).

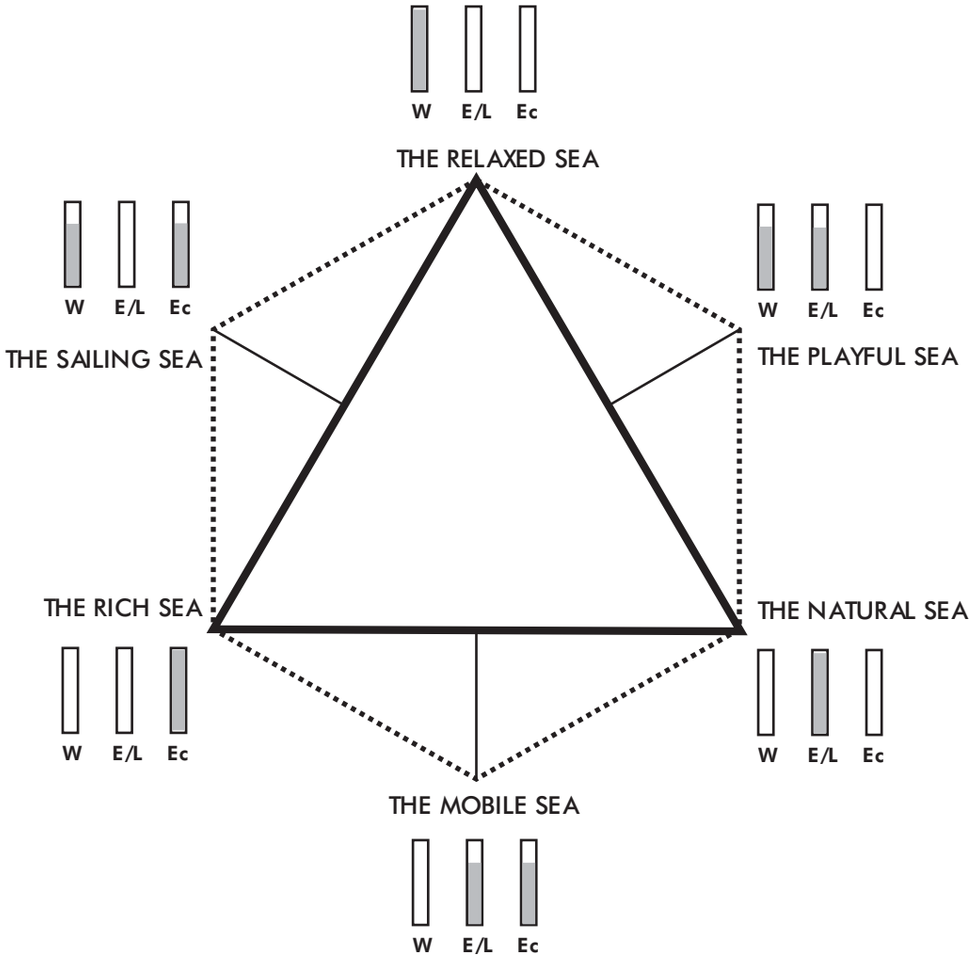
The different starting points and keynotes which were postulated for the North Sea in the past can be reduced to one or a combination of the key values: well-being, ecology and landscape, and economy.

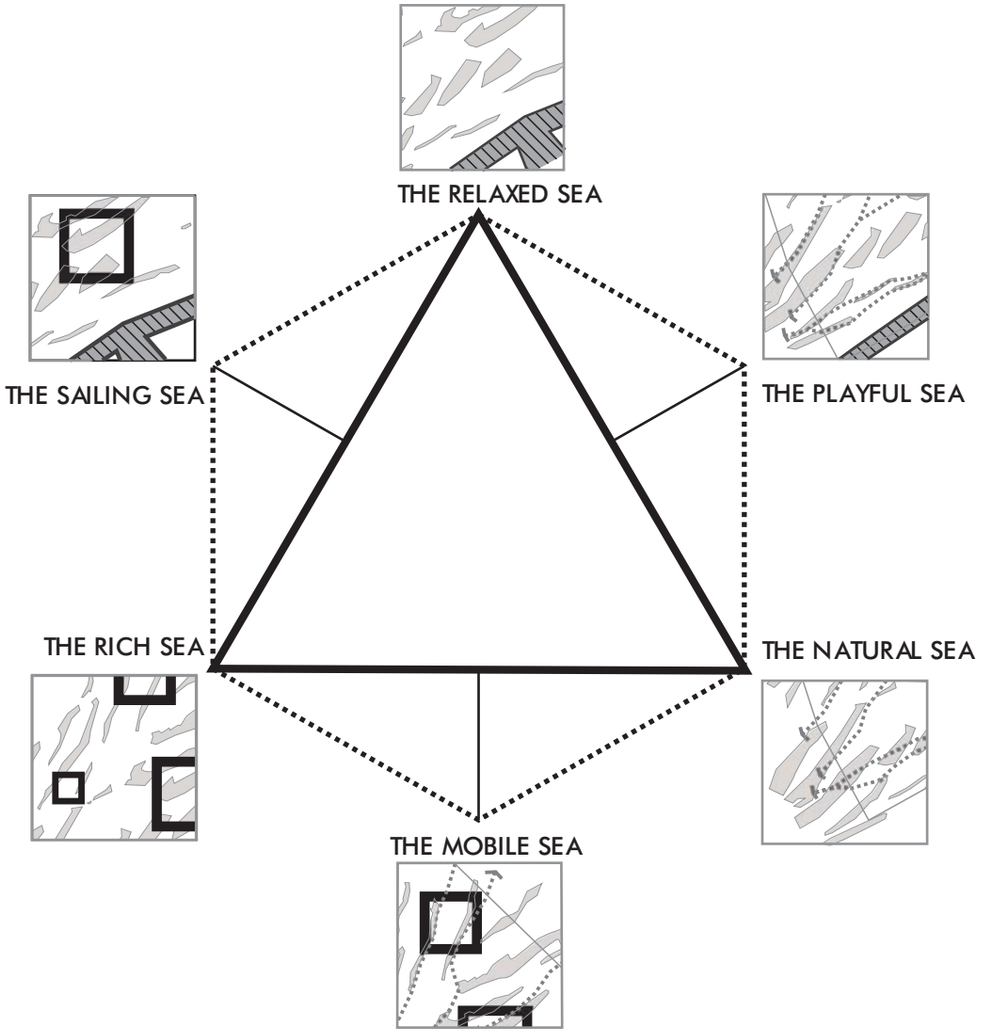
Even the precautionary principle, the principle of sustainable management and the security principle are manifestations of the combination of these three key values.



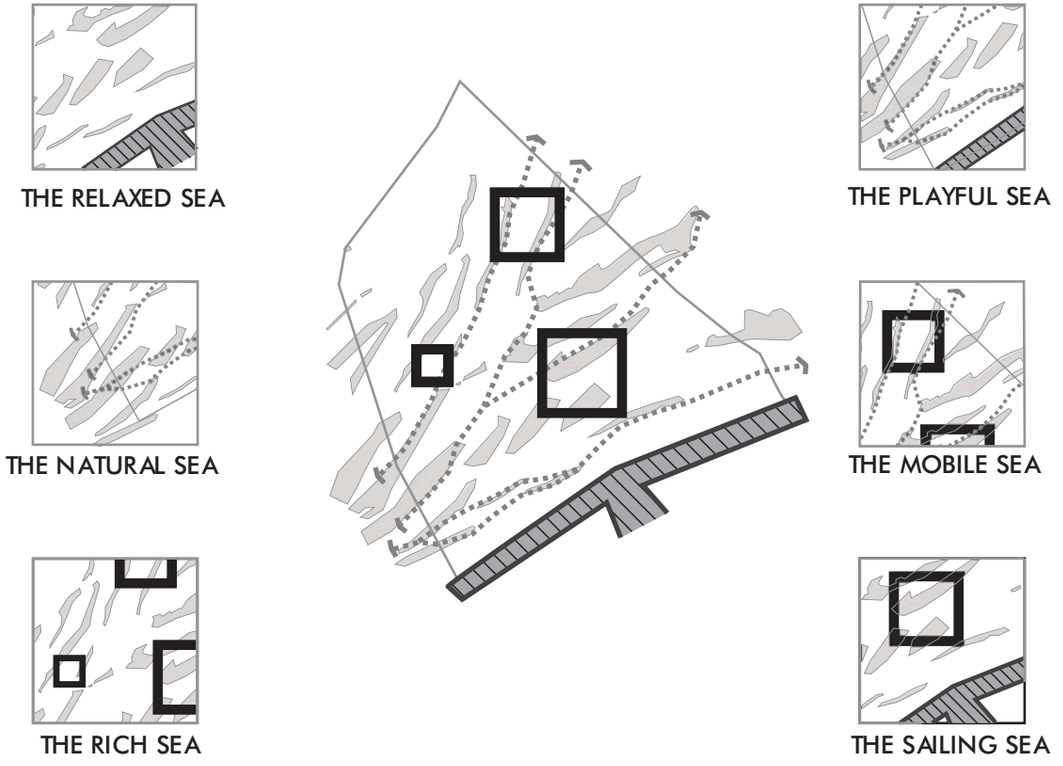

# OF THE NORTH SEA

# STEP 2 DEVELOPMENT OF



# SCENARIOS FOR THE BPNS

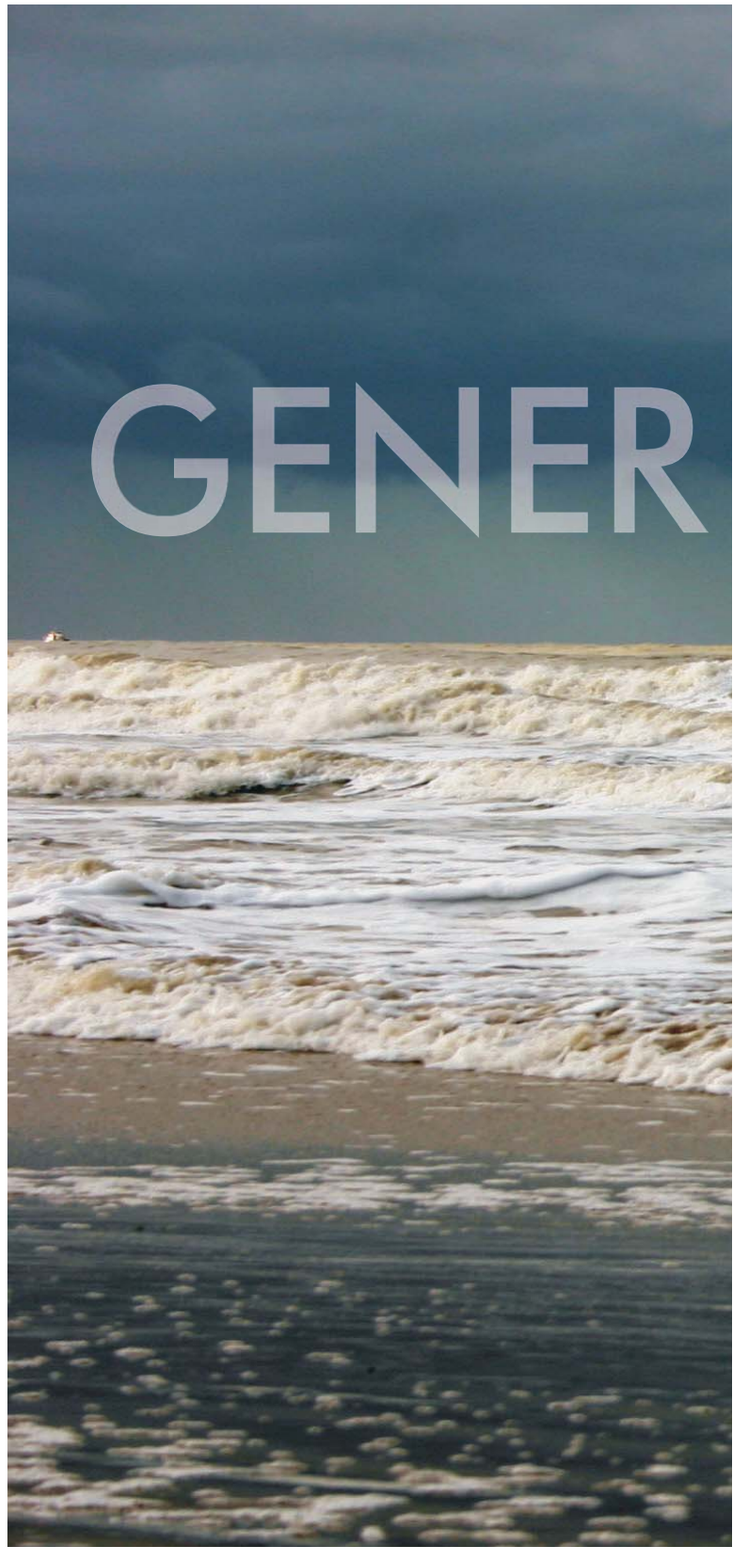



In this book six scenarios are developed for the future of the BPNS. These scenarios are based on the key values specified in the preceding pages.

Three of the scenarios strongly focus on one of the key values. The other three scenarios are based on crossovers between two of the key values.

Schematically, the six scenarios are respectively presented on the six angles of a hexagon. Each scenario has been elaborated to produce relatively extreme and conflicting results. These extreme scenarios provide an opportunity to consider a larger and less obvious picture. They reveal new possibilities and are designed to encourage the development of a policy that not only reflects present trends, but also anticipates future movements within the North Sea environment.

It was not the intention of the GAUFRE project to provide the ultimate spatial structure plan for the BPNS (step 3 on page 198). A spatial structure plan for the BPNS should rather try to balance the key values, and would therefore be situated at the centre of the hexagon.


GENER

# AL 'RULES OF THE GAME'

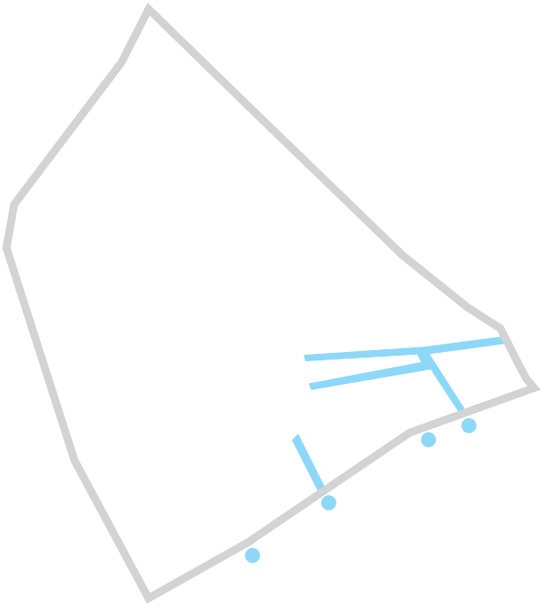
THERE ARE A FEW 'FIXED PRINCIPLES' WHICH ARE APPLICABLE FOR EACH SCENARIO.
THESE ARE SHORTLY EXPLAINED BELOW.

shipping > 80 m

*Shipping is regulated by international agreements and can therefore in terms of planning hardly be called a flexible function.*

*Other use functions potentially conflicting with shipping have to take shipping into account as a dominant use, namely for safety reasons.*

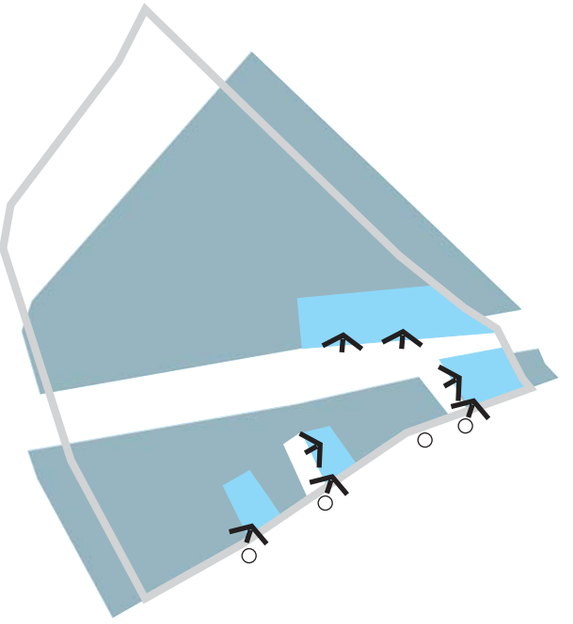
*Therefore, in the case of conflicts other uses are secondary. Shipping routes not regulated by international agreements (ships < 80 meters of length) have more potential to be fine-tuned with respect to other uses.*



dredging

*Shipping routes and port channels require dredging.*

*Dredging will evidently occur in the important harbors and in the shipping lanes up to 1 2 nautical miles.*



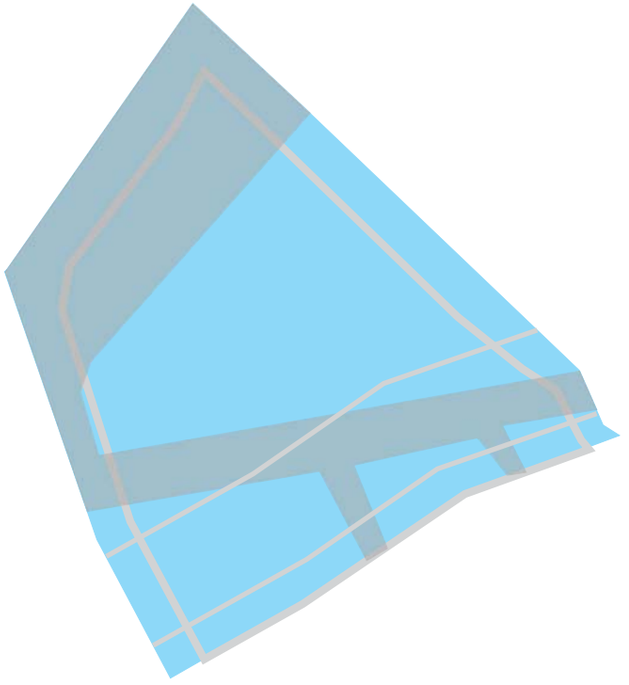
dumping of dredged material

*Dumping of dredged material has to take place as close as possible to the dredging zones (economic considerations). The main flow on the surface of the BPNS has a south-western/north-eastern direction. Accordingly, the dumping sites have to be located eastwards of the dredging zones.*

## sand and gravel extraction

*In principle, sand and gravel extraction is allowed and permitted anywhere within the BPNS with the exception of the main shipping routes (as the extraction may obstruct shipping) and the vicinity of cables and pipelines.*

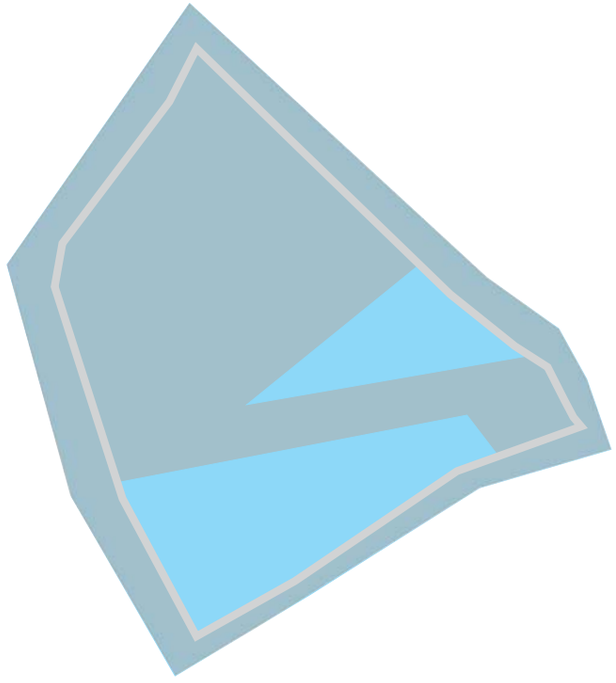
*Additional factors in the allocation of sites for extraction of sand and gravel are the quality of the sediment (grain size) of the sand (the sand must not be too fine, which excludes sand in the coastal zone) and the distance to the coast (economic considerations).*



## fisheries

*In principle, fisheries is allowed anywhere in the BPNS.*

*Determining factors in fisheries are the cost-effective distance between the fishing ground and the ports of call (related to the specific fleet segments) and its relationship with shipping. Fisheries are of secondary importance to shipping, as is the case for other uses.*



## nature conservation

*It is preferable that the most 'valuable' zones are protected. The GAUFRE project departs from the hypothesis that the shallow coastal waters have the largest natural value or potential (refer to the chapter 'The natural sea', pages 38 - 47).*

not allowed or not applicable

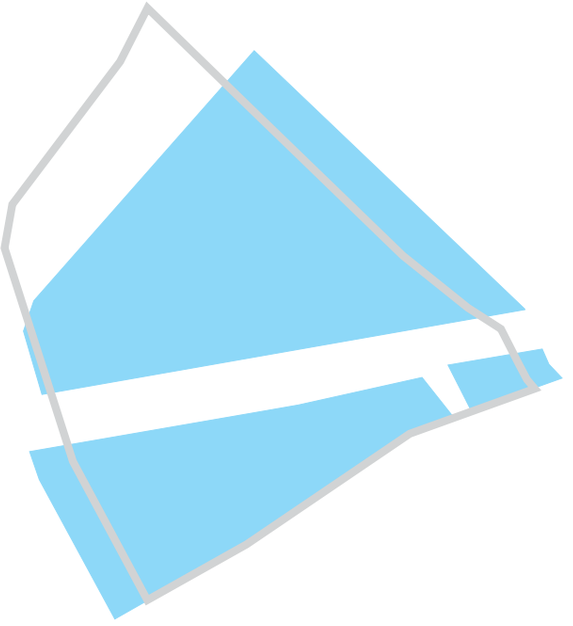
allowed, but with restrictions

allowed, or preferred location

## cables and pipelines

*In general, new cables and pipelines should be bundled with existing bundles if possible. Bundling with existing solitary cables is also possible but is less advisable. Priority is given to the existing large bundles.*

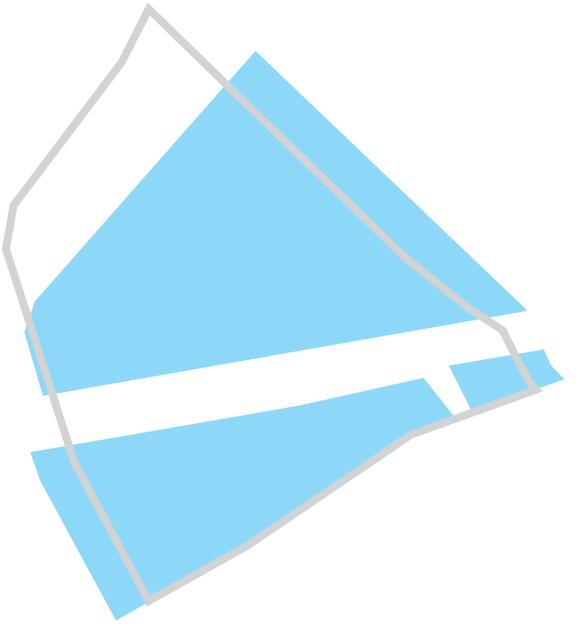
*The most suitable bundles are those that leave Zeebrugge and Ostend and the bundle that crosses the BPNS more or less in the centre, parallel to the coastline. Several cables and pipelines already have connecting points in Zeebrugge and Ostend and the terrestrial infrastructure is well developed in these areas. The bundle that leaves the western part of the coast is less suitable because the cables are more spread out (some of them are not even used) and the terrestrial infrastructure is less developed.*



## wind turbines

*Wind turbines are in principle allowed anywhere on the BPNS. But their location is very much dictated by economic considerations and issues in terms of profit. This means that wind turbines are to be located as close as possible to the coastline and as many turbines as possible should be located on sites with optimal wind speeds. Considering the present technology, this will be between 5 and 35 kms from the coastline.*

*Obviously wind turbine parks are not allowed in the internationally recognized shipping lanes or in the war ammunition dumping site called the 'Paardenmarkt'.*

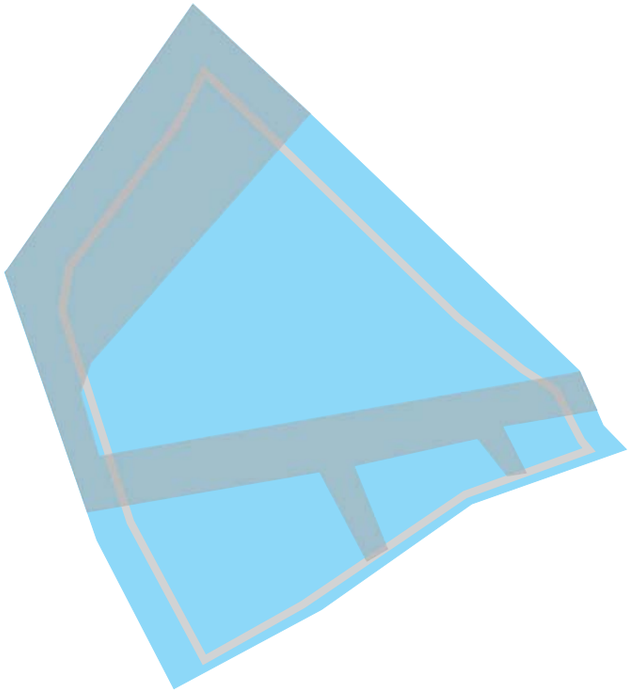


## aquaculture

*Aquaculture can in principle be located in any marine space in the BPNS.*

*As is the case for most activities, economic considerations play a role with issues such as distance from the coastline influencing location. Aquaculture furthermore requires areas that have few disturbances. This means that the busy shipping lanes and other highly dynamic zones are excluded.*

*It is possible to allocate aquaculture and wind turbine parks to the same area. This approach is followed in most of the scenarios.*

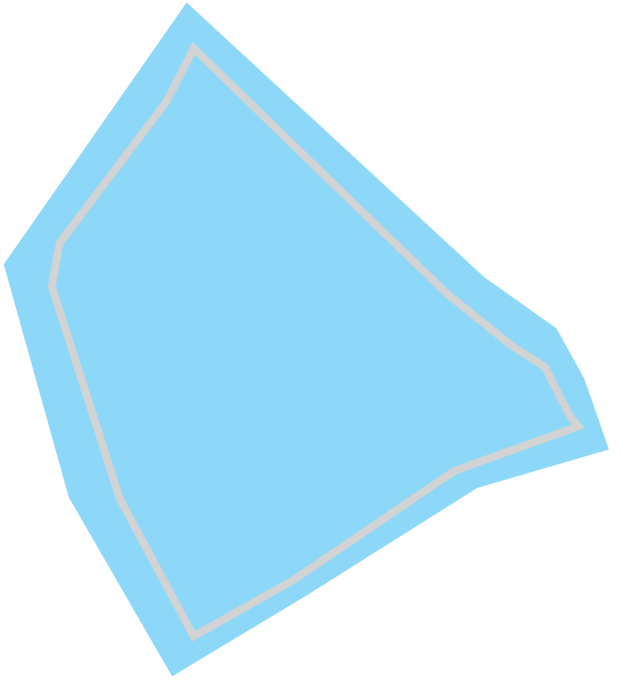


## military use

*Military activity is not frequently carried out and has a low impact. So in principle, this use will be allowed to take place anywhere in the BPNS.*

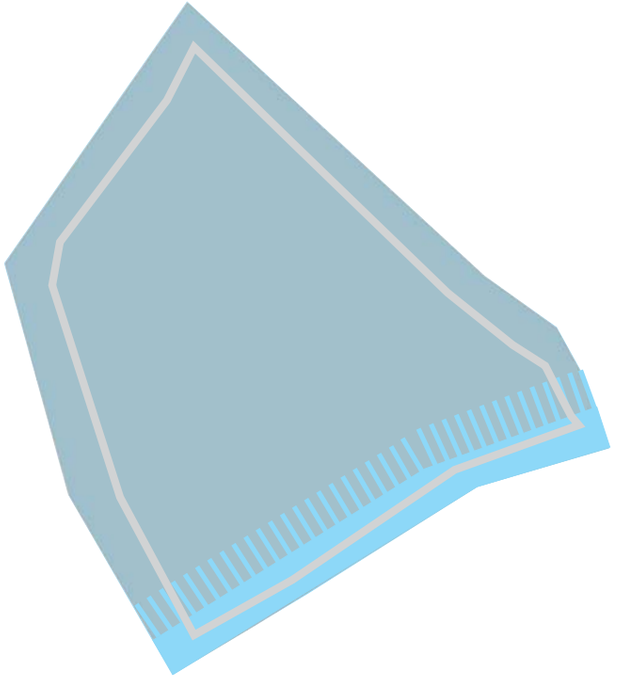
*Moreover, it is a flexible use that can interact with many other activities and infrastructures within the BPNS.*

*Again however, its use should be in accordance with major shipping activities.*



## tourism and recreation

*Tourism and recreation are - depending on the kind of recreation - rather neutral in terms of their interaction with other uses or activities. Therefore they can be located on any site within the BPNS.*



## coastal defence

*Coastal defence can in principle be located anywhere within the BPNS. There are types of defence that can be located in deeper parts of the sea.*

*New coastal defence structures should be in accordance with other uses, in particular with tourism or recreation. They should also ideally act as an extension of existing soft and hard coastal defence structures.*

not allowed or not applicable

allowed, but with restrictions

allowed, or preferred location

# THE RELA


XED SEA

In this scenario, attention is mainly given to the issue of consumer 'welfare' in the North Sea.

The welfare of the consumers, being the tourist, the recreationist, and also the consumer of fish and shellfish, pharmaceutical and beauty products etc, is central in this scenario.

The Relaxed Sea, therefore, is mainly experienced from a landward point of view. In this scenario the North Sea exists of two parts: the coastal zone and the deeper sea. The Relaxed Sea overlaps the coastal zone and can therefore be reduced to a narrow strip of about 65 kms along the coastline in which the consumers can meet their various demands.

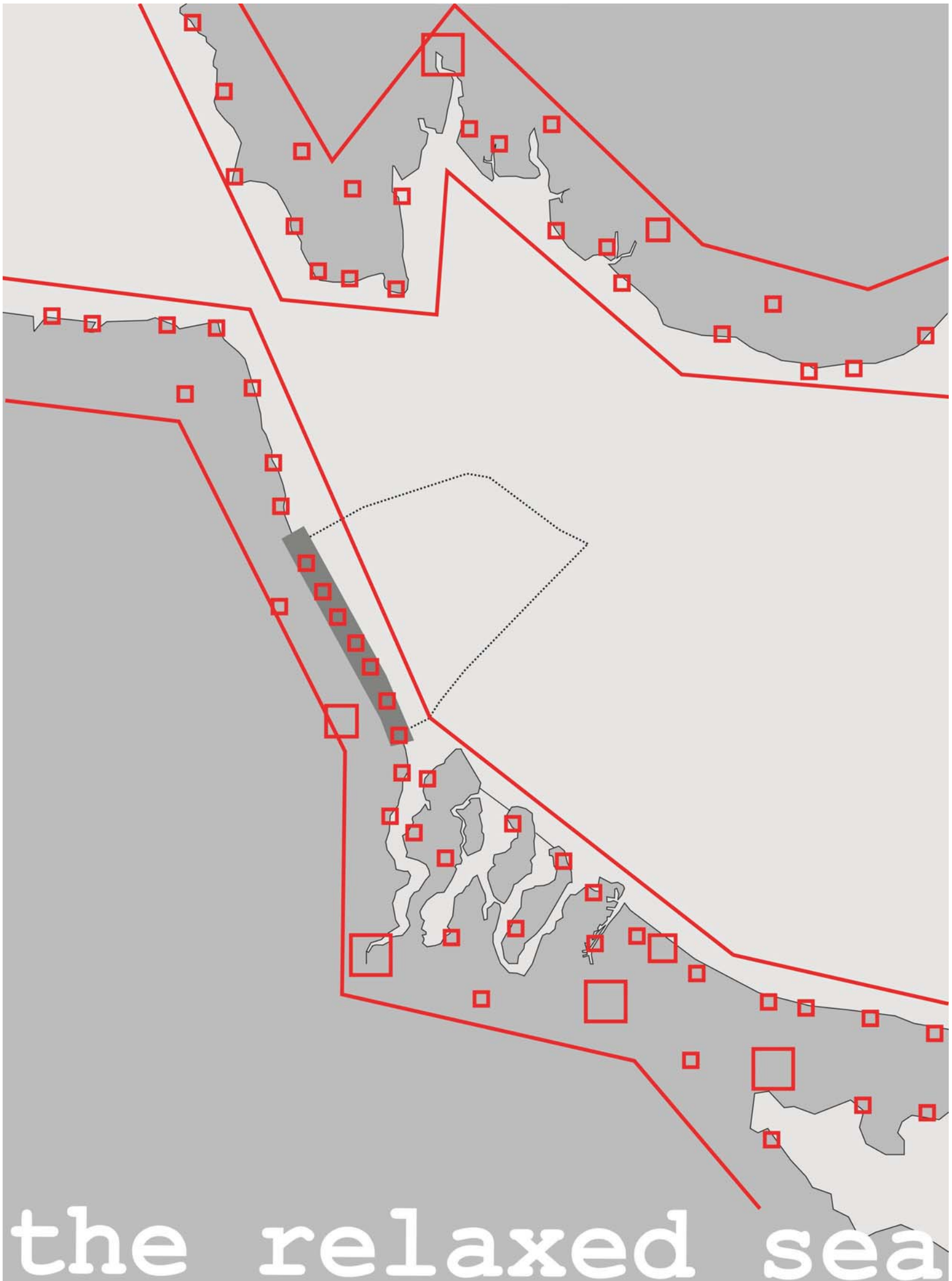
The Belgian coast is a very densely developed coastline. All major activities are situated within a narrow strip of about 5 kms wide that covers both the concrete strip as well as the shallow coastal waters.

In this scenario, the North Sea stands for sunbathing and sports on the beach, strolling along dykes, swimming, sailing and surfing, enjoying the scenery with an icecream or delicious seafood. In short, it aims at refilling the welfare battery.

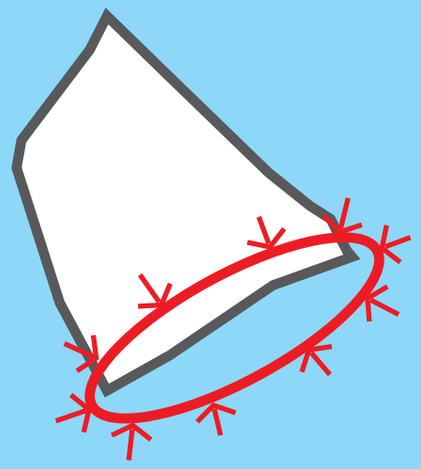
In the scenario of the Relaxed Sea the structure and the use of the BPNS are meant to maintain, protect and further develop this narrow space for recreation and consumption purposes. The infrastructure of the hinterland is arranged entirely to assist access to the coastal strip, whereas mainly hard coastal defense structures are used to keep the sea under control.

Each area within the coastal zone develops into a sub-zone with its own profile.

The area deeper at sea and therefore further away from the coast seems to be of less importance here. In fact, it does not form part of the Relaxed Sea whatsoever. This space, being an area that is seen as separate from coast and land, is mainly used for activities that are not suitable on land, on the condition that they do not disturb the relaxing activities as discussed above.

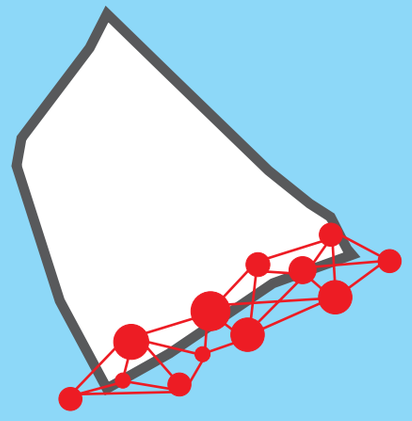

the relaxed sea

# the relaxed sea



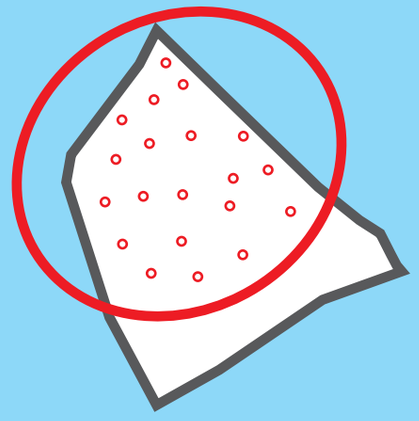
concentration and intensification of activities in the coastal strip (sea and land)

*Since the coastal strip is most important in this scenario, several activities are concentrated within the coastal strip. Both the terrestrial and marine side are of significance.*



coastal strip as network of complementary activities (tourism - marine land development - ...)

*Tourism and recreation are not the only 'welfare' related activities that take place within the coastal strip. Other suitable 'welfare' related activities include such things as marine development that can be undertaken on land, for instance certain types of aquaculture. These new types of activities that are related to the sea will in turn contribute towards enhancing the identity of the coastal area. This in turn should lead to a coastal network of complementary 'nodes'.*



activities that hinder tourism and recreation deeper at sea

*Activities that might hinder the well-being of the 'consumer of the coastal strip' are avoided as much as possible in this scenario. The degree of impact on the consumer (both tourist as well as inhabitant) will largely depend on the distance of an activity from the coast.*

*Structure plan*

subareas:
the coastal zone and the deep-sea

most important connections between
the subareas coastal zone and deep-sea

subareas with a personal
profile

hard coastal defences and other structures
parallel with the coastline (roads, coastal tram)
as backbone for development

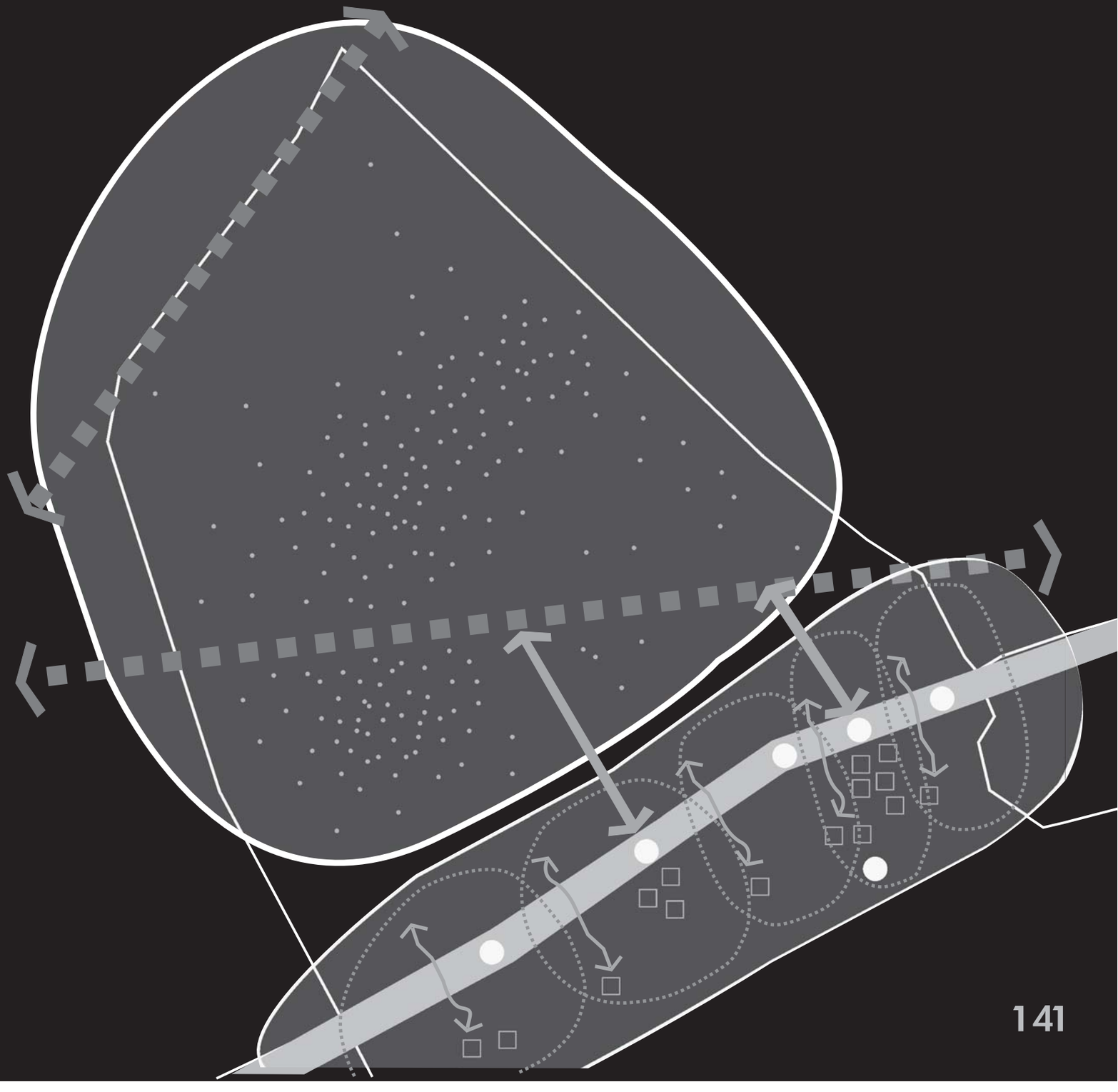
seaside resorts as development centers

intense relation between sea-
and landside

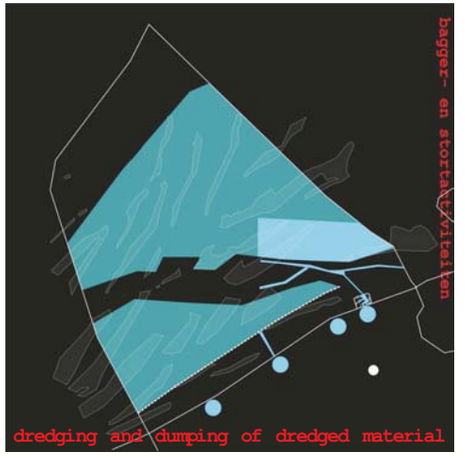
new development poles for marine induced
land development (mariculture, pharmaceutical
industry, food and beverage industry)

activities on sea
(point density represents intensity)

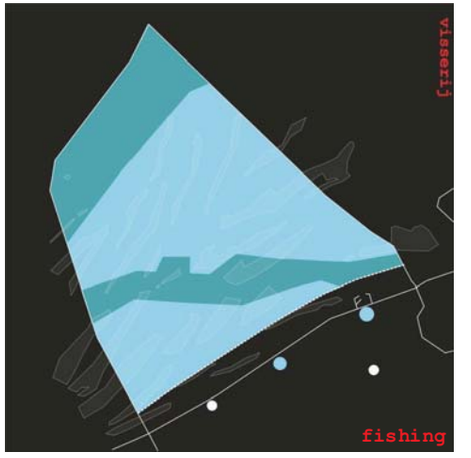
international shipping lanes

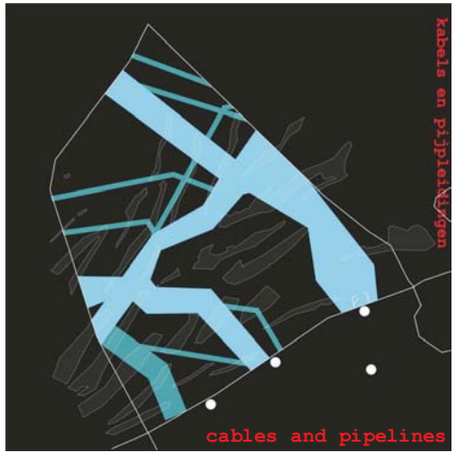



scheepvaart
shipping


bagger- en stortactiviteiten
dredging and dumping of dredged material


zand- en grindontginning
sand and gravel extraction

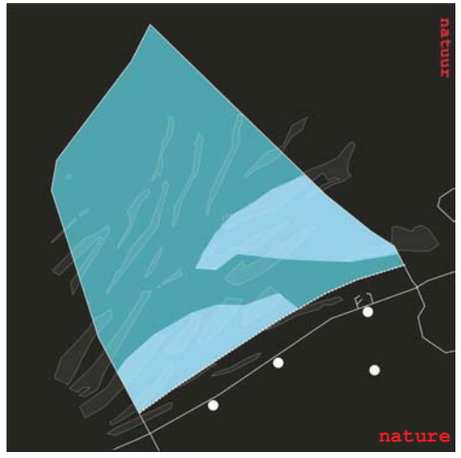

visserij
fishing

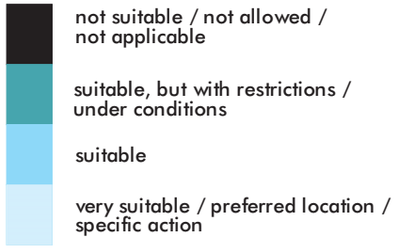

kabels en pijpleidingen
cables and pipelines


windmolenparken
wind parks

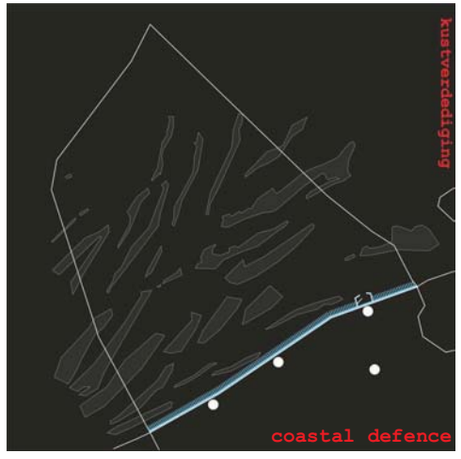

aquacultuur
aquaculture


militair gebruik
military use








## Significance of the scenario for the different functions and activities on the BPNS

Some activities will not be able to take place in the coastal zone due to the fact that they hamper the coastal consumer in his or her leisure activities. As a boundary, a three mile limit is being employed indicating the border of the 'exclusive' consumption zone.

The maintenance and the expansion of the hard coastal defences will be a major investment source due to their role in the protection of the coastal consumer and the consumers' leisure activities such as walking and fishing, on those hard structures.

Tourism and recreation are intensively taking place in the coastal zone (terrestrial and marine part). Tourism and the marine induced land development could increase the profiling of the coastal communities and contribute to the complementary cooperation of the development poles (for example the water sport-pole, the gastronomic-pole, the saunter-pole, the beach-pole, the nature-pole,....). Moreover a major part of the hinterland will play a role in this coastal network.

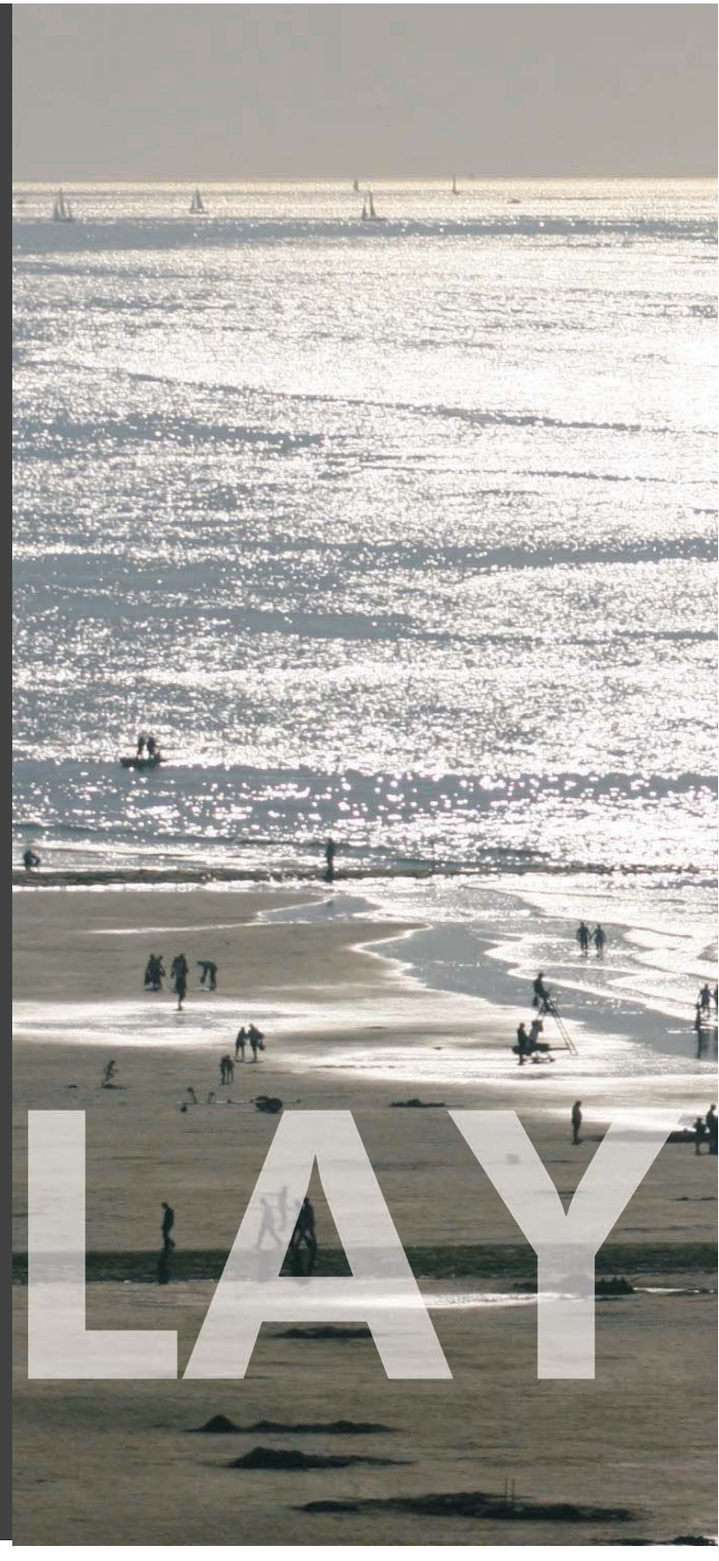

## The potential for marine induced land development within the Relaxed Sea scenario (4)

An extended and long term view of this scenario could eventually give way to the cultivation of marine organisms in closed production systems (fish, shellfish, salty vegetables, algae, sponges or corals) on land.

The attraction of new research centers, biopharmaceuticals and food and beverage industries willing to specialize in such marine organisms, will contribute to new developments of the coastal zone.


***Figure***
*A caricatured futuristic view in the Relaxed Sea scenario: the coastal zone will be used intensively by the coastal consumers for recreational and tourism purposes but also for marine induced land development like biopharmaceutical or food and beverage industries using land based aquaculture.*

# THE PLAY




FUL SEA

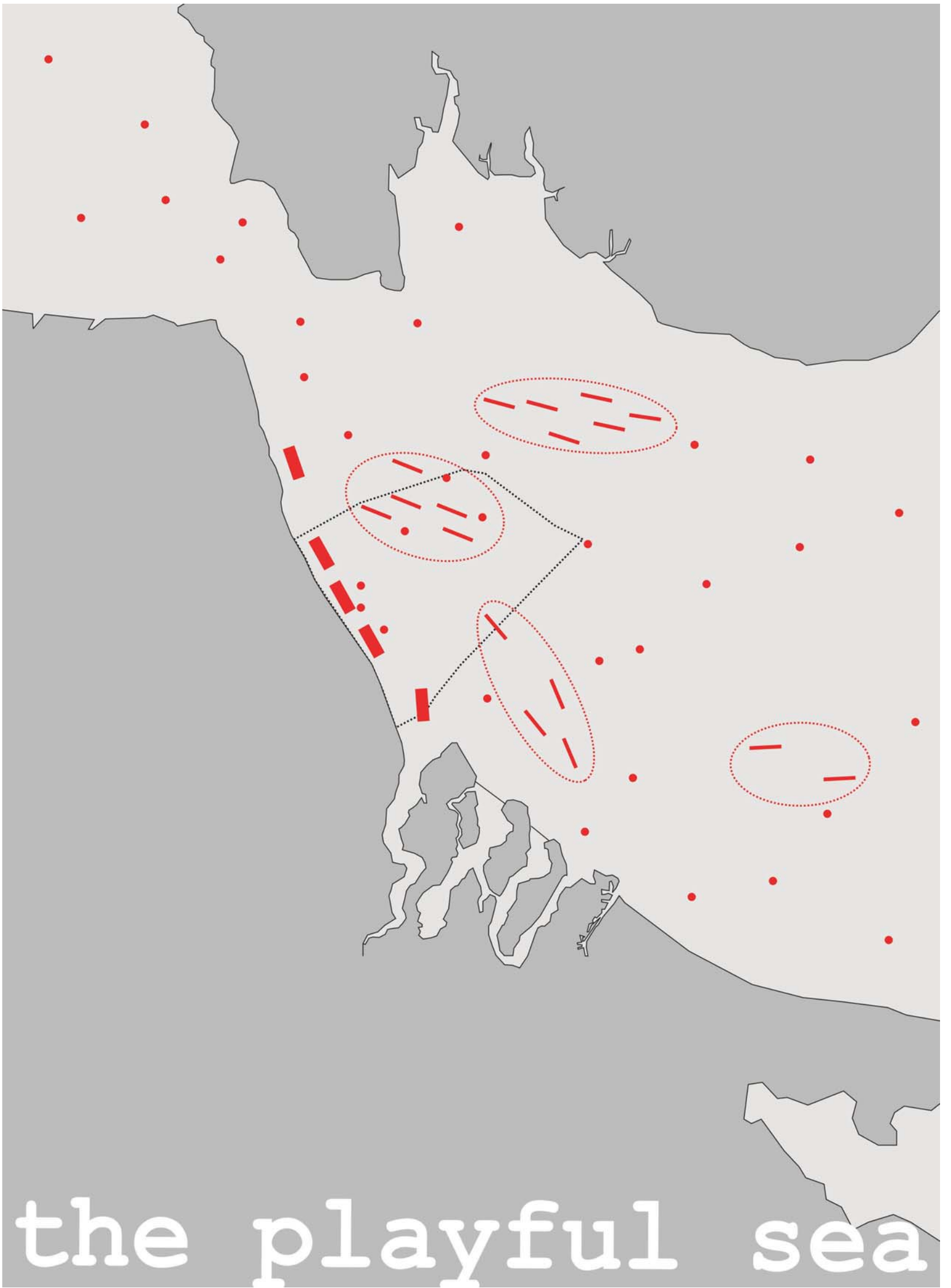
The North Sea provides many opportunities for different kinds of tourism and recreational activities. The Playful Sea places emphasis on exploring and exploiting the opportunities that are available to 'experience' the sea.

Current recreational development is mainly linked with the beach, as is discussed in the scenario for the Relaxed Sea. This scenario however, goes beyond the beach and attempts to zone the entire sea for recreational purposes.

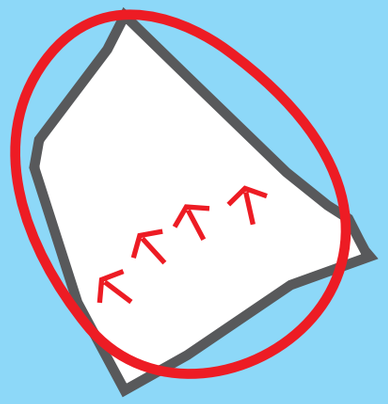
The BPNS turns into a space entirely devoted to recreational activities where recreationists can take advantage of a range of environments including the dynamic dune environment with sea inlets (known in Dutch as 'slufters') and marshes; coastal islands with opportunities for sport in the tidal zone and for wind recreation; valuable wrecks as nature hotspots for divers and historians; cruises and excursions at sea, etc.

Spatially the term 'seascaping' is central in this scenario: the sea therefore is seen as one big attractive landscape that can be given shape and can boost tourism or nature development. Thus, diversity of the marine landscape as well as the recreational response to that landscape is intensified.

Increasing the significance of the North Sea as a tourist attraction will of course lead to high levels of development along the coastal strip. This will need to be managed within the framework of landscape values.


the playful sea

# the playful sea

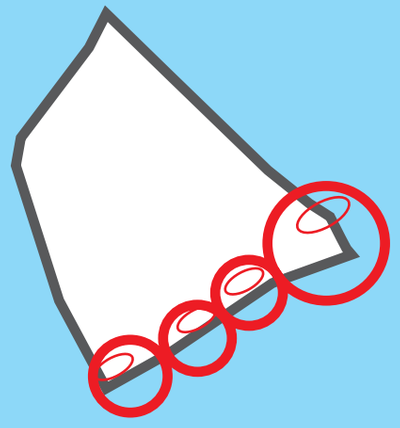


**the entire North Sea as a space for adventure and experience**

*The recreational potential of the sea is no longer restricted to the coastal strip alone. An extension of the recreational possibilities will see recreation activities spread and evolve into the deeper waters of the North Sea.*

**visualise the landscape of the sea**

*The sea is a dynamic environment. Its landscape diversity is much more varied than that of the fixed coastline and the open horizon. The development of new structures at sea may have the effect of revealing the hidden patterns of the underlying topography. For example, the construction of wind turbines may serve to denote the existence of sand banks. In this way an activity at sea is used for 'seascaping'.*



**coastal islands render a new and particular coastal profile**

*Extending the fixed coastline with a range of coastal islands (comparable with the Dutch Wadden Sea islands) would add to the tourism potential of the coastal strip. Different areas of the coast could be given a renewed identity by constructing a variety of different islands ranging from shallow sand banks to surfing reefs and holiday islands. The islands could also have a function in coastal defence.*

*Structure plan*

the entire North Sea
as a space for experience and adventure

most important connections
to the shipping lanes

subareas with a personal
profile

hard coastal defences

soft coastal defences
(scenic variations)

coastal resorts as development centers

coastal islands give rise to a new profile
for the coast

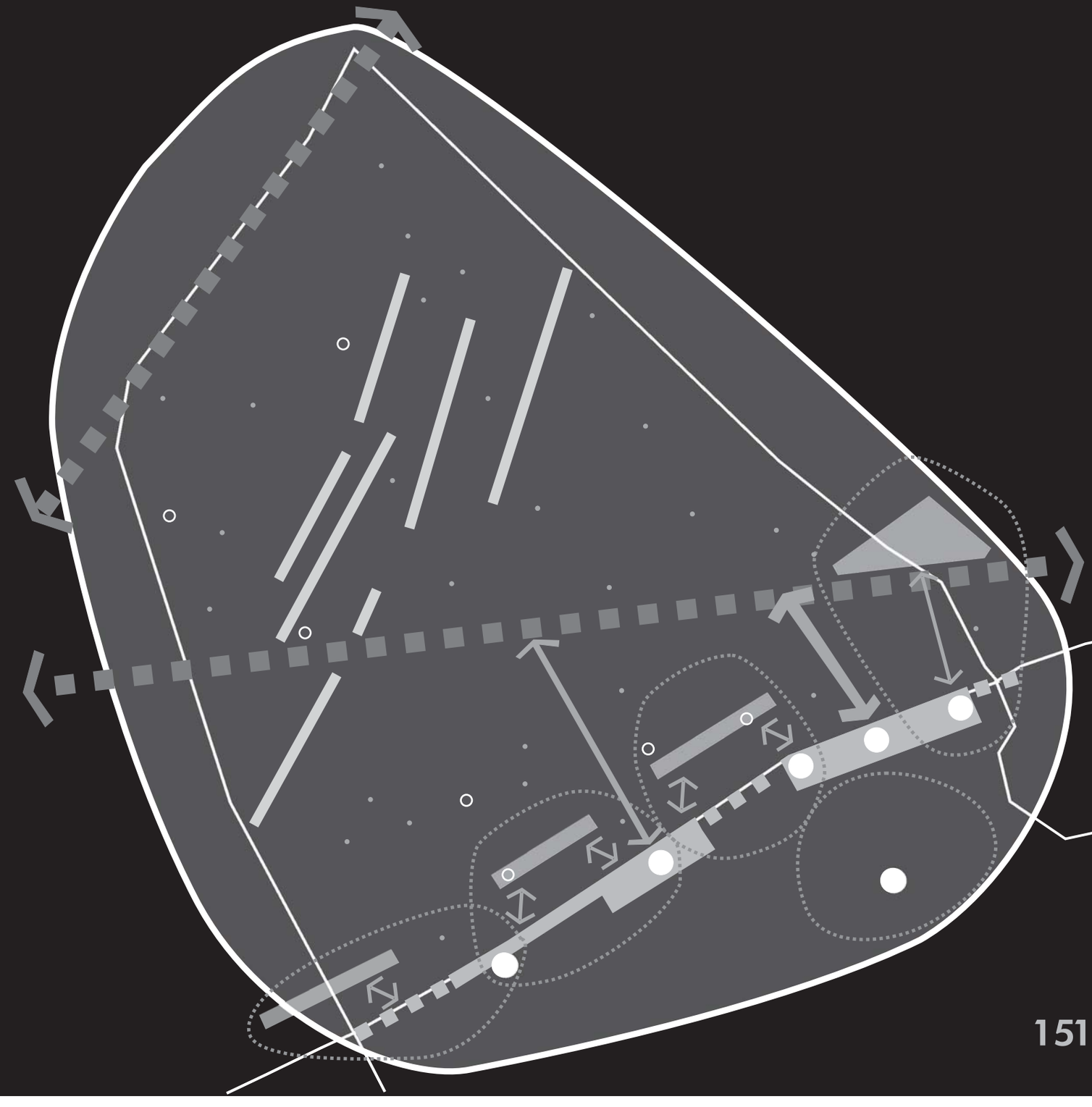
intense relations between coastal resorts
and coastal islands

windmill farms induce visibility of underlying
sand bank pattern

shipwrecks as hotspots for
nature, recreation and research

activities on sea
(density of the points represent intensity)

international shipping lanes

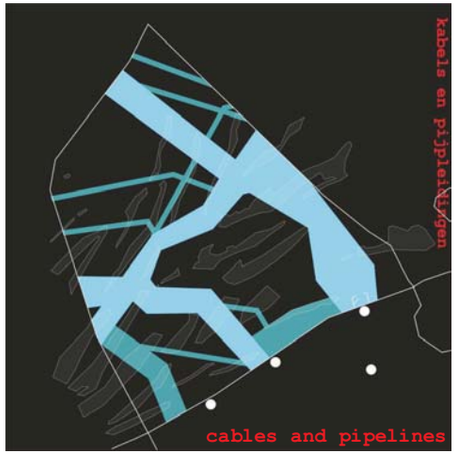


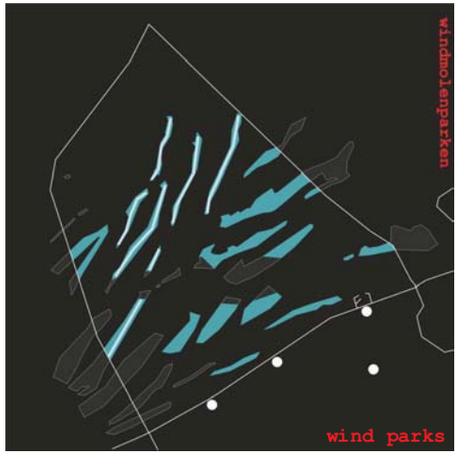

scheepvaart
shipping

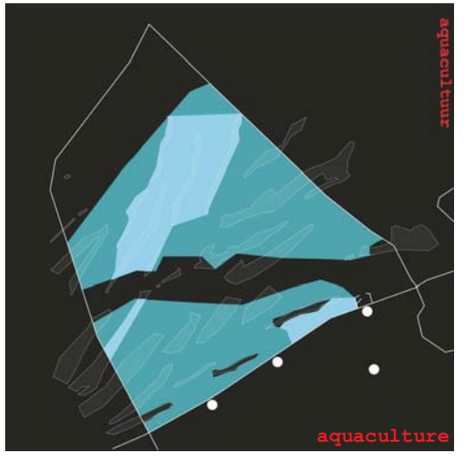

bagger- en stortactiviteiten
dredging and dumping of dredged material


zand- en grindontginning
sand and gravel extraction

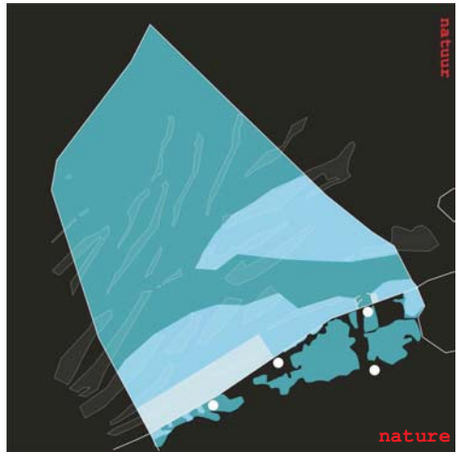

visserij
fishing


kabels en pijpleidingen
cables and pipelines


windmolenparken
wind parks


aquacultuur
aquaculture


militair gebruik
military use

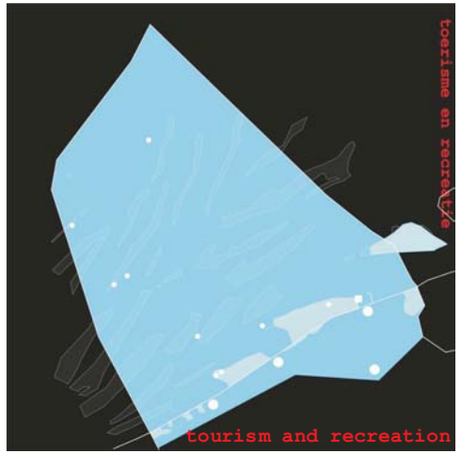



not suitable / not allowed / not applicable

suitable, but with restrictions / under conditions

suitable

very suitable / preferred location / specific action





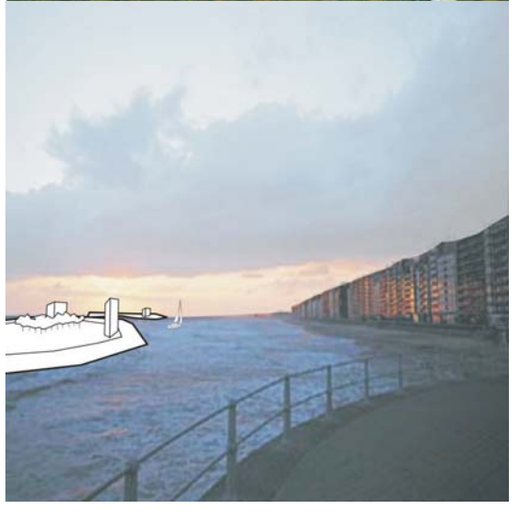
## Significance of the scenario for the different functions and activities on the BPNS

Nature plays an important role in the development of a beautiful coastal landscape both on land as on sea. There will not actually be any 'heavy' nature reserves delimitated by very strict and severe protective measurements: in this scenario nature protection is not a goal itself, the nature reserves are installed chiefly for their recreational and scenic value.

The construction of islands or very shallow sandbanks a few kilometers offshore contributes considerably, in addition to the fact that these constructions are an experience on themselves, to the coastal defence of the coastline. Hard coastal defence structures could than be removed locally and replaced by coastal defence structures that encourage the dynamic freedom of the sea.

In this scenario the whole sea will be able to provide possibilities for short excursions (i.e. to the windmill farms and their underlying sandbanks made visible by the method of their deployment), North Sea cruises, recreational fishing and archeological scuba diving in and around shipwrecks. This last example has a huge potential to become a tourist attraction on sea or, if during construction of these islands shipwrecks are removed from sea, these shipwrecks can then be part of maritime museums on land.

# the playful sea



## The potential for coastal islands within the Playful Sea scenario

Coastal islands render a particular coastal profile. Extending the fixed coastline with a range of coastal islands (comparable with the Dutch Wadden Sea islands) would add to the tourism potential of the coastal strip.

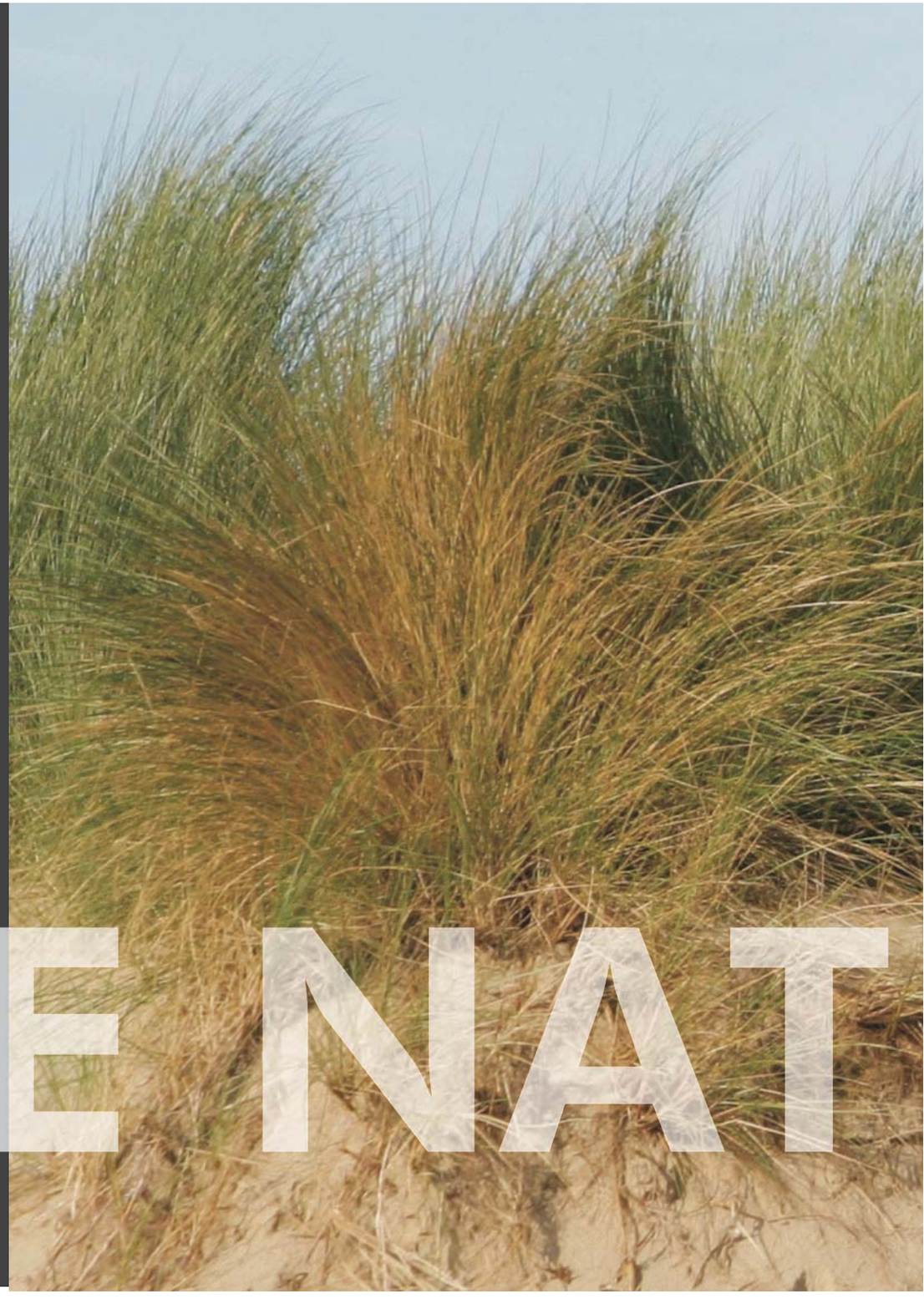
Due to their specific location, size or distance from the coastline each island would have a specific purpose and function. This way there can be a place dedicated to nature (education) and recreation for the West coast (in the valuable marine reserve), or a large wind and water sport dune in front of Knokke-Heist as an extension of the current water sport activity of this coastal resort. Yet another island can then be developed into a vacation island with accommodations such as caravan parks, camping grounds, and so on.

There will even be a place on these islands for a small number of windmill farms as long as they do not hinder the recreational activities.

Furthermore, the shallow areas between the island and the coastline provide new opportunities for aquaculture. The reduced dynamics and the shallow nature of these zones together with the proximity to the coastline give them large potential for becoming very important economic zones for aquaculture. Here again one should reduce possible conflicts with the recreational sector.

Last but not least, these islands could perform a role as coastal defence structures due to the fact that the largest force of the sea will be absorbed by the islands. This gives rise to a reduced need of coastal zone protection of the coastline. Hard coastal defence structures could then be removed locally and replaced by coastal defence structures that encourage the natural dynamics of the sea. Thus, giving rise to another coastal experience.

***Figure***
*A caricatured future vision of the Playful Sea scenario: the coastline gets a special profile through the construction of coastal islands. Due to their specific location, size or distance from the coastline each island would have a specific purpose and function.*
***Upper left:***
*Windmill farms can be used to reveal the underlying sandbank structure and can thus contribute to the seascape.*



# THE NAT


URAL SEA

This scenario envisages maintaining the North Sea as a natural reserve.

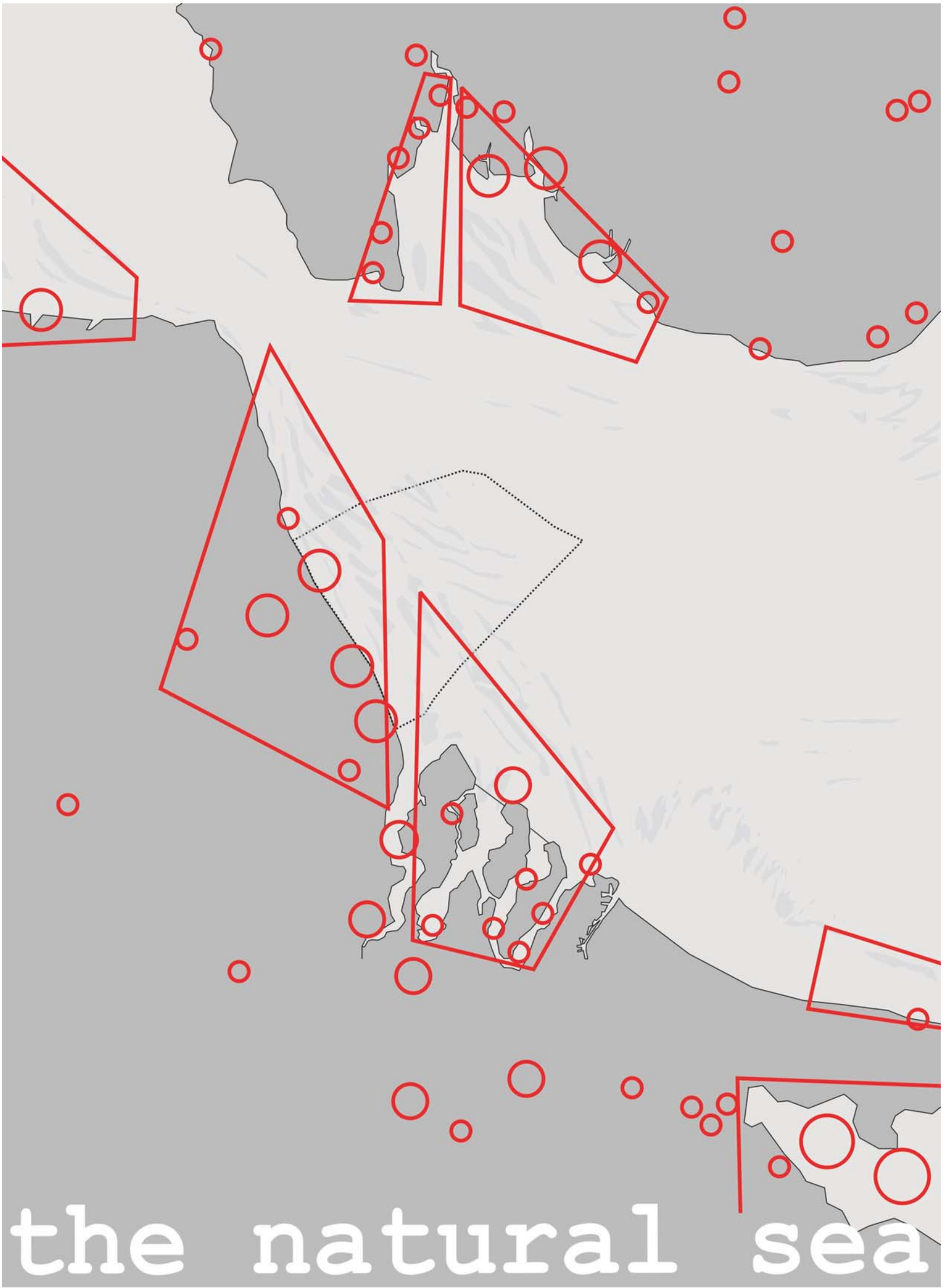
Clear cut differences can be observed between the natural environment on land and the natural environment at sea. These differences can be broadly defined under the following headings: the sea's dynamics and the open landscape. Both aspects are crucial in the Natural Sea scenario. The sea is a much more wild and rough environment than the natural environment on land. It is one of the only remaining natural landscapes that are intact in Western Europe today.

Preservation of the sea's natural dynamics could lead to the delimitation of large parts of the BPNS, where every form of use and consumption is banned or restricted and where natural values in their broadest sense are given priority. These become places of absolute wilderness.

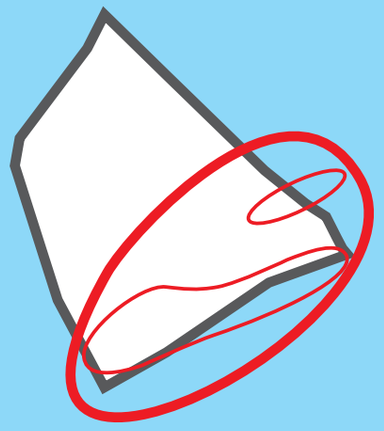
The vast open landscape and clear horizon are images that typify the natural landscape of the North Sea. In the Natural Sea scenario restrictions are imposed by leaving the horizon vacant.

In this scenario attention is also given to the unique natural environment on the border of land and sea. Here, the sea meets the land and vice versa.

At present this transitional environment is rigidly controlled to ensure that the land is protected from the dynamics and wilderness of the sea. Under this scenario, natural solutions would need to be devised to defend the land against the sea, in order to leave the sea as free as possible to follow its natural processes.


the natural sea

# the natural sea

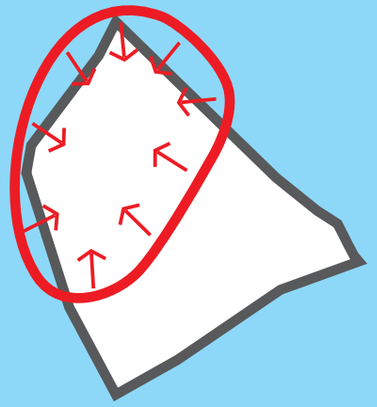


protection of the natural wealth of shallow coastal zone and coastal polders ( marine protected areas)

*In this scenario attention is focused on safeguarding and strengthening the natural resources of the North Sea. Protection of the most valuable areas is therefore essential. Limitations would be imposed in 'marine protected areas' (MPA's), on different types of uses. Some activities would be prohibited in these MPAs. It is generally accepted that the shallow coastal zone (western coastal banks and 'Vlakte van de Raan') would be suitable for such protection. The protected areas would be extended to land in order to protect beaches, dunes and coastal polders.*

moving activities to deeper sea areas

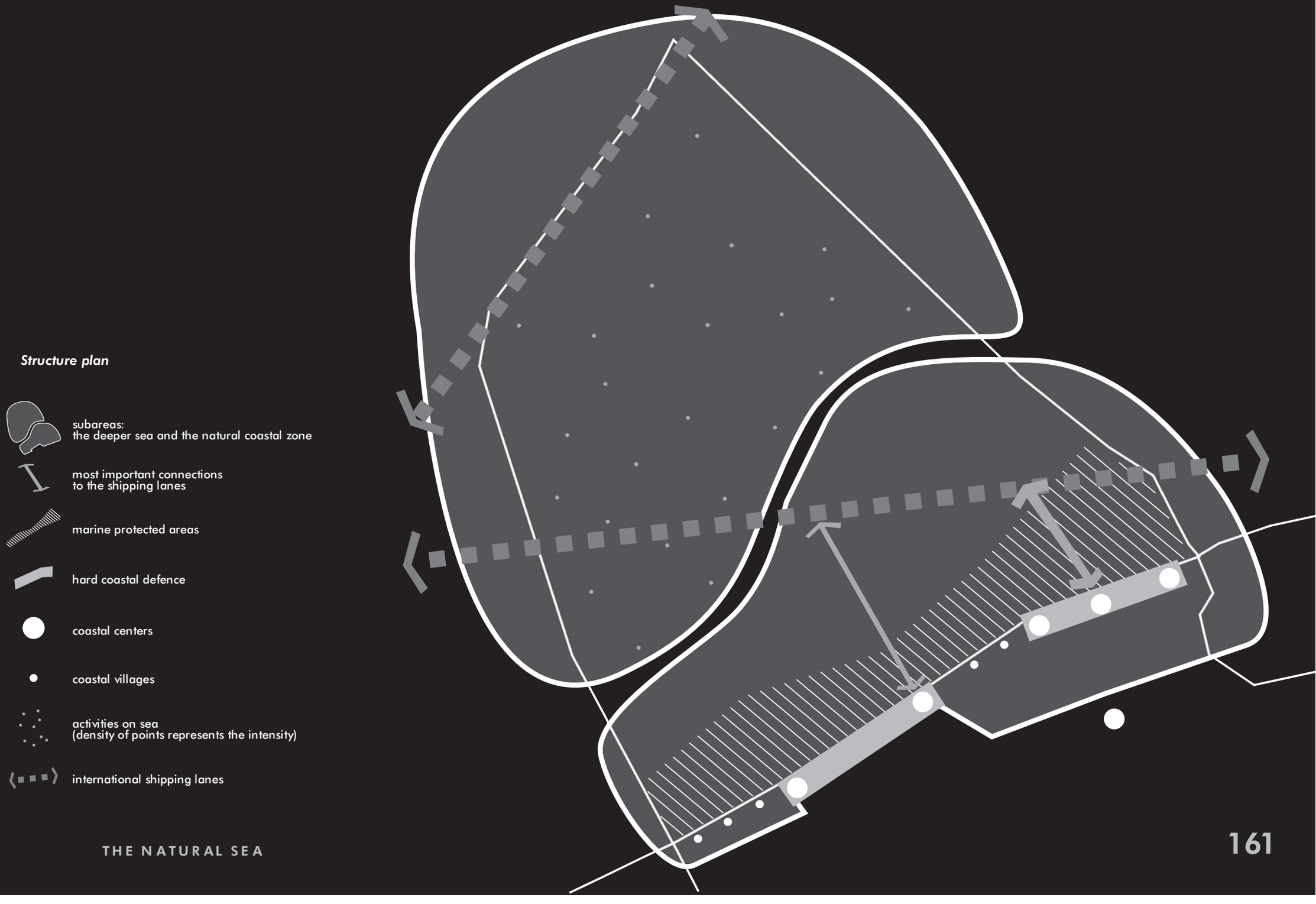
*Protecting the shallow coastal zone implies that activities that were prohibited from taking place in these zones need to be relocated to other areas where they cause less nuisance to the ecosystem. This would lead to many activities being moved to deeper sea areas.*



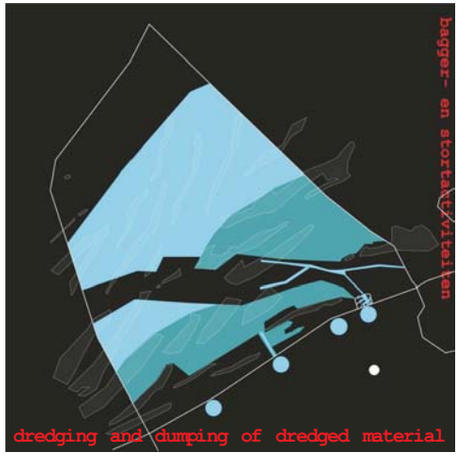
reducing ( the intensity of) activities that are harmful to nature
banning activities whose impact on nature is too large

*In some cases, relocating activities will not be sufficient to protect the natural value of the North Sea. Some activities will have to be reduced or transformed (e.g. transformation of the trawling fishery into more ecologically sound alternatives), and other functions will have to be banned completely because their impact on the ecosystem in the BPNS is too large (e.g. wind turbine parks, as fixed installations that form an atypical rock-like habitat in the BPNS).*

*Structure plan*

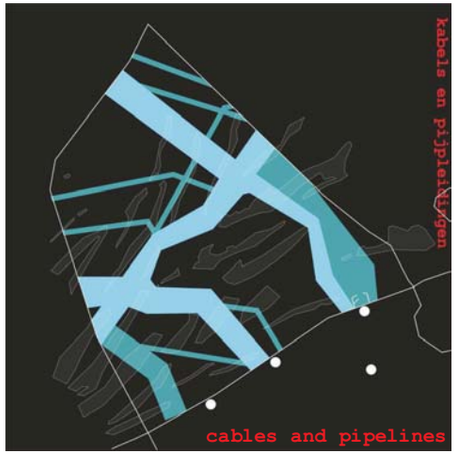


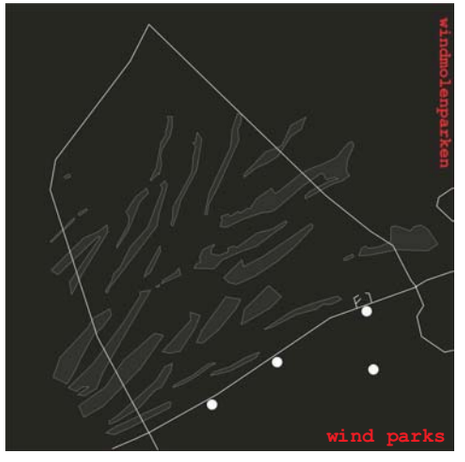

scheepvaart
shipping


bagger- en stortactiviteiten
dredging and dumping of dredged material


zand- en grindontginning
sand and gravel extraction


visserij
fishing


kabels en pijpleidingen
cables and pipelines


windmolenparken
wind parks


aquacultuur
aquaculture


militair gebruik
military use


not suitable / not allowed / not applicable

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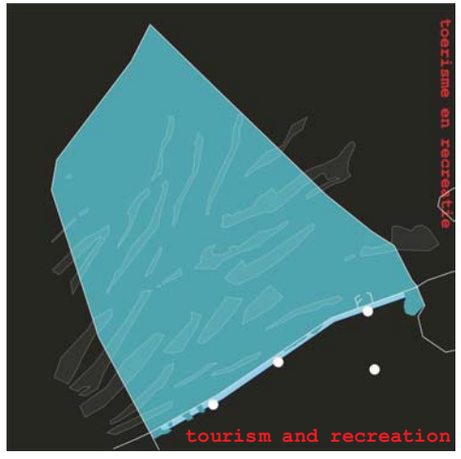
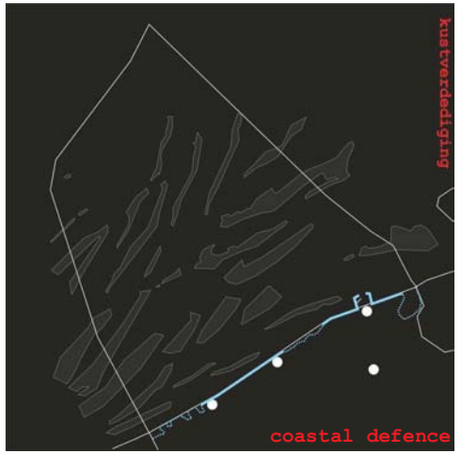



## Significance of the scenario for the different functions and activities on the BPNS

Nature conservation is of major importance in this scenario of the Natural Sea. Opposed to the Playful Sea, the Natural Sea does incorporate hard marine protected areas with severe protective measures. These areas are mostly located in the coastal zone (land and sea based), however, in the deeper parts of the sea some less rigid protective measures will be taken.

In the marine protected areas with high levels of protection, almost no other activity will be allowed. These activities will preferably take place elsewhere.

Sea based windmill farms will not be allowed in this scenario. Although the gain of wind energy from these windmills can be seen as environmentally friendly, their nature as an atypical rocky substrate in the BPNS is definitely not environmentally friendly. This introduction of an alien infrastructure can be seen as opposed to the vision of the conservation and protection of the natural personality of the BPNS put forth by this scenario.

Only in the places, where for security reasons the hard coastal defences are needed, will they be kept. In less disturbed areas, the hard coastal defences will be replaced by defences that allow the natural transition between land and sea to be maintained.

## The potential for marine protected areas within the Natural Sea scenario

Attention in this scenario is focused on safeguarding and strengthening the natural resources of the North Sea. Protection of the most valuable areas is also essential to ensure that natural resources are safeguarded and strengthened for future generations.

In the marine protected areas, restrictions will be enforced upon activities with a large impact on the natural ecosystem. The nature of these restrictions (flexible measures like rotation systems, demands for alternative techniques or a complete prohibition of activities that are too damaging) depends on the location within the BPNS (is it a very important area or not?) and of the area of impact from the activity.


***Figure***
*A caricatured future vision of the Natural Sea scenario: the North Sea and coastal zone recover to their natural character (for example creation of additional tidal gullies see figure on left) and the conservation and strengthening of the natural fauna and flora and ecosystems in the sea and in the coastal zone will get priority above economic development possibilities of the BPNS.*

# THE MO


BILE SEA

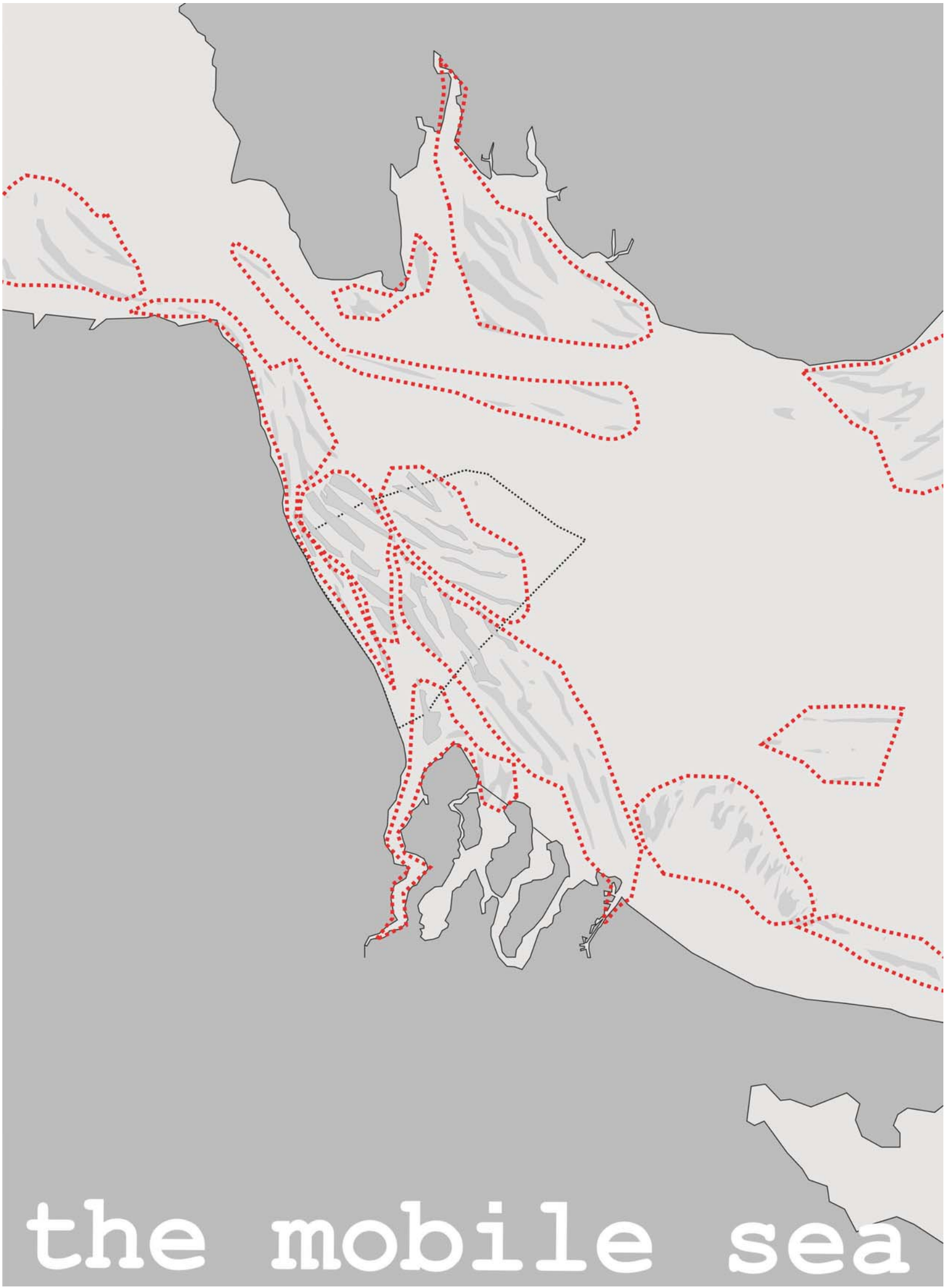
In this scenario the use of the BPNS starts from the combined action of economic and ecological processes and the connected dynamics of the North Sea.

'Dynamics' means the constantly changing intensity, quantity and movement of natural elements including (amongst other things) the movement of sand and sediments, the transition between fresh and saltwater, water currents, wind directions, the spread of nutrients and biodiversity of the North Sea.

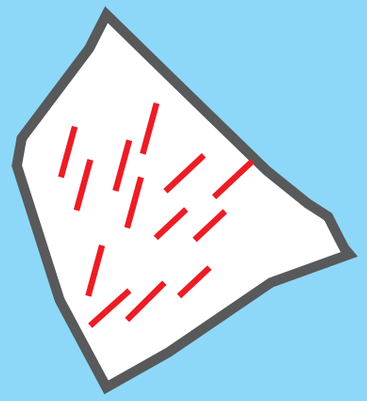
Dynamics also refers to temporal factors including: the periodicity of low and high tide, changes from day to night and the passage of the seasons.

Contrary to the Natural Sea scenario, the use and consumption of natural resources is possible under this scenario, provided that such use and consumption is controlled.

In this manner the North Sea is treated as a storage room of resources where economy and ecology go hand in hand. Every use and exploitation is flexible or mobile, based on the natural dynamics of the sea. The emphasis in this scenario is on mobile structures that can follow the sea's dynamics. Immobile structures are therefore limited and in some cases even prohibited.

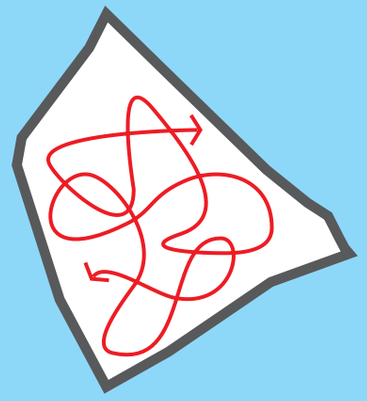

the mobile sea

# the mobile sea



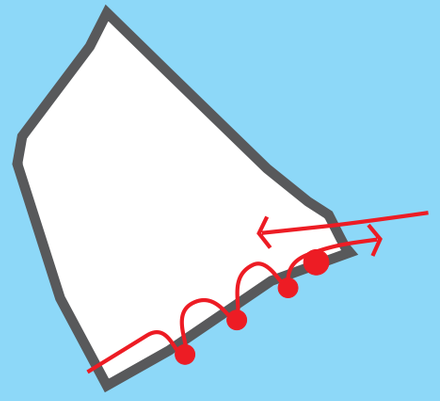
concentrate alternating activities on sandbanks ( quick regeneration)

*In this scenario, activities are preferably located on sandbanks. This is because sandbanks provide a highly dynamic system that is capable of quickly regenerating following intervention. As many suitable sandbanks need to be found as possible to ensure a sustainable rotation system. Working with rotation systems prevents one specific location from becoming exhausted (which was the case with sand and gravel extraction at the Kwinte Bank) and causing long-term adverse effects on the ecosystem. Furthermore the environment is protected during vulnerable periods, because using rotation systems implies a regular change of extraction zone depending on a cycle (winter, summer, day, night, etc).*



mobile energy platforms

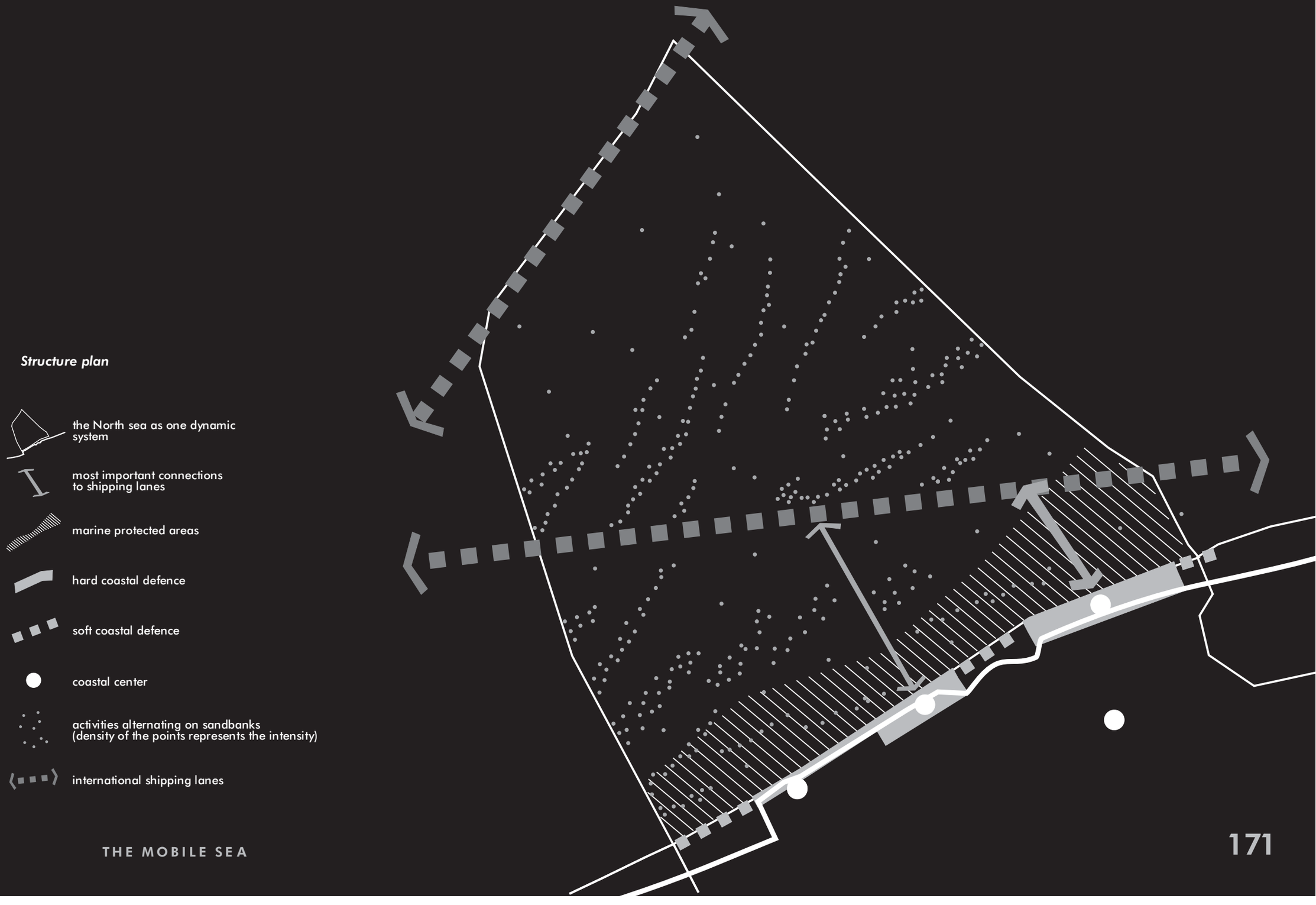
*The emphasis in this scenario is put (as much as possible) on mobile activities that can follow the sea's dynamics. For immobile structures, such as wind turbine parks, mobile alternatives will need to be sought.*



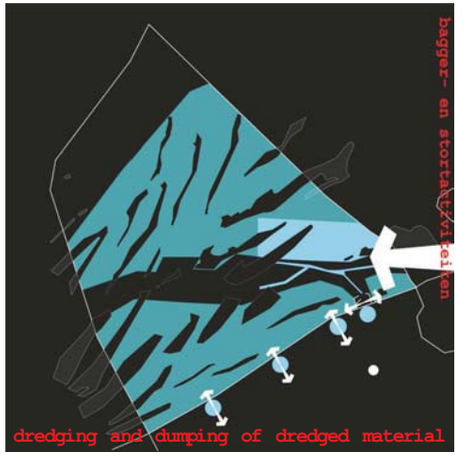
coastal currents can provide natural dredging of harbours and shipping lanes

*It is necessary that as many natural alternatives as possible are sought as alternatives to present activities. For instance, the force of the sea could be used and controlled to undertake natural dredging in some locations. Lessons can be learned from port construction. In Ostend the 'Spuikom' was built to enable natural dredging of the port. However, this never succeeded because the 'curve current' of the Spuikom was constructed using incorrect dimensions. In addition, breaks in the groynes of the port of Zeebrugge would contribute to a natural dredging of the port channel.*

*Structure plan*




scheepvaart
shipping


bagger- en stortactiviteiten
dredging and dumping of dredged material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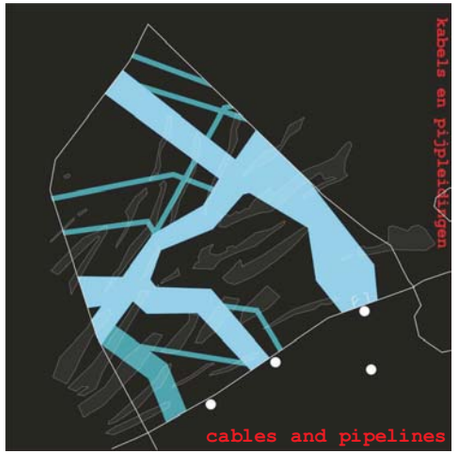
kabels en pijpleidingen
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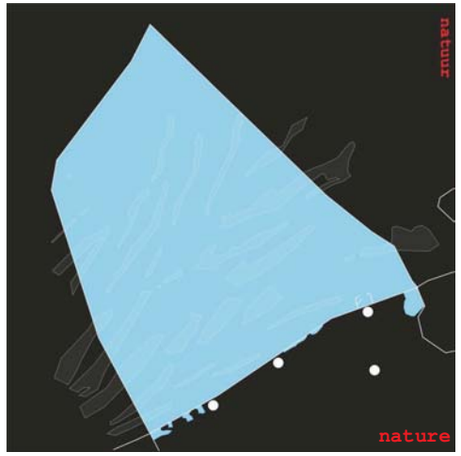
windmolenparken
wind parks


aquacultuur
aquaculture


militair gebruik
military use

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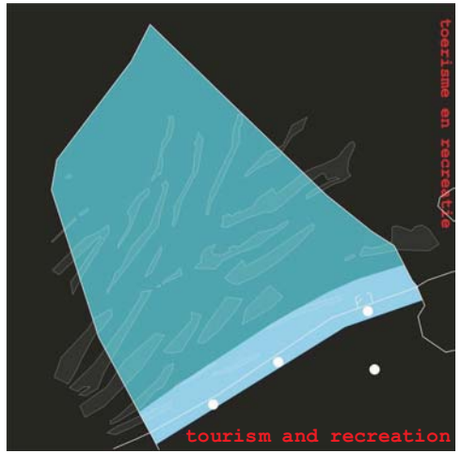
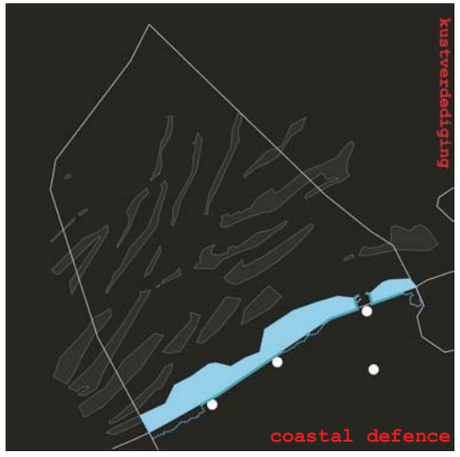


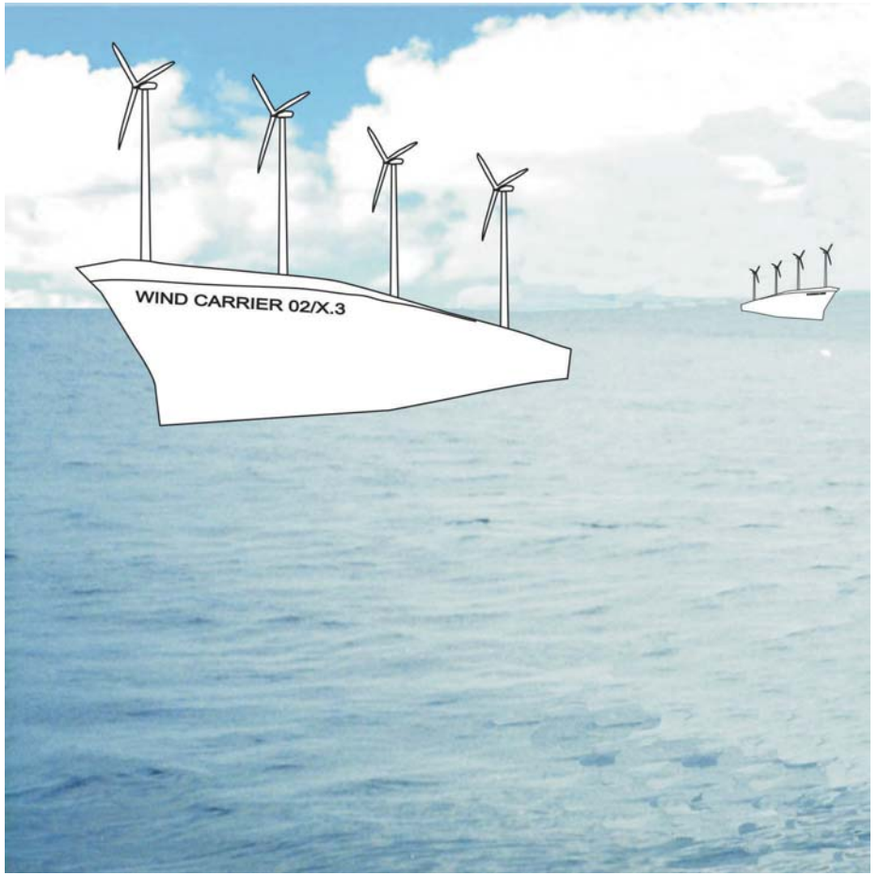

## Significance of the scenario for the different functions and activities on the BPNS

In the scenario of the Mobile Sea economy and ecology go hand in hand. The nature conservation measures go less far as in the Natural Sea scenario, but are capable of guaranteeing the survival of the natural resources bearing in mind the extraction possibilities.

Windmill farms are allowed in this scenario but nevertheless exert, as a persistent structure, an impact on the natural dynamic systems in the North Sea. Bearing this in mind this scenario prefers alternative mobile constructions for the generation of energy (energy from water force, floating platforms for storage of energy,….).

As well, there is a search in this scenario for alternative dredging techniques. Also for the harbor gullies and shipping lanes one can use the natural dynamics of the currents as a dredging technique. Here it is of importance to guide the water wisely by correctly calculating the dimensions of breakwaters, groynes and 'spuikommen'. The natural dredging phenomena can also contribute to the coastal defence.

Sand and gravel extraction and fisheries will take place on the sandbanks in the scenario of the Mobile Sea. A rotational system would prevent exhaustion of the resources.

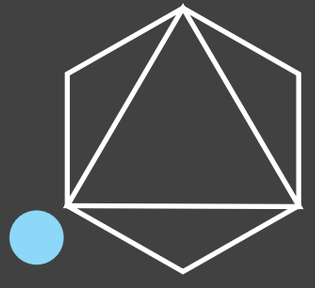



## The potential for rotation systems for sustainable management of the natural resources of the sea within the scenario of the Mobile Sea

In this scenario, one needs to look for as many rotation systems as possible. The use of such a rotational system prevents the exhaustion of a certain area and thus prevents the development of persistent ecosystem damage. Furthermore this system provides the possible closure of certain areas during fragile periods.

Rotation systems are already being used in the BPNS for sand and gravel extraction, but this could be expanded to other activities in the North Sea, like fishery, military use, tourism and recreation.


***Figures***
*A caricatured futuristic view in the Mobile Sea scenario.*
***Figure on the right***
*Rotation systems regulate exploitation of the BPNS. Fisheries and sand and gravel extraction follow the dynamics of the North Sea and the exploitation primarily takes place on the upper region of the sandbanks (where recovery is quickest after perturbation).*
***Figure left***
*For the generation of energy this scenario mostly sought alternative mobile construction.*





THE

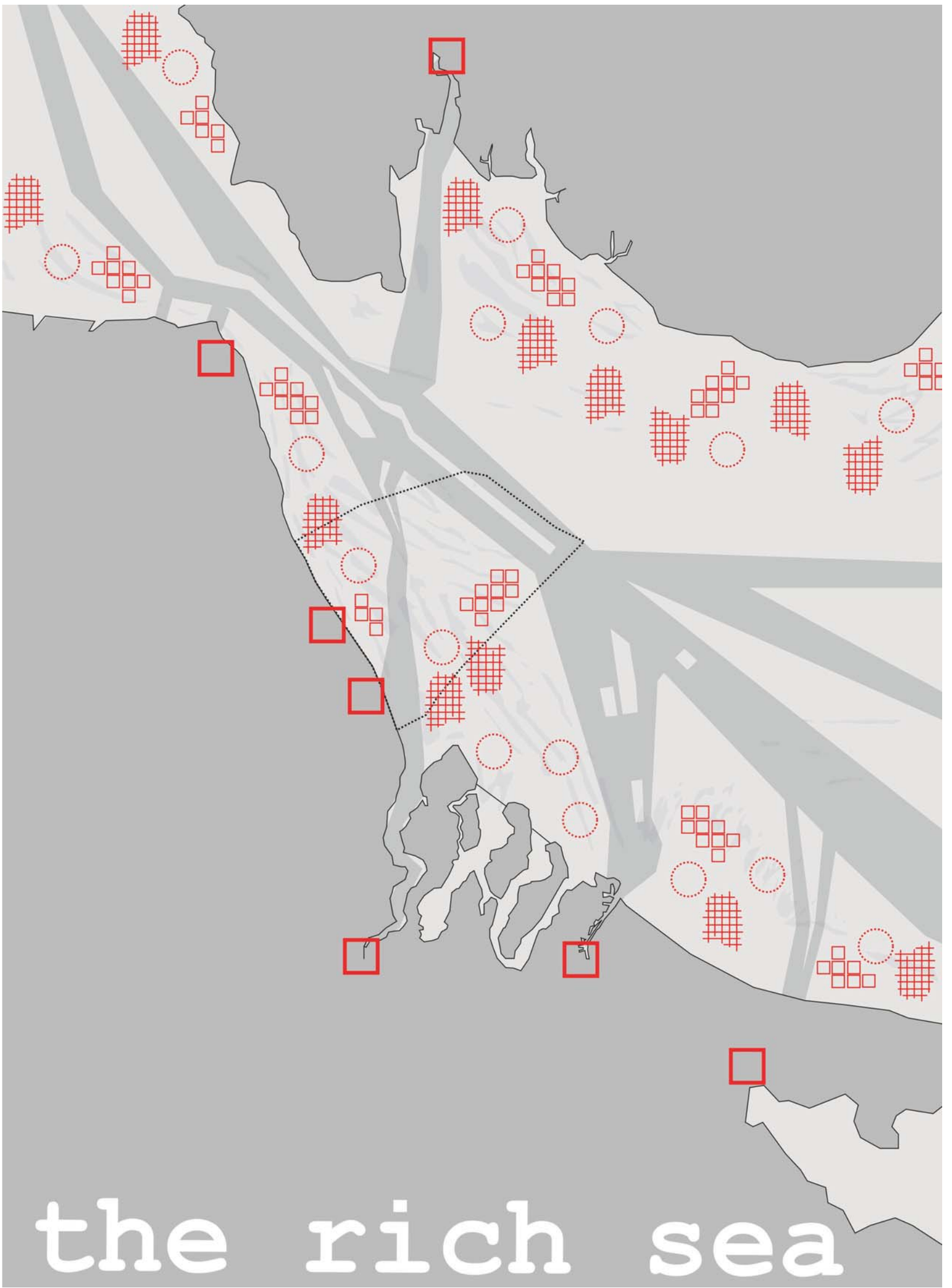

RICH SEA

The North Sea is rich in natural resources, living and non-living.

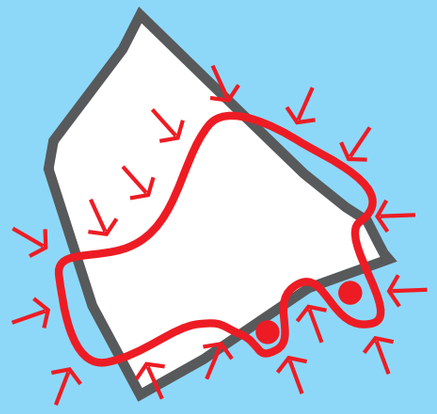
In the Rich Sea scenario economic development is the most important objective, and the sea is considered as a production space where many more resources can be exploited than at present.

Accordingly, the maximisation of exploitation is the priority in this scenario. The different uses of the sea's wealth should be geared to complement one another in order to maximise the return on exploitation. If necessary, conflicting uses that do not contribute to the economic exploitation of the BPNS must yield in favour of exploitation, or even disappear.

In the Rich Sea scenario, many criteria must be considered in order to spatially plan for different activities. Firstly, the suitability of the local marine environment needs to be considered. Secondly, new methods and structures must be applied to optimise exploitation. Economic criteria are decisive, and include such things as the distance to the ports, the exploitation techniques and the intensity of the exploitation.

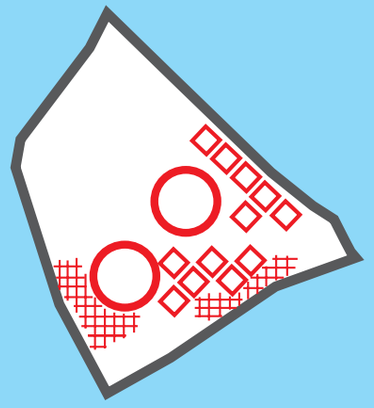

the rich sea

# the rich sea



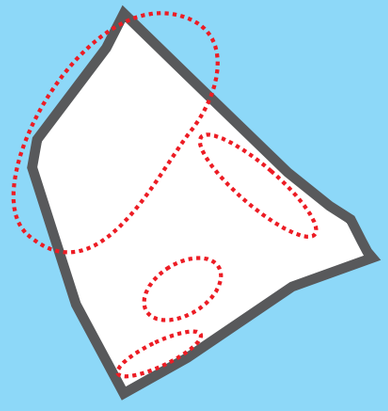
concentration of economic activities in a core zone

*In this scenario it is very important to use the economic potential of the North Sea as efficiently as possible. Each different economic activity must take place in the best location, considering the distance to the ports and the physical qualities of the location. Since we can assume that activities of exploitation will increase, a rather large area is reserved for these economic activities. Economic criteria (distance to the coast, substrate, intensity of activities) favour locations in the southern and central parts of the BPNS.*



concessions in the economically most suitable locations

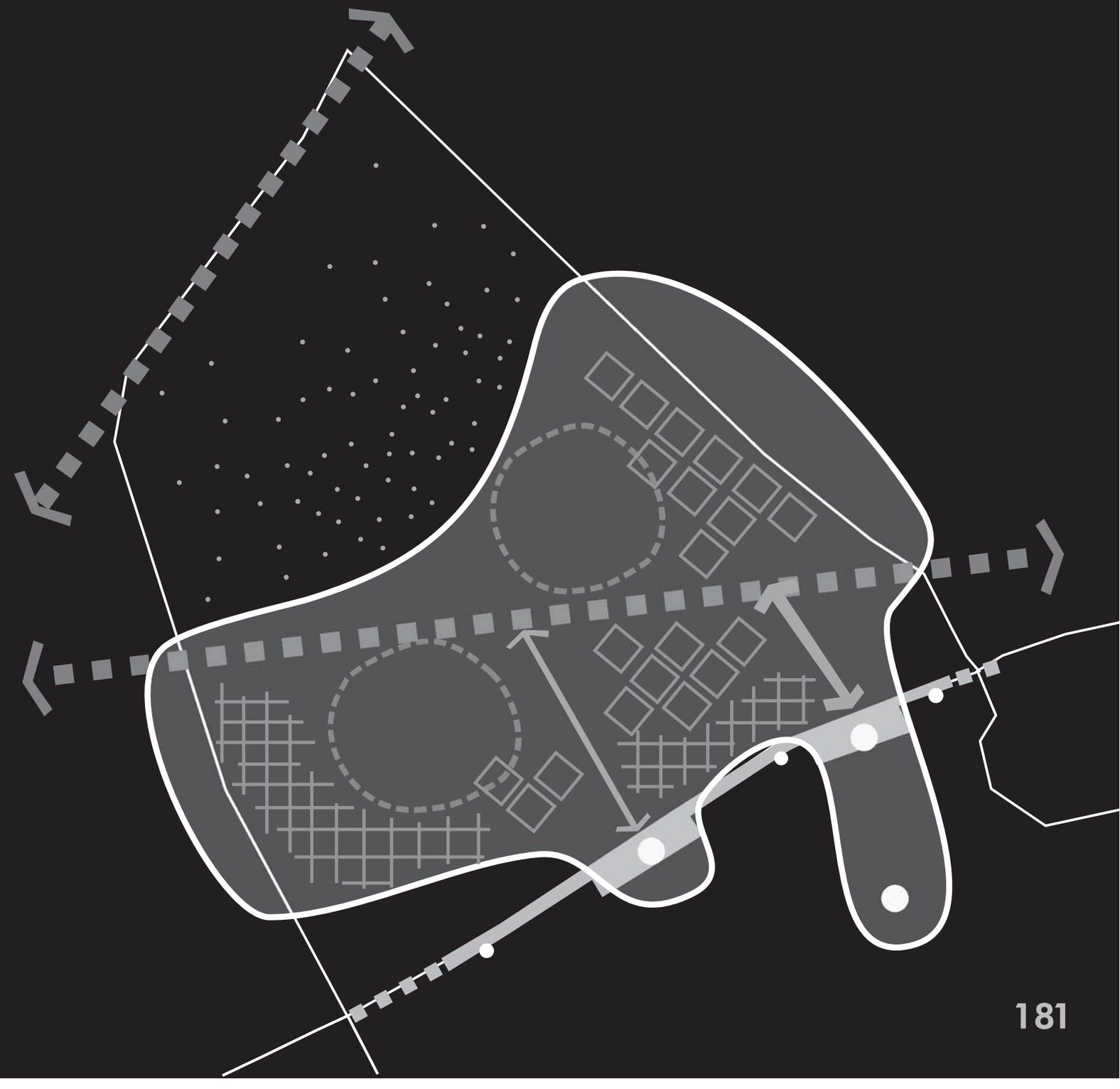
*The most important economic activities in this scenario (fishing, sand and gravel extraction and wind turbine parks) are geared towards one another as well as possible. The aim is that they will be allocated to a specific location in which the physical conditions, combined with the distance to the coast, are optimal. To avoid mutual conflicts, a system of (temporal and spatial) concessions will be used.*

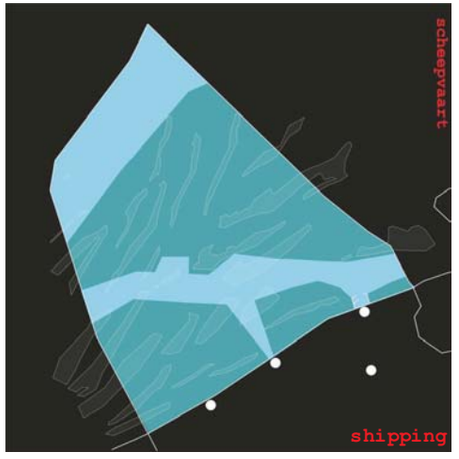


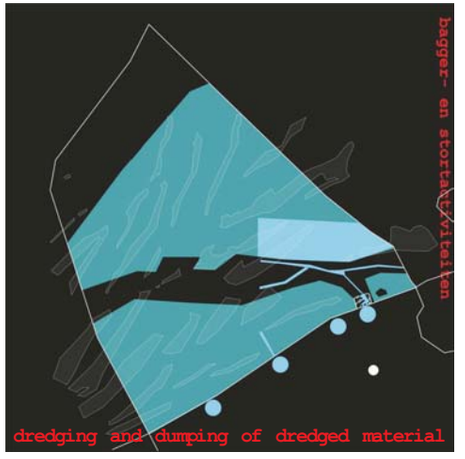
natural and 'sheltered' zones (wind parks, deep sea) act as storage rooms (extra possibilities for fishing and aquaculture)

*'Natural' zones (zones with few or no activities) and wind turbine parks have additional uses as storage rooms for fishing and aquaculture. Aquaculture can easily be combined with wind turbine parks, and wind turbine parks and natural areas can serve as shelter for fish (fishing and other 'interfering' activities are not possible in and around nature zones and wind turbine parks). In this way the use of these areas is maximised by rendering extra advantages to fisheries.*

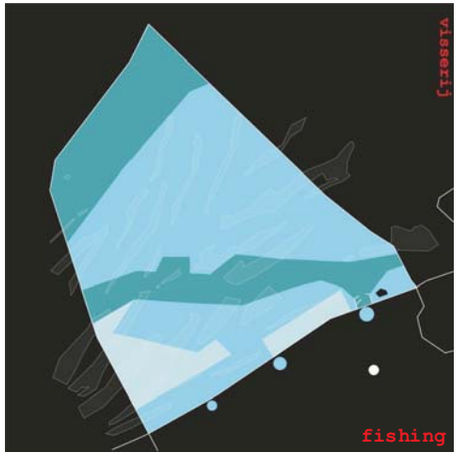
*Structure plan*

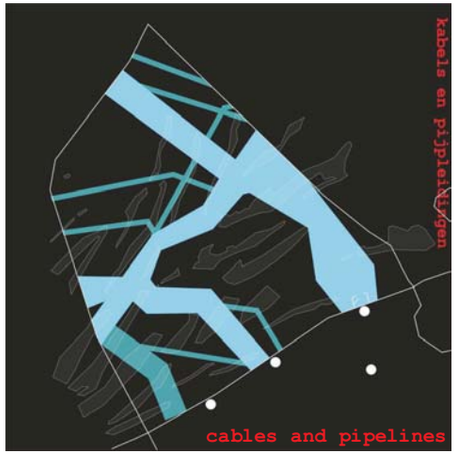




scheepvaart
shipping


bagger- en stortactiviteiten
dredging and dumping of dredged material


zand- en grindontginning
sand and gravel extraction

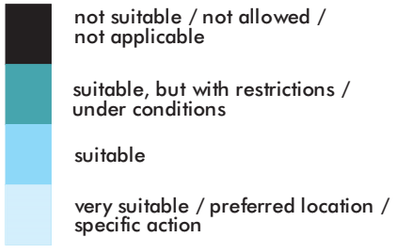

visserij
fishing

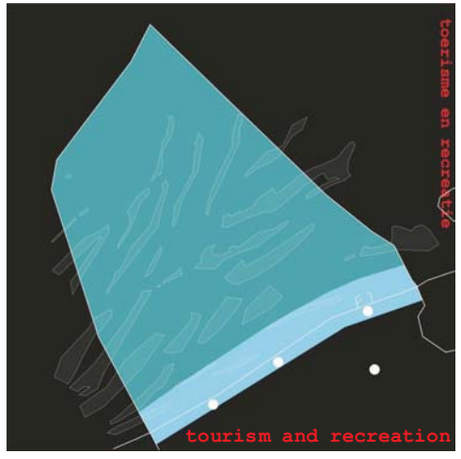

kabels en pijpleidingen
cables and pipelines

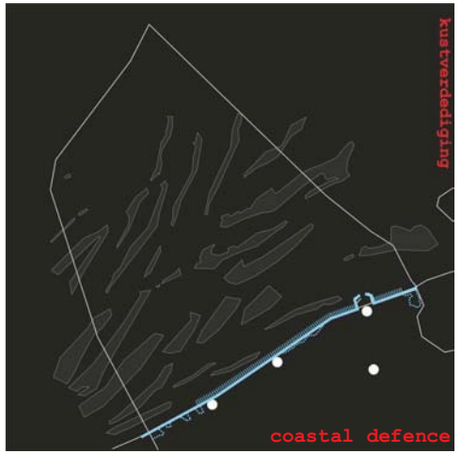

windmolenparken
wind parks


aquacultuur
aquaculture


militair gebruik
military use


## Significance of the scenario for the different functions and activities on the BPNS

The economic extraction activities, especially, (fisheries, windmill farms and sand and gravel extraction) are being stimulated in this scenario and other activities like nature conservation, military activities or recreational activities are subordinate to this economic exploitation and could get restrictions imposed upon them.

The intensively used fishing concessions, windmill farms or sand and gravel extractions are then also exclusively reserved for the extraction of the economic potential of the BPNS. Few restrictions will be imposed upon these activities: in these concessions there will be no quotas imposed or any time related restrictions (like rotational systems seen in the Mobile Sea scenario.)

The harbors of Zeebrugge and Ostend will receive, as important economic poles, the greatest attention during the further expansion and reinforcement of the existing coastal defenses. In economically less important areas (Westhoek, Zwin,) a combination of soft and hard coastal defences should be feasible.


## The potential for concession zones for fishing within the Rich Sea scenario

An extended and long term view of this scenario could eventually give way to the idea of concession zones for beam trawler fisheries (4).

These 'fishing fields' are believed to provide self-organising ecosystems in which an optimal turnover would lead to a maximum harvest. This confirms nothing more than an ongoing pattern in the current fisheries. Surveys indicate that fishermen tend to return to the same favourite fishing spots instead of using the entire sea.

Eventually these fields could be managed by the concession holders without having to deal with strict European rules and quota. It would be up to them to decide what fishing intensity would be most sustainable for the catch in that area in the long run.

In this way, the fishermen get more responsibilities in their own concession. They will be in fact the 'managers' and 'stewards' of their concession being responsable not to overexploit the resources within.

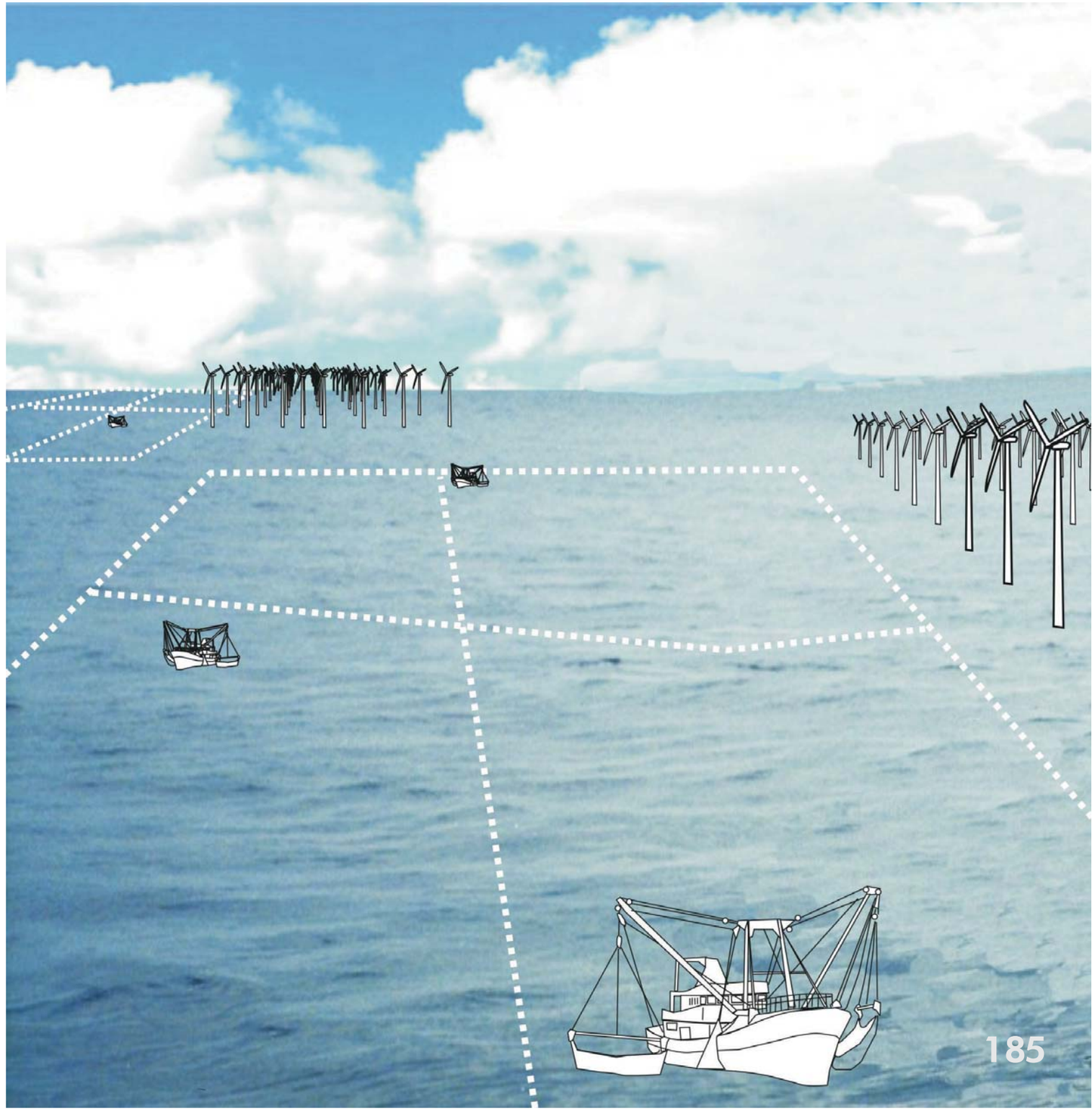


***Figure***
*A caricatured futuristic view in the Rich Sea scenario: windmill farms, fisheries and sand and gravel extraction take place in exclusive concession zones, where concessionaires bear a huge responsibility over their 'stretch of sea'. Windmill farms are in this scenario huge parks with distribution of windmills optimizing the economic rentability.*


# THE SAI

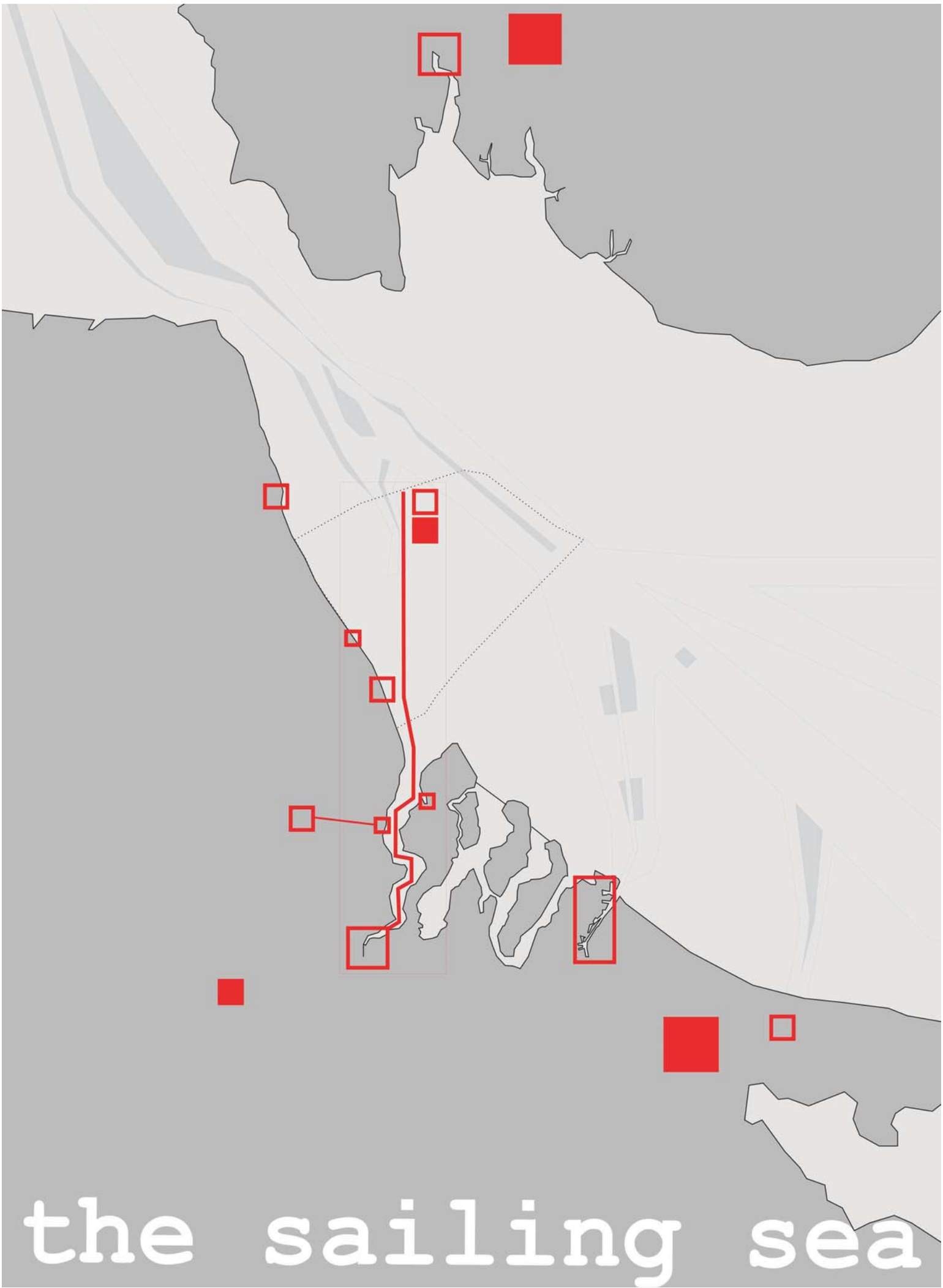

GOLDEN ENERGY
LING SEA

In the Sailing Sea scenario the North Sea becomes a place of both social and economic importance. The BPNS is seen as more than just an area for exploitation, from which as many resources as possible should be extracted. It is also a place where social needs should be addressed.

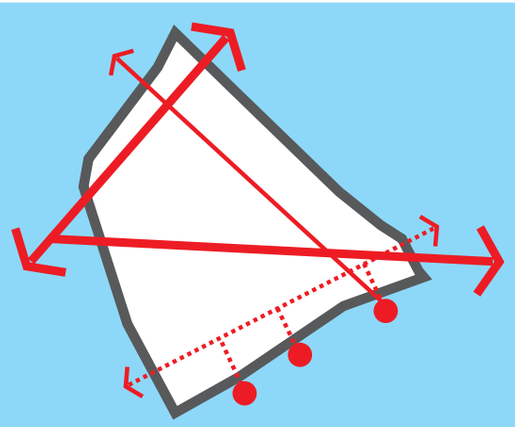
In this scenario a lot of attention is given to immobile structures that have a social value, such as communication infrastructure, hard coastal defence, wind turbine parks that deliver sustainable energy and even (in the long run) the development of port activities at sea. A project such as the airport island near the Dutch coast (as extension or substitution for the Schiphol Airport) is a good example.

Unlike the Relaxed Sea scenario the focus in this scenario lies on the deeper sea, as opposed to the coastal area.

The BPNS is a place of transit in this scenario. Attention is given to new means of transport. On the one hand, this means larger ships on the international shipping lanes, maybe in combination with port activities at sea. On the other hand, more flexible and small-scale coastal navigation between the different coastal ports (short sea shipping in a hub system) could be developed.

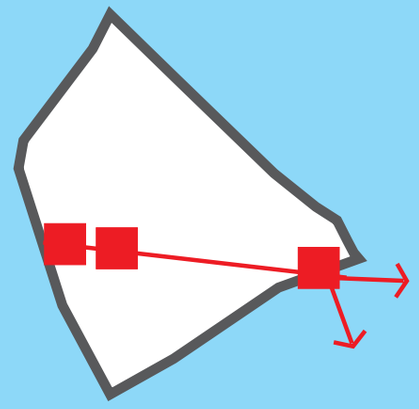

the sailing sea

# the sailing sea



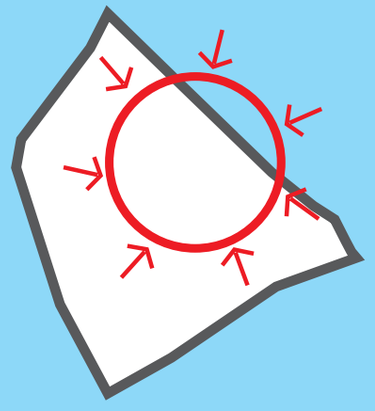
development of a differentiated transport network
(short sea shipping - traffic separation scheme for economic traffic - ferry lines)

*Mobility issues are very important in an area that belongs to one of the busiest sea routes of the world. To increase the efficiency a strongly differentiated transport network should be developed. This network will consist of mobility nodes and transfer points, short sea shipping, tourist routes, economic routes, etc.*



development of a combined airport and port island connected to the port of Zeebrugge to provide relief to Ostend, Zaventem, . . .

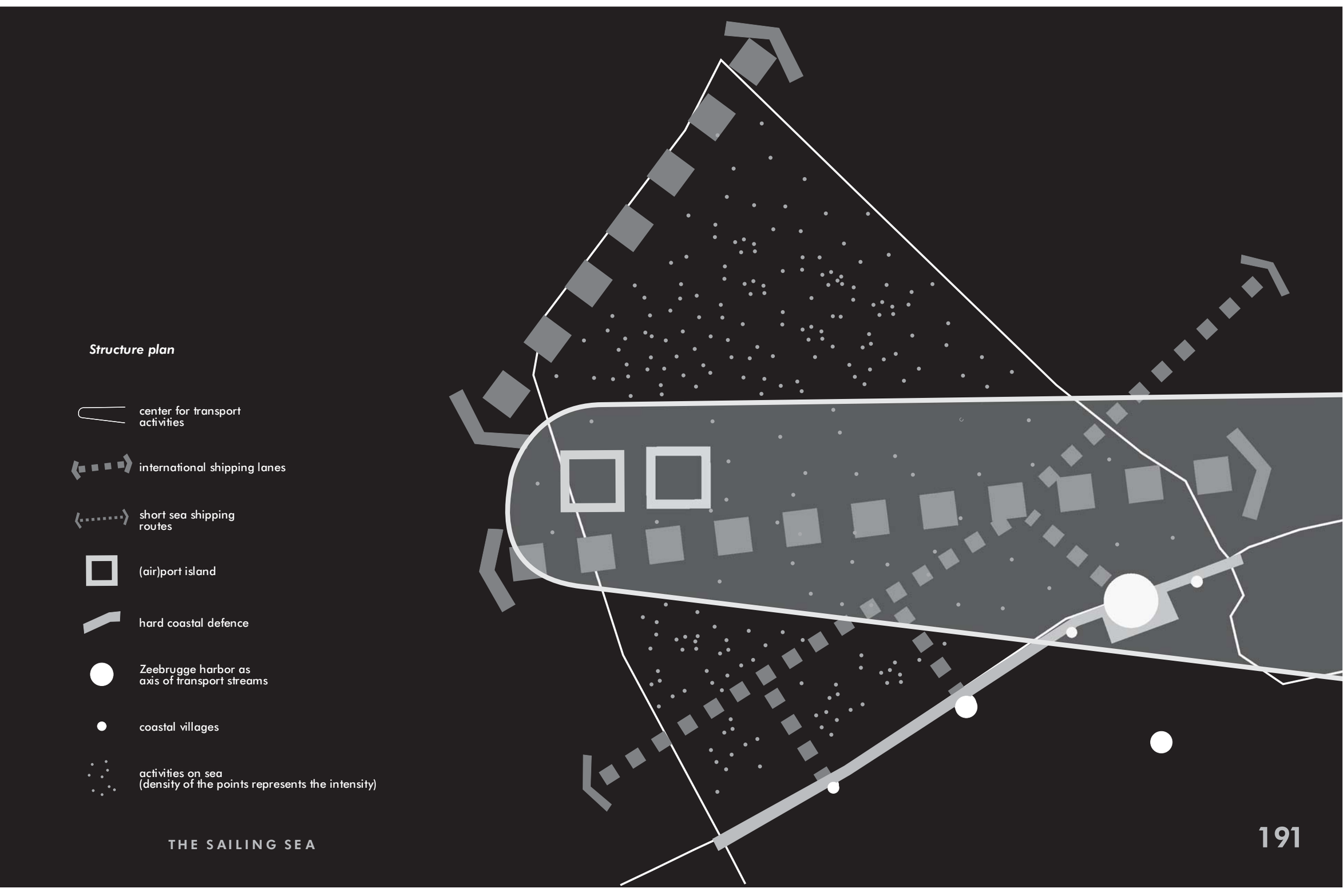
*It is possible to develop a combined airport and port island at the 'exit' of the international shipping lane to the ports of Zeebrugge, Gent and Antwerp. This island could provide relief to the current ports on land and would also save a lot of time for large cargo vessels. In addition, the island could also serve other ports in the whole southern part of the North Sea (including the port of London, Rotterdam ... etc).*

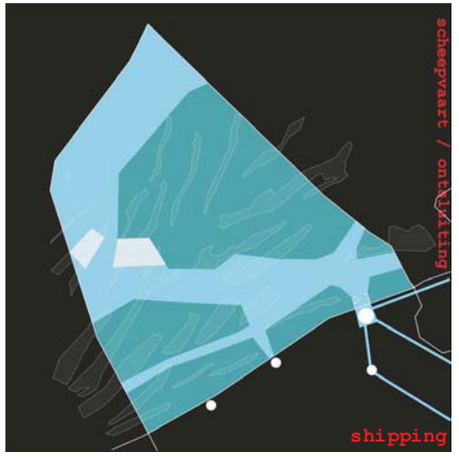


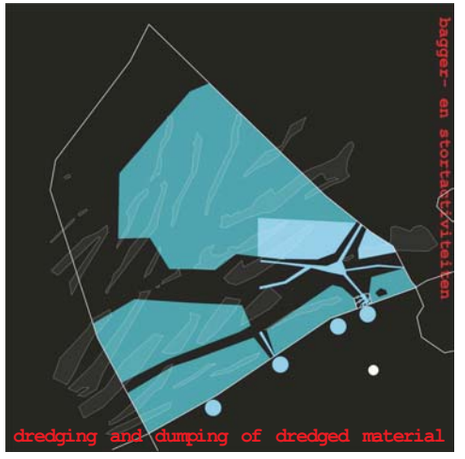
concentration of other economic activities

*Other economic activities would be located where they cause minimal disturbance to fast transport to other ports. The area in the central and eastern part of the BPNS currently has minimal transport movements and is therefore most suitable for the concentration of other activities.*

*Structure plan*

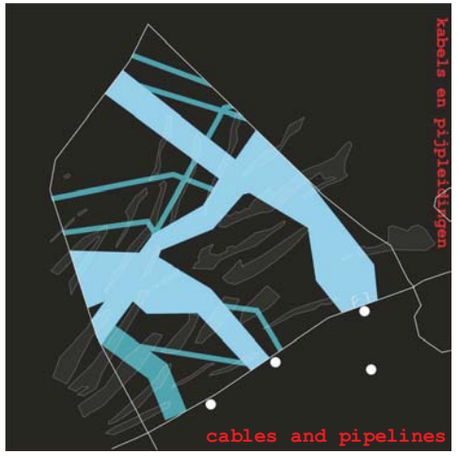



scheepvaart / ontmijting
shipping


bagger- en stortactiviteiten
dredging and dumping of dredged material


zand- en grindontginning
sand and gravel extraction

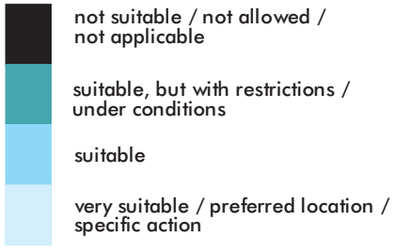

visserij
fishing

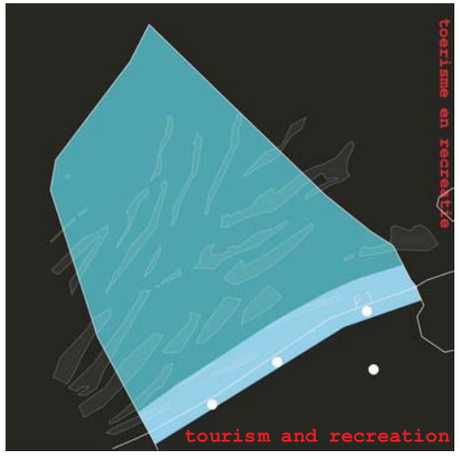

kabels en pijpleidingen
cables and pipelines

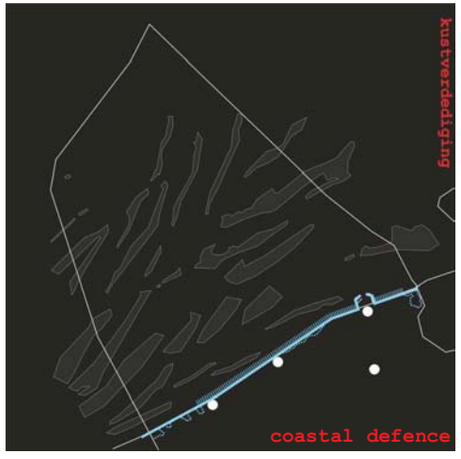

windmolenparken
wind parks


aquacultuur
aquaculture


militair gebruik
military use

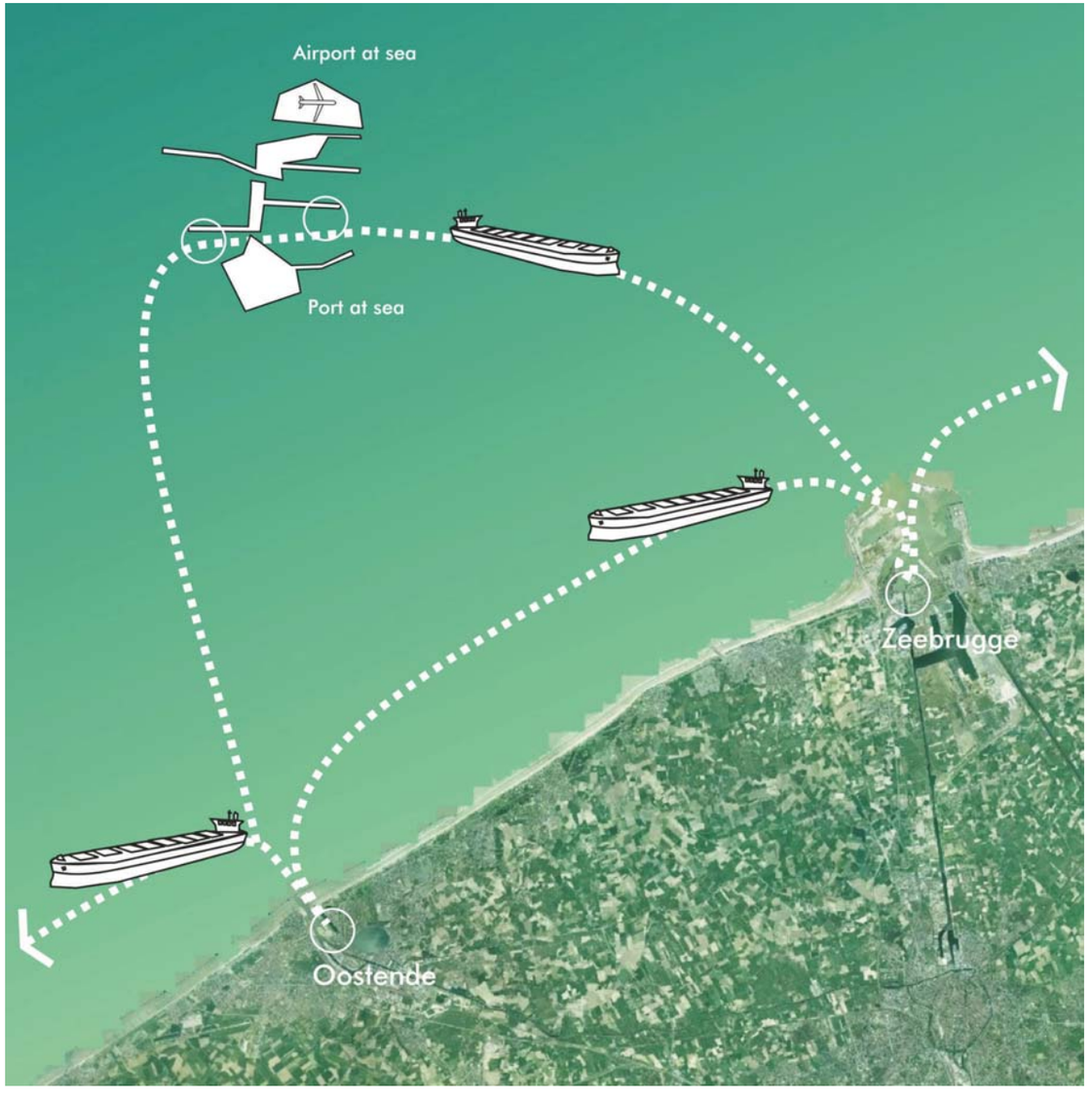

## Significance of the scenario for the different functions and activities on the BPNS

In this scenario most investments will be put towards infrastructure which have a social surplus value, such as communication infrastructures, hard coastal defences, windmill farms, etc. This will go hand in hand with an extended development of a differentiated mobility network, for the advancement of the efficient transport and transfer of goods. Even more than currently is the case, the North Sea will be developed into a so called 'hub-and-spoke-system' where certain harbors will be able to develop further as 'hubs' from a pure transfer and storage pole into centers of economic and social development. An airport island as an extra 'hub' (next to the harbors of Antwerp, Zeebrugge and the other North Sea harbors) will be one of the possibilities to investigate on a mid to long term basis.

Economic activities like sand and gravel extraction or fisheries should hinder as little as possible the transport and transfer of goods in the North Sea.

Moreover nature conservation and military activities do not have priority in this scenario.

# the sailing sea

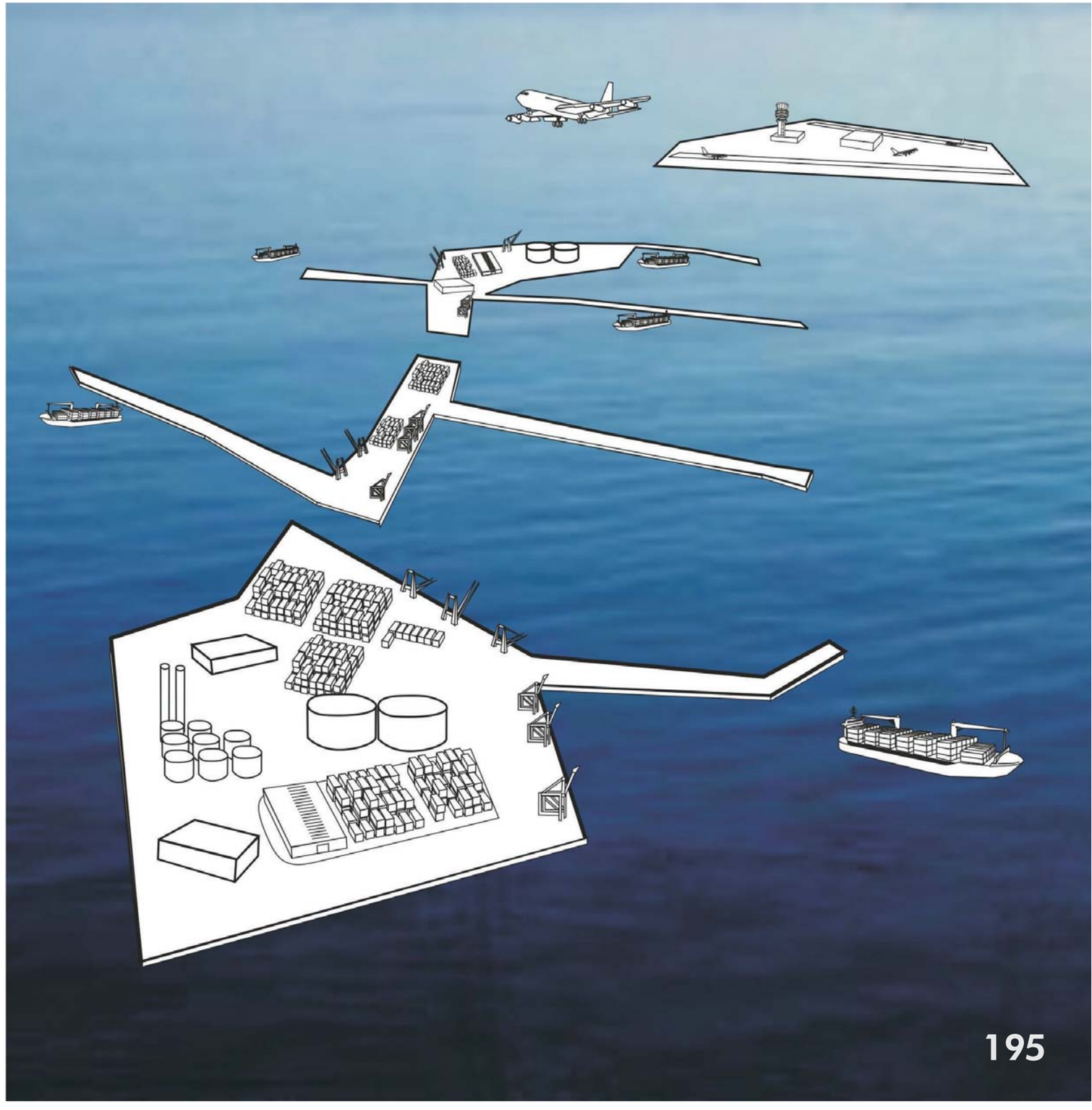



## The potential of the development of an (air)port island within the Sailing Sea scenario

Mid to long term airport and harbor islands could be developed at the 'exit' of the international shipping lane to the harbors of Zeebrugge, Gent and Antwerp.

This island could provide relief to the current ports on land and for people that live near cargo airports (Ostend, Zaventem). The development of such an island would save a lot of time for large cargo vessels. The cargo could be transported from the island to the surrounding ports by short sea shipping. In addition, the island could also serve other ports in the whole southern part of the North Sea (including the port of London, Rotterdam … etc).

This system would enable Belgium to be further developed as a logistic centre. In this respect the (air)port would be an example of the spatial 'hub-and-spoke'-principle as applied at sea: a few hubs (logistic centers developing into growth poles and development centers), connected to a few spokes (important transport axes).



***Figures***
*A caricatured futuristic view in the Sailing Sea scenario: A combined airport-harbor island forms a 'hub' in the transport network of the North Sea. Large cargo ships would not need to continue further towards the harbors of Zeebrugge, Vlissingen, Gent and Antwerp. The goods will be transferred to smaller faster coastal transport ships. The island could also be significant for some other harbors in the southern bight of the North Sea.*

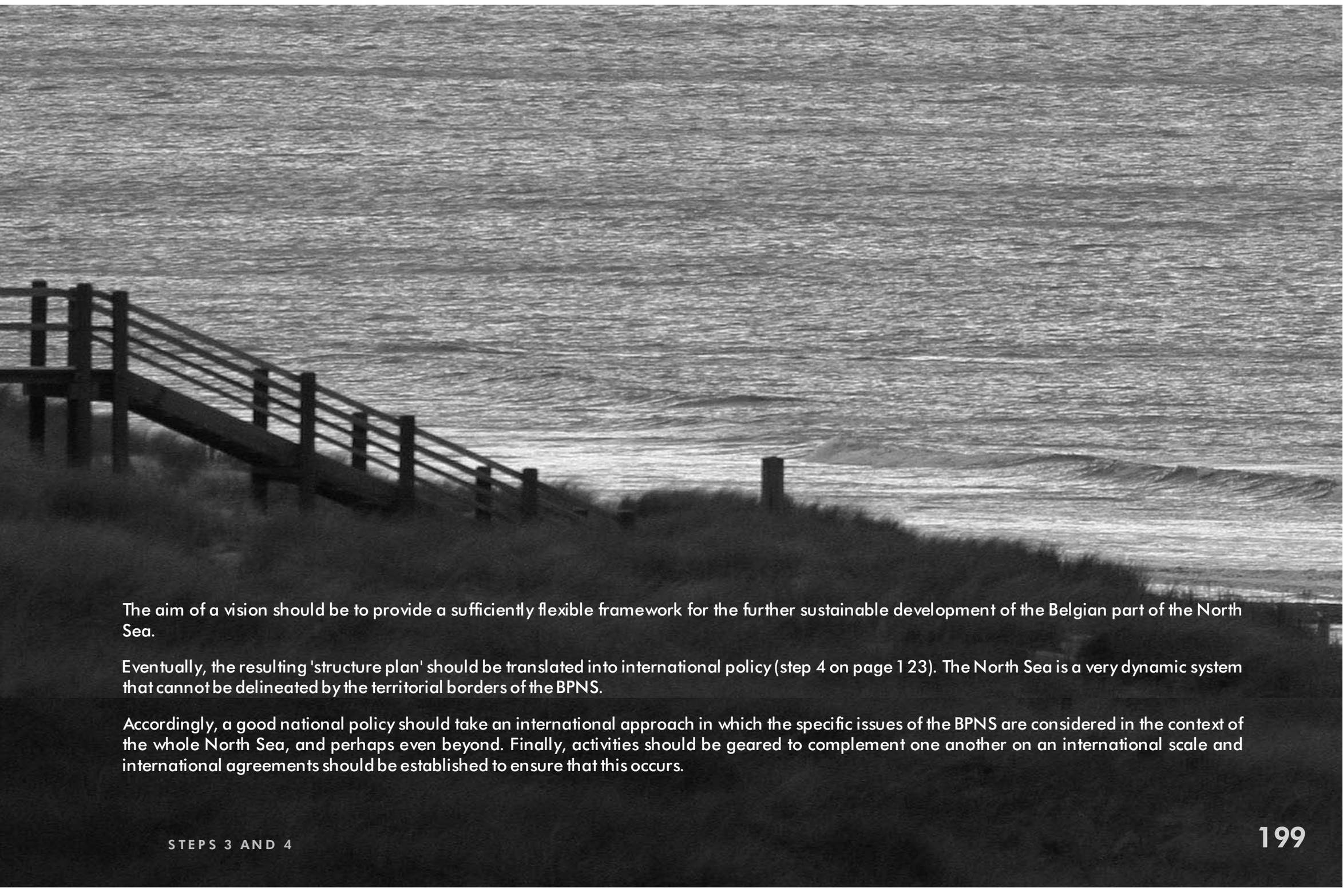
to be continued?

## Challenges for the creation of a spatial structure plan and transnational issues

It is clear that marine spatial planning must include an integrated vision of all the uses within the North Sea. It is not possible to plan with just one user in mind. The combined actions of uses as they relate to other uses and uses as they relate to the marine environment should also be taken into account.

A sectoral approach or strict zoning is not suitable for managing the sea's dynamic system. To have a sustainable North Sea, we need the integration and participation of many different parties in the policy making process. The sea cannot be seen as separate from the coastal area (on land).

This approach would place a structural plan for the North Sea somewhere in the middle of the hexagon, with the scenarios mentioned in this book situated on the six angles of the hexagon. In other words, there should be a consideration and weighing of the different values of well-being, ecology and landscape, and economy to elaborate a 'complete' spatial structure plan for the BPNS (step 3 on page 123).



The aim of a vision should be to provide a sufficiently flexible framework for the further sustainable development of the Belgian part of the North Sea.

Eventually, the resulting 'structure plan' should be translated into international policy (step 4 on page 123). The North Sea is a very dynamic system that cannot be delineated by the territorial borders of the BPNS.

Accordingly, a good national policy should take an international approach in which the specific issues of the BPNS are considered in the context of the whole North Sea, and perhaps even beyond. Finally, activities should be geared to complement one another on an international scale and international agreements should be established to ensure that this occurs.

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# A FLOOD OF SPACE

## TOWARDS A SPATIAL STRUCTURE PLAN FOR SUSTAINABLE MANAGEMENT OF THE NORTH SEA

In the GAUFRE project (2003-2005) four partners worked together (three research teams of the University Gent and Ecolas nv) to gather scientific knowledge about the use of the Belgian part of the North Sea and its possible effects. Additionally, they worked out a vision for an optimal spatial planning of the Belgian part of the North Sea.

This book reflects the spatial-analytical and the design aspects of the GAUFRE project. Major emphasis is on the development of a specific methodology for spatial planning at sea.

The GAUFRE project fits within the framework of the Second Scientific Support Plan for a Sustainable Development Policy (SPSD II) funded by the Belgian Science Policy (BELSPO).