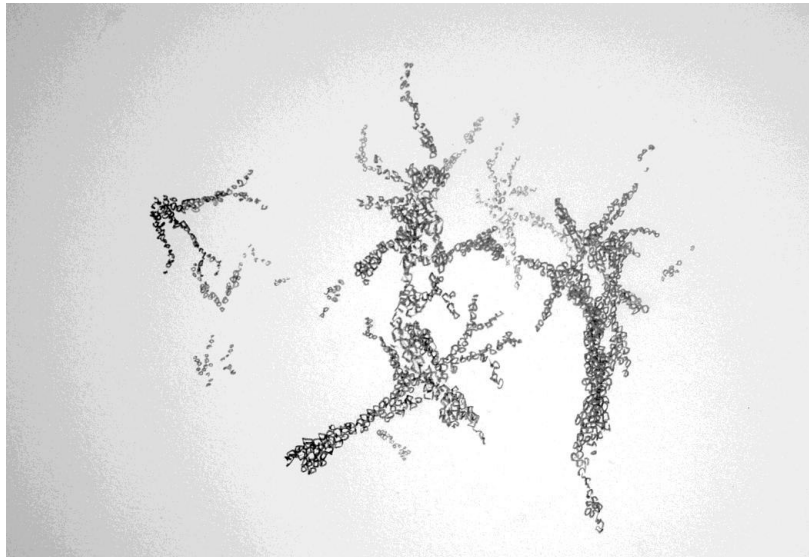


CHAPTER 8

Policy analysis of the 'MPA-process' in temperate continental shelf areas



Published as:

Rabaut, M., Degraer, S., Schrijvers, J., Deros, S., Bogaert, D., Maes, F., Vincx, M. and Cliquet, A. 2009.
Policy analysis of the 'MPA-process' in temperate continental shelf areas.
Aquatic Conservation: Marine and Freshwater Ecosystems, 19: 596-608.

Abstract

1. The decision to designate, implement and manage marine protected areas (MPAs) is often made *ad hoc* without clear guiding procedures. This study evaluates the process of establishment and management of MPAs in temperate soft-bottom marine areas, including identification of objectives, site selection, designation, implementation, ecological effectiveness and socio-economic impacts.
2. For the first time, literature about marine conservation strategies in soft-bottom temperate areas is brought together in one 'systems approach', which is visualized in a flow chart including three phases: setting policy objectives, making decisions and evaluating the eventual effects of the MPA. Policy objectives are generally easy to identify and in most cases national policy objectives are driven by international and regional legal obligations. The decision making process is the most complex phase, as the acceptance of MPAs has to be balanced against the human activities that take place in the area.
3. The relation between fisheries and MPA-management appears to be most challenging in soft-bottom temperate marine areas because of conflicting interests and institutional differences. Activities limited in space and not relying directly on ecosystem functions (e.g. offshore energy production and aggregate extraction) are generally easier to manage than fisheries.
4. The conceptual mapping exercise presented here serves as a basis for a systems approach for MPAs and has been tested for the Belgian coastal environment. In the Belgian 'MPA -process', the application of the systems approach proves to be useful in providing insight into the complex interactions of various authorities with scattered jurisdictions.
5. The unified and simplified representation of the various aspects is (1) a useful communication tool for policy makers and managers to inform other sectors and the public at large and (2) a valuable support system during the 'MPA -process' that considerably enhances the prospects for success.

Key words

MPA-process, policy, systems approach, fisheries, ecology, legalities, soft-bottom marine areas

Introduction

While the concept of marine protected areas has been around for centuries, the term Marine Protected Area (MPA) has been in use for only just over two decades. An MPA has come to mean different things to different people, primarily based on the level of protection provided by the MPA (NOAA, 2003). According to the World Conservation Union (IUCN, 1988) an MPA is defined as: ‘Any area of intertidal or subtidal terrain together with their overlying waters and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or the entire enclosed environment’. The level of protection of MPAs can vary from strictly protected areas to multiple use zones in which several fishing activities are still allowed. All MPAs can thus be fitted into one of the six IUCN categories of protected areas (IUCN, 1994), ranging from strictly protected areas (IUCN Category I) to multiple use zones (Category VI). However, the analysis from Wood of the MPA Global database (Wood, 2007) shows that there might be little correlation between actual protection levels and their IUCN Categories (MPA News, 2007). MPAs are one of the essential tools and approaches in the conservation and sustainable use of marine and coastal biodiversity. The designation and management of MPAs is an important objective for the parties to the 1992 Convention on Biological Diversity. A subtarget to the 2010 Biodiversity target requires that at least 10% of each of the world’s ecological regions should be effectively conserved. Specifically on marine and coastal areas the parties adopted the target of developing a system of MPAs by 2012, which should be effectively managed. Moreover, MPAs are recognized as a viable tool for marine conservation by conservationists, resource managers, scientists and coastal planners. However, they are often implemented without a firm understanding of the economic, social and ecological consequences. The rush to implement MPAs has set the stage for paradoxical differences of opinion in the marine conservation community (Agardy *et al.*, 2003). Especially, the discussion to use MPAs as a mean to restore fish populations or even to increase fisheries profits is still going on and has recently been reviewed by Kaiser (2005).

MPAs have often been designated without clear guiding procedures and are too often allocated as an *ad hoc* decision in the framework of the management of natural resources, or because of international obligations. Although various MPA-studies may provide

information on some significant attributes of individual MPAs, there is a lack of a simplified or unifying concept to follow during their establishment and operation. This study approaches the complex process of establishment and operation of MPAs (further referred to as the 'MPA-process') in an analytical way, including: identification of objectives, selection, designation, implementation, assessment of ecological effectiveness and socio-economic impacts. For the first time, literature on marine conservation strategies in soft-bottom temperate areas is brought together in one framework that provides answers to the questions 'why?', 'how?' and 'what is the effectiveness?' for MPAs.

Research strategy

Bringing together the available literature on various aspects of MPAs allowed construction of a theoretical or 'systems approach' that is applicable to temperate soft-bottom marine areas. This analytical systems approach led to the identification of three chronological blocks: policy objectives, decision making and impacts. This systems approach was visualized in a flow chart, which made the general approach to MPAs easier to apply within a broader marine management framework.

Some aspects of this topic have been covered before, but this paper seeks to integrate research and theory about the 'MPA-process' to build a systems approach which simplifies the complexity of many real-world scenarios. This concept is tested with the inclusion of a case study of how MPAs are established, managed and have impacts in the Belgian part of the North Sea (BPNS). The BPNS is a shallow shelf area of 3600 km², characterized by the presence of several sandbank systems, in which a diversity in soft-bottom habitats is found (Van Hoey *et al.*, 2004). It is a well known and heavily exploited marine area with a rich marine management history where an 'MPA-process' is evolving. It is also characterized by a high institutional complexity and multi-level government. This makes it an ideal case to test the systems approach proposed here.

The current paper aims to combine the various aspects of the 'MPA-process' in temperate continental shelf areas. The first section presents the flow chart, while the various aspects of the concept are next explained in depth (for each block of the flow chart).

Table 1. Multi-level government in the BPNS and the coastal zone

International obligations: conventions and commitments (2010 Target...)	
EU obligations: EU-directives (Habitats Directive...)	
Federal state	
Federal competences at sea: nature conservation, protection of the marine environment, offshore windmill parks, shipping, military, etc.	Federal competences on land: contingency planning, etc.
Flemish Region	
Flemish competences at sea: fishing, dredging, etc.	Flemish competences on land: nature conservation, tourism, ports, etc.
1 Province (West-Flanders)	
10 coastal municipalities	

The focus is on the legal and the ecological dimensions of the ‘MPA-process’ and the systems approach is tested through the application of each part of the flow chart to the Belgian coastal environment. Finally, potential bottlenecks in the systems approach are discussed as well as the value of such a flow chart for a marine management framework in temperate shelf areas.

Results

Flow chart

Based on the literature review, a flow chart (Figure 1) was built with three horizontal layers which coincide with three chronological blocks considered as phases in the ‘MPA -process’. The first block on policy objectives serves as an answer to the question ‘why?’ and indicates that basically five different objectives exist to establish an MPA (*i.e.* commercial species conservation, reference site creation, species conservation, habitat conservation and international commitments). The second block reflects the decision making process. The number of MPAs needed, their location and size, as well as the degree of protection afforded,

have all to be decided on in order to meet these objectives. The parameters for designation and the management measures need to be enshrined in a legal framework with compliance mechanisms. The establishment of an MPA always interacts with other sectors that make use of the marine environment, and consultations with other management organizations need to take place at this decision making phase. Monitoring of the established MPAs is an essential part of the MPA management, which is directly linked with the last block that evaluates the implications for both the ecology of the system and the socio-economic sectors related to the marine environment. Note that the effect of the measures implemented to reach policy objectives may require changes to (international) legislation and management strategy (dashed feedback arrows).

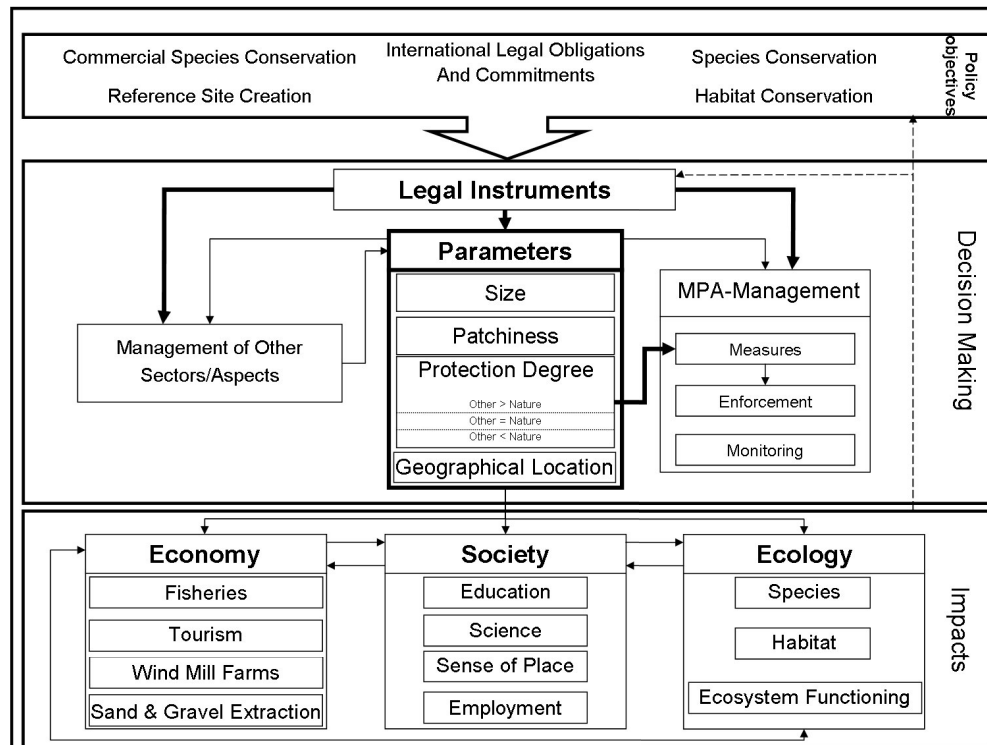


Figure 1. Flow chart as a visualization of the analytical systems approach. Three horizontal layers represent the 'MPA-process' over time. This approach starts with the identification of the policy objectives (five different objectives exist). The designation and management scheme are settled during the decision making phase, in which there is also consultation with the management of other sectors. Established MPAs are expected to have an impact on the socio-economic activities of the concerned area as well as on the ecology of the system. This systems approach helps to analyse and evaluate the 'MPA-process' in soft-bottom marine areas.

Systems approach and case study as test

Policy objectives

Concept

Policy objectives are commonly associated with habitat and species conservation. In such cases, indicator species are most often used (Kabuta and Laane, 2003). In general, surrogate species (*i.e.* flagship, focal, keystone, indicator and umbrella species) have been recognized as legitimate conservation targets on their own (Favreau *et al.*, 2006) as well as being effective in the selection of networks of areas for conservation (Larsen *et al.*, 2007), although this might cause some difficulties, especially in the marine environment (Rees *et al.*, 2006). A specific way of selecting species for conservation is valuing them according to their commercial value, although this has mostly no connection with their function within the ecosystem (Norton and Noonan, 2007). The policy objective of conserving a pristine environment is valuable in complex ecosystems with a low disturbance level (Pauly *et al.*, 2002), but is not very useful in temperate coastal shelf areas. Therefore, a policy objective that is feasible in these areas is to create a reference site. International legal obligations and commitments are considered here as policy objectives.

Belgian case

Belgian policy objectives are mainly the result of international obligations to protect and restore marine habitats, accepted in international and regional conventions such as the 1971 Ramsar Convention on Wetlands of International Importance, especially as Waterfowl Habitat, the 1992 OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic, the 1992 Convention on Biological Diversity and at the EU-level, the Directive 79/409/EEC on the conservation of wild birds, and the Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.

Belgium has to comply with international commitments on the designation and management of MPAs to establish a representative system of MPAs by 2012 (e.g. World Summit on Sustainable Development; Biodiversity Convention). At the EU level, several commitments have been made regarding conservation of marine biodiversity. The objective of the EU

Biodiversity Action Plan (European Commission, 2006) is to complete a network of marine Special Protection Areas (SPAs) by 2008 and Special Areas of Conservation (SACs) by 2012, for which management and conservation measures have to be established by 2012. The Belgian policy objectives focus on the protection of certain bird species and their habitats, obtaining a favourable conservation status of marine habitats, avoiding deterioration of habitats and disturbance of species and conserving the ecosystem function of the marine habitat. The objective to create a reference site was included in the first preparatory documents in the designation process (Vande Lanotte, 2004), but was eventually withheld from the legislation as a formal objective. The conservation of commercial species is not explicitly mentioned as a policy objective, although conservation of the marine habitat can include this as an implicit objective. Thus, four out of five policy objectives that were identified in the conceptual framework are included as Belgian policy objectives.

Decision making

Concept

After setting clear policy objectives, decisions to designate an appropriate area and to take appropriate management measures have to be made. The various aspects of this phase are based on legal instruments. Four basic parameters have to be decided on during the decision making phase: location, size, patchiness and degree of protection. As an MPA is a spatial management tool, the first three parameters are obvious and include a decision in the 'single large or several small' (SLOSS) dilemma (Baz and Garcia-Boyer, 1996, Simberloff and Abele, 1976). Site selection for a representative system of MPAs requires a biogeographic classification system (Hockey and Branch, 1997). This systematic selection of habitats starts with the abiotic environment, including morphological features, sediment conditions and water circulation. Afterwards, data generated with new research techniques can be supplemented (Rachor and Gunther, 2001), e.g. with side-scan sonar surveys (Degraer *et al.*, 2008a) and modelling exercises (Willems *et al.*, 2008). The size of an MPA has been discussed by several authors; according to Rachor and Günther (2001), a coherent network of MPAs in the German Bight could be achieved, if MPAs were not to be more than about 100 km apart. Furthermore, with a possible larval displacement of 10 km within 2-3 days, minimum areas of about 100 to 200 km² should be designated for successful protection. MPAs should be

designed large enough to contain short-distance dispersing propagules and placed far enough apart so that long-distance dispersing propagules released from one reserve can settle in adjacent MPAs. A reserve of 4-6 km in diameter should be large enough to contain the larvae of short-distance disperses, and MPAs spaced 10-20 km apart should be close enough to capture propagules released from adjacent MPAs (Shanks *et al.*, 2003). The optimal size of MPAs should, however, be determined for each location by evaluating conservation needs and goals, quality and amount of critical habitat, levels of resource use, efficacy of other management tools, and characteristics of species or biological communities requiring protection (NRC, 2001). Hastings and Botsford's (2003) modelling exercise clearly shows the direct influence on the parameters to be chosen by decision makers. The model predicts that biodiversity goals will be reached with a single large reserve that is spacious enough to be self-sustaining. The required size is determined by the mean dispersal distance of the species and the required recruitment level. Then again, the model points out that MPAs as small as practically possible will meet the fisheries goals, because of enhanced larval export. A reserve network is a possible solution to these conflicting policy goals. Alongside the spatially defined parameters, the degree of protection must be settled during the decision making process. According to van der Meulen and de Haes (1996), three different degrees of protection are important: (i) areas primarily designated for other functions, where nature is 'supporting'; (ii) areas where nature conservation is equal to other functions; and (iii) areas primarily established for nature, including functions that are directly derived from this, such as ecotourism.

The setting of the parameters will influence the future management of the MPA itself as well as the management of other activities at sea. These activities may involve conflicting interests and include the following sectors or aspects: pollution (Jameson *et al.*, 2002), eutrophication (Ospar-Commission, 2000), dumping and dredging (Bergman *et al.*, 1991, Rachor and Gunther, 2001), oil/gas transport (Bergman *et al.*, 1991), navigation (Maes *et al.*, 2000), wind mill farms, fisheries effects (Lindeboom, 1995) and coastal defense (Kelleher, 1999).

The final part in the decision making process is the establishment of a management system for the MPA concerned. Wood (2007) estimates that MPAs cover about 0.6% of the world's oceans, of which 71% appear to have no active management (Pet and Mous, 2002). The

management of an MPA should be based on several measures that are coupled to the degree of protection (as defined during the parameterisation). The period between reviews should be neither so short that lack of resources is a problem, nor so long that the management is not responsive (Kelleher, 1999). Restriction of (existing or potential) activities with a severe impact is the most applied way to improve or conserve the ecological value of a marine area. To carry through such restrictions, a business planning approach adapted to MPA-management has been proposed (Jameson *et al.*, 2002). With this approach, managers focus on the viability of the management system, *i.e.* the ability of the MPA to provide ecological goods and services to its target users over the long term. Besides, MPA-management should understand the participants involved in the management of other activities at sea. Collaborative management has been argued for as a possible model to use (*i.e.* stakeholders jointly manage the MPA with the conservation agency) (Kelleher, 1999), but Beem (2007) points out that the process of developing institutions for co-management is lengthy and time consuming. Chuenpagdee and Jentoft (2007) focus on what happens before the actual decision to implement a co-management system and they show that this 'step zero' is an important factor for ultimate success. They point out that this pre-implementation period can be very lengthy and that there is a certain degree of muddling through before successful co-management is achieved. It is clear that at least consultation with other interested parties at sea is necessary during the decision making process. The third aspect of MPA-management is monitoring (Figure 1). Out of 1306 MPAs surveyed world-wide by Kelleher *et al.* (1995), only in 31% of the areas did the managers think that they achieved their management objectives. To make MPA-management successful and adaptive, a periodic revision of the management is needed on the basis of ecological monitoring.

Belgian case

The federal Act on the protection of the marine environment (Act of 20 January 1999, amended by Act of 17 September 2005) is the basic legal instrument for the specific 'MPA - process'. This Act enables the designation of MPAs in Belgian marine waters (including the territorial sea and the exclusive economic zone). Five types of MPAs have been distinguished in the Act: integral marine MPAs, specific marine reserves, Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), closed zones and buffer zones (Cliquet and Maes,

1998). Although the degree of protection of these MPAs might differ, all of them will probably fit into IUCN Category IV or VI. The requirements for IUCN Categories I, II, III and V, such as size and ecological integrity, can probably never be met for Belgian MPAs. Only the marine reserves and SPAs/SACs are relevant for the focus of this paper. While marine reserves are, in principle, the areas most strictly protected, SPAs and SACs give implementation to the EU Birds and Habitats Directives respectively. After some failed attempts to designate marine reserves in the period 1999-2003 (Bogaert *et al.*, 2008, Bogaert *et al.*, 2009), several SPAs and SACs were designated by Royal Decree of 14 October 2005. A Royal Decree of 5 March 2006 designated the specific marine reserve the 'Baai van Heist'.

In the BPNS, different areas for marine protection have been designated implying that the geographical features (size, location, patchiness) were parameterized. Three areas along the coastline (Figure 2) were designated for the protection of birds (SPAs), with surface areas of 110.01 km², 144.8 km² and 50.95 km² respectively. Another two areas for the protection of habitats (SACs) were established: 'Trapegeer -Stroombank' (SAC 1), parallel along the West coast with a surface area of 181 km² and 'Vlakte van de Raan' (SAC 2) at the East coast with a surface area of 19.17 km². These two SACs have the necessary surface and distance to each other (28 km) to be considered biologically linked (*cf. supra*). The specific marine reserve 'Baai van Heist' is a very small reserve of only 6.76 km² adjacent to a Flemish beach nature reserve (Figure 2).

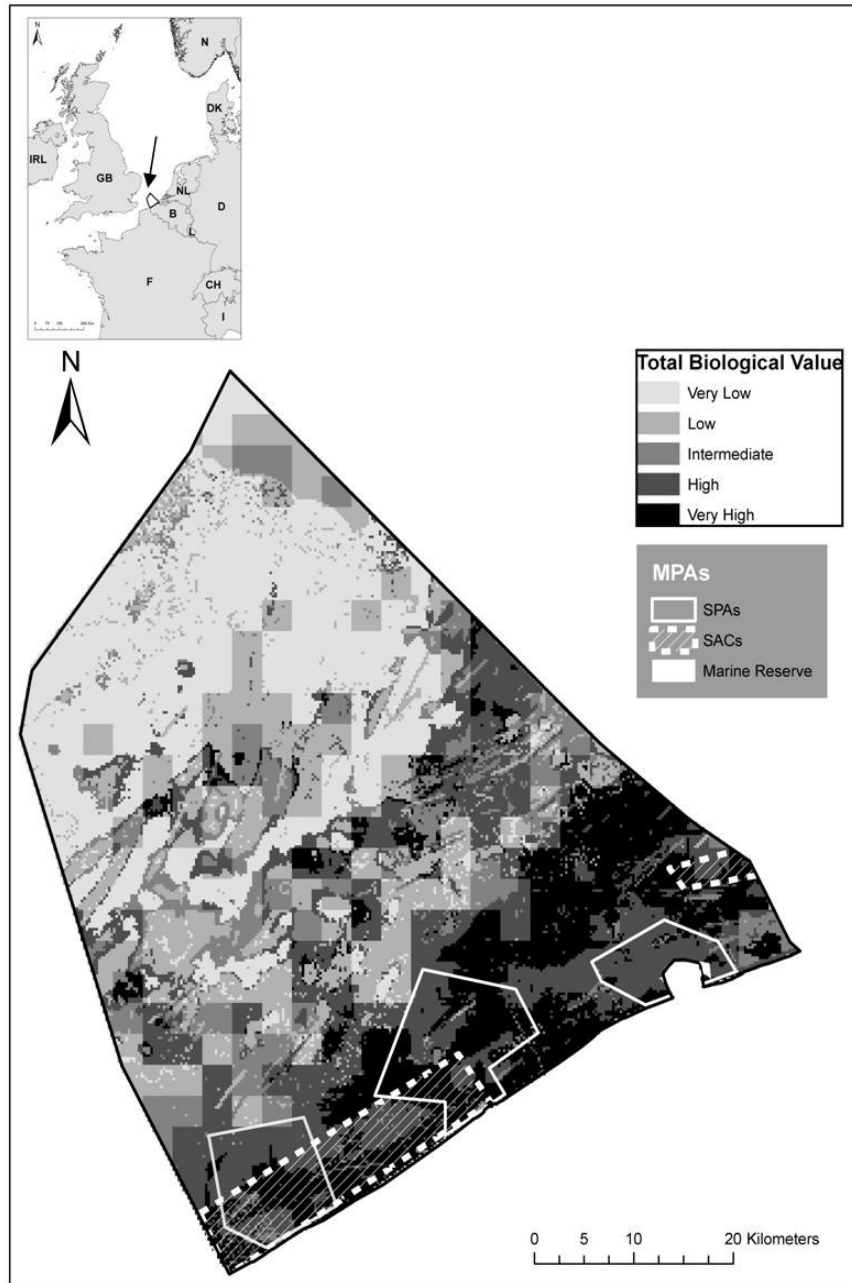


Figure 2. Location of the Belgian Part of the North Sea (BPNS) (left above); BPNS with indication of total biological value (adopted from Derous et al., 2007b) and the different MPAs (SACs, SPAs and the marine reserve 'Baai van Heist').

This parameterisation was based on the policy objectives of species and habitat conservation (which coincides with the fulfilment of international obligations). The present study evaluates whether the designated MPAs coincide with the areas hosting the most valuable species and habitats using the concept for biological valuation in marine environments proposed by Derous *et al.* (2007). This valuation strategy uses several valuation criteria other than the commercial value: namely rarity, aggregation, fitness consequences, biodiversity, naturalness and proportional importance. The strategy was subsequently tested for the BPNS (Derous, 2007) in which data of macrobenthos, sea birds, epibenthos and demersal fish were combined. The overall valuation map is shown in Figure 2, on which the different designated protected areas (SPAs and SACs) are superimposed. To evaluate the location of the SACs, the macrobenthos valuation map is used because this species group is most often used to typify temperate soft-bottom habitats (Van Hoey *et al.*, 2004). The highest biological value for macrobenthos was found near the coast, especially near shore in the western coastal area and diverging away from the shore line in the eastern coastal area. Other valuable areas for macrobenthos seem to be further offshore (Figure 3a). The high value of the coastal area mostly coincides with the presence of the *Abra alba* community. The most valuable areas for birds are represented in Figure 3b, with the three SPAs overlain the map. The valuation map clearly shows the high ornithological value of the coastal zone ('Vlaamse Banken', 'Zeelandbanken', 'Vlakte van de Raan'). This zone has long been recognized as being important for seabirds on the BPNS both as foraging area for breeding birds and for wintering birds (Haelters *et al.*, 2004, Seys, 2001, Seys *et al.*, 1999, Stienen and Kuijken, 2003).

The fourth parameter (degree of protection) was built on the reasoning that the designated areas have to be protected against potential impacts of future activities. Hence, current activities within the MPAs were not perceived as a threat to reaching the objectives. Specific conservation goals for each MPA have not yet been set, although several measures have been taken. Within the SPAs and SACs, the following activities are prohibited: all building activities, industrial activities and activities of commercial and advertising enterprises. In the SACs, the dumping of dredged material and inert materials of natural origin is also forbidden. In SPA 1 and SPA 2, common tern, sandwich tern, little gull and great crested grebe are protected.

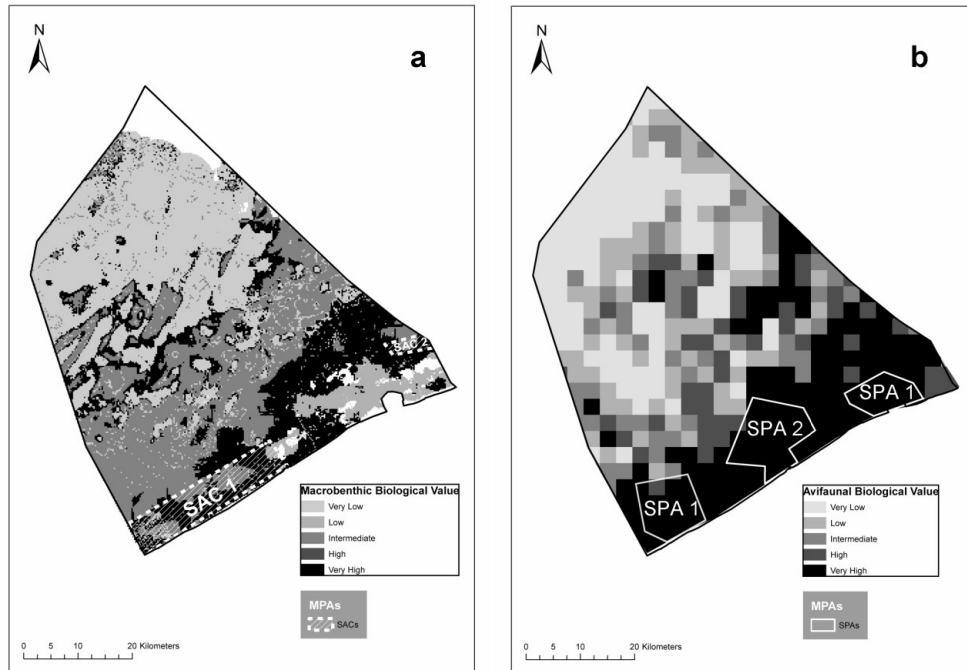


Figure 3. The BPNS with indication of the macrobenthic biological value (adopted from Derous et al., 2007b) and the Habitats Directive areas (SAC 1: 'Trapegeer-Stroombank' and SAC 2: 'Vlakte van de Raan') superimposed (a); the BPNS with indication of the avifaunal biological value (adopted from Derous et al., 2007b) and the Birds Directive areas (SPA 1, SPA 2 and SPA 3) superimposed (b).

During winter, helicopter flights at altitudes of less than 500 ft and the passage of high speed vessels and offshore water sports are forbidden. The Minister of Environment can consult with the Minister of Defence on the planning of military firing exercises and other military activities. For the 'Baai van Heist', there is an in-principle, legal, strict protection regime forbidding all activities, except those explicitly allowed by Act or royal decree. This list of allowed activities, however, is rather extensive: surveillance and control, scientific research and monitoring, military activities, sea fisheries, pilotage, rescue and towing services, dredging, laying and maintaining of cables and pipelines, the digging of trenches and raising of the seabed, and those activities that are mentioned in the voluntary user agreements. Since all these different activities can still continue, the marine reserve and the SACs and SPAs in the Belgian marine environment can all be categorized as IUCN Category IV. For all MPAs, voluntary user agreements can be concluded with user groups such as sailing clubs,

fishermen, etc., moreover, a policy plan must be formulated within three years after the designation of the site. Furthermore, an appropriate assessment has to be designed of all new plans and projects that are likely to have a significant effect on the site in view of the site's conservation objectives. A new plan or project can only be allowed if it does not adversely affect the integrity of the site concerned. In case of a negative assessment, the plan or project can only be allowed under certain strict conditions as provided in the royal decree (which implements Article 6 of the EU Habitats Directive).

Impacts

Concept

Once an MPA has been designated and implemented, this will have implications at the economic, social and ecological levels (Figure 1). In a simulation model, Martinet *et al.* (2007) examine the viability of fisheries and point out that economic, social and biological constraints have to be included to achieve sustainability. Ecological impacts relate to species gain/mortality and habitat recovery/destruction. These impacts depend greatly on the degree of protection and on the eventual measures taken. Within-MPA mechanisms might impact the outside-MPA area. This influence can be both on the ecosystem of the surrounding areas as well as on areas further off (Gell and Roberts, 2003). In temperate soft-bottom areas, the ecological status of benthic life is important. Benthic densities and species richness are heavily determined by the seabed characteristics (mainly sediment types) (Bergman *et al.*, 1991, Van Hoey *et al.*, 2004, Vanaverbeke *et al.*, 2000) and this benthic productivity is important in determining the densities and species richness of higher trophic levels such as demersal fish (Cabral, 2000, Langton and Watling, 1990, Molinero and Flos, 1992, Rijnsdorp and Vingerhoed, 2001) and birds (Cramp and Simmons, 1977, Degraer *et al.*, 1999, Van Waeyenberge *et al.*, 2001, Von Blotzheim and Bauer, 1968, 1969). Protection of keystone habitats and key species therefore leads to an enhanced settlement and recruitment of demersal fish, providing an increased biomass and spawning activity as well as changing age class structure. If the age/size of the stock residing within the protected areas increases and fecundity increases with age/size, then it is possible that the abundance of larvae in the system can increase dramatically after establishment of the MPA. The increased spawning activity leads to an enhanced reproductive output and could possibly end in a growth in

larval export. Increasing densities and biomass ultimately can result in spill over to the adjacent fishing ground (Gell and Roberts, 2003, Kelleher, 1999, Pet and Mous, 2002, Pezzey *et al.*, 2000, Roberts *et al.*, 2001, Sainsbury and Sumaila, 2002, Sanchirico, 2000). The most important economic impacts of MPAs that can be expected in a soft-bottom temperate area are on sectors such as sand and gravel extraction (Rachor and Gunther, 2001), wind mill farms (Rachor and Gunther, 2001), tourism (Davis and Tisdell, 1996, Kelleher, 1999, UNEP, 2002) and fisheries (Hastings and Botsford, 2003, Pezzey *et al.*, 2000, Piet and Rijnsdorp, 1998, Sanchirico, 2000). Fisheries are generally recognized as the major critical factor for an MPA to succeed or fail (Kelleher, 1999). Kaiser *et al.* (2002) describe how productivity is decreasing as fishing intensity increases and high-biomass species are being removed from the benthic habitat. Moreover, the fishing industry is an economic sector that is active in large areas and is the basis for the strongest opposition to marine protection. This is attributed to people from the fisheries sector being anxious that reducing the area of fishing grounds will mean a decrease in catches.

Fishing with mobile fishing gear is known to be a major cause of habitat deterioration in many soft-bottom ecosystems (Dayton *et al.*, 1995). Jennings *et al.* (2001b) investigated the impact of trawling on benthic communities. They found that total biomass of infauna and epifauna significantly decreased with trawling disturbance. There is evidence of damage and mortalities in invertebrates in trawl nets (Bergman and Hup, 1992, Brylinsky *et al.*, 1994, Kaiser and Spencer, 1996, Schratzberger *et al.*, 2002, Witbaard and Klein, 1994).

Moreover, trawling has the capability of altering, removing or destroying the complex, three-dimensional physical structure of benthic habitats by the direct removal of biological and topographic features (Turner *et al.*, 1999). When looking specifically at soft-bottom areas, locations with biogenic structures are proven to be vulnerable to fishing impacts (e.g. *Pectinaria (Lagis) koreni* (Bergman and van Santbrink, 2000)). Chronic fishing disturbance may be sufficient to severely reduce the complexity of such habitats by removing the fragile sessile fauna (Collie *et al.*, 1997, Thrush *et al.*, 1998), reducing the suitability of the area to species of commercial importance (Kaiser *et al.*, 1999a, Sainsbury, 1987). For epifauna, a general decrease in sessile larger bodied species was observed, while more resilient, mobile fauna increased along with increasing fishing disturbance (e.g. Kaiser *et al.* (2000b)). A

conceptual model of Auster (1998) demonstrates that fishing gear significantly reduces habitat complexity for most habitats, except for gravel areas with high current velocities where little settlement of epifauna occurs.

Belgian case

Figure 3 shows that the protected areas are allocated in areas that have a high biological value. The spatial parameters were chosen (i) to give the biologically most valuable areas a protected status (Figure 2 and 3) and (ii) to avoid some negative economic impacts (Figure 4). The areas where wind mills are allowed lie outside the protected areas and there has never been aggregate extraction in the protected areas as the grain size of the sediments in these areas is not valuable. The current protection measures inside the areas were explicitly chosen not to harm the only real economic activity taking place here, namely fisheries, which is the sector expressing the strongest opposition to marine protection. Reducing fishing effort is a decision that creates political difficulties as it has far-reaching, short term, social implications (Smith, 1995). Moreover, in Europe and North America, it is a sector that has been receiving significant public support, even when it is economically not significant (Steele and Hoagland, 2003), e.g. the fisheries sector in Belgium represented only 0.02% of the GNP in 2002 (National Bank of Belgium, Alex Hermans personal communication) and most fishing activities take place outside the BPNS.

By far the commonest fishing technique in Belgium is beam trawl fisheries, mainly small beam trawlers for *Solea solea* (common sole) and *Pleuronectes platessa* (plaice) (45 thousand fishing hours per year) and shrimp fisheries for *Crangon crangon* (brown shrimp) (23 to 35 thousand fishing hours per year) in the coastal areas. The most valuable areas for macrobenthos in the BPNS coincide with places where the *Abra alba* community is found. This community hosts various bio-engineering species that form biogenic structures (e.g. *Lanice conchilega* (Callaway, 2006, Rabaut *et al.*, 2007, Van Hoey, 2006) and *Owenia fusiformis* (Rabaut *et al.*, in prep., Somaschini, 1993) which are often referred to as hotspots of biodiversity. These ecologically valuable areas are often vulnerable to beam trawl disturbance as was proved in the case of *L. conchilega* in an experimental trawling study (Rabaut *et al.*, 2008).

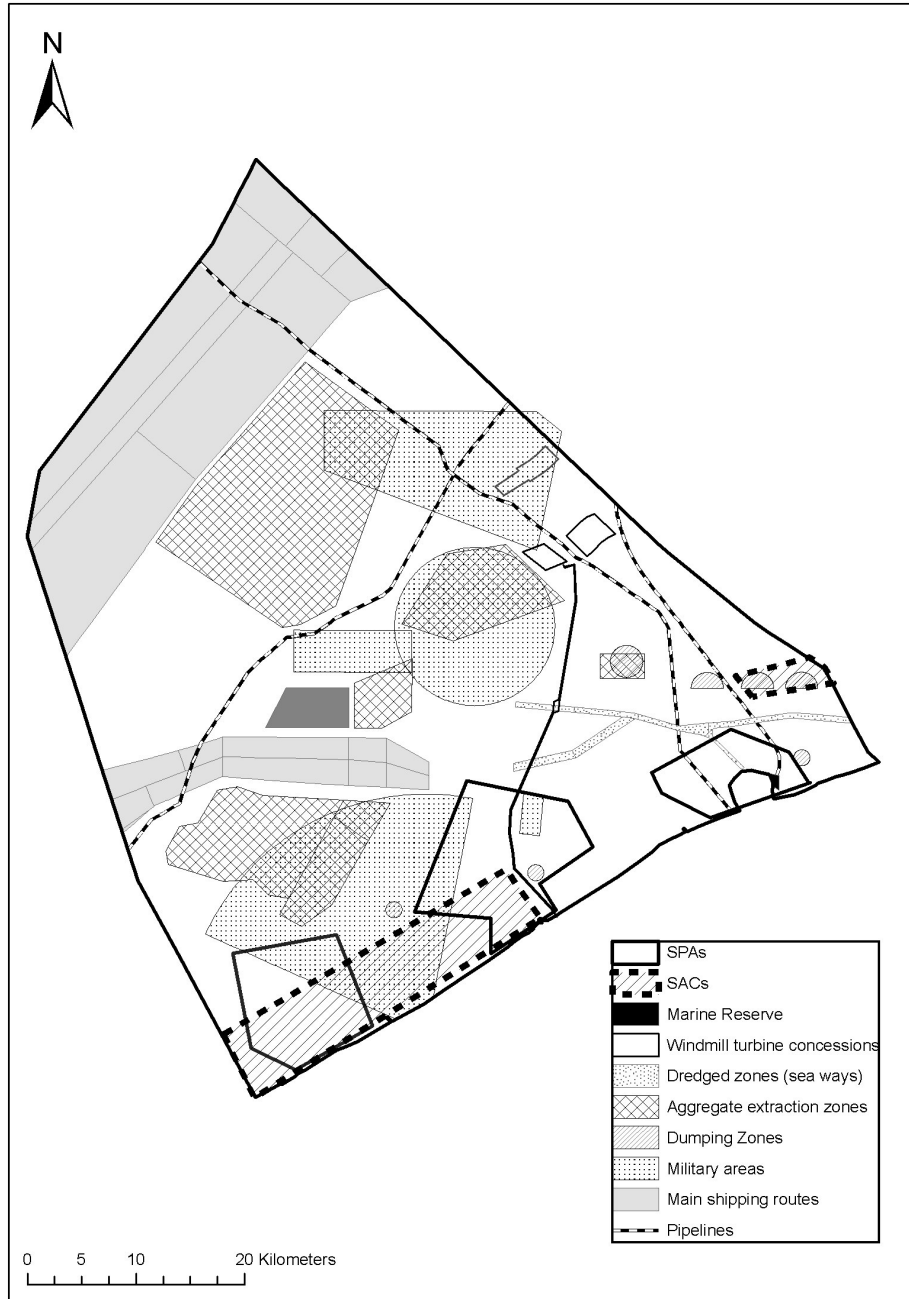


Figure 4. The BPNS with indication of both the allocated areas for different human activities (adopted from Maes et al., 2005; updated) and the allocated MPAs.

Discussion

Policy objectives

It is very likely that there would be far less interest in MPAs without current international legal obligations and commitments as demonstrated in Belgium where almost all designated areas have been established in the framework of the European Natura 2000 Network. This requires species and habitat conservation to be the fundamental objective of MPA establishment whilst the conservation of commercial species is considered a potentially indirect additional benefit, rather than a separate objective for MPA designation. The objective to create reference sites through MPAs was eventually not included in the Belgian legislation.

Decision making

The demarcation of MPAs in Belgian marine waters has been based on ecological information. Combining the biological valuation maps, produced by Derous (2007), with the designated Belgian MPAs, the parameterisation is concluded to be fairly well adapted to affect or conserve the ecology of the system in a potentially positive way. The main objective concerning the management of the MPAs uttered by the North Sea Minister (Vande Lanotte, 2004) was to safeguard them from future threatening activities (such as building of artificial islands etc.). The existing activities were considered to have no significant impact or belong to another level of competence, which cannot be dealt with within the framework of the Act on the protection of the marine environment (*cf. infra*). Nevertheless, consultation with the responsible authorities and stakeholders of other sectors took place. For sand extraction and offshore energy production demarcation zones outside the current MPAs were defined. In spite of this consultation, one energy firm (Electrabel) started a legal procedure for the Belgian Council of State to file a complaint against the designation of the 'Vlakte van de Raan' as SAC, because the withdrawal of an earlier environmental permit for building an offshore windmill farm in that area. The energy company asks for the annulment of the designation decision. In February 2008, the Belgian Council of State annulled the decision on the designation of the 'Vlakte van de Raan' as an SAC (*cf. post scriptum* below), because of insufficient motivation. Furthermore, the MPAs are not completely safeguarded against

future activities as projects with a significant impact on the site can be allowed under certain conditions (in legal conformity with article six of the EU Habitats Directive and the Belgian legislation, *cf. supra*). Since absolute prohibition of only a few activities exists and certain activities can be allowed under limited circumstances, an inadequate protection regime might be the resulting practice.

Mobile fishing gear has a significant impact on the ecology of benthic systems (*cf. supra*). Therefore, it is surprising that there was no cooperation with the fisheries management, leading to the situation where none of the existing fishing activities have been restricted in the designated MPAs, not even within the two SACs. Social implications make it politically delicate to restrict fisheries and this probably explains in part why no fisheries restrictions currently exist for the Belgian MPAs. Furthermore, the federal government has only limited competence in this matter due to the state structure. The Belgian North Sea policy is divided over several institutional levels with the federal level and the regional level (Flemish Region) the most relevant. In this regard, the federal government has authority over environmental policy and protection of the marine environment, wind farms at sea, shipping, military activities, aggregate extraction, cables and pipelines. The Flemish Region is responsible for policy areas such as nature policy on the beach and the hinterland, recreation, ports, fishing, dredging, piloting and coastal defence. The Act on the protection of the marine environment states that the federal government cannot limit or restrict activities within the MPAs that are the competences of the Flemish Region. Thus, despite having competency over marine nature conservation, the federal government cannot deal with several activities affecting this competence (e.g. fisheries). Although the original Act of 1999 included the possibility to limit fisheries within marine reserves, the federal government amended the Act in 2005, excluding this option. This legal change was motivated on constitutional grounds, but is legally debatable (Cliquet and Bogaert, 2006). Consequently, if the conservation of the MPAs requires a limitation on fisheries, the Flemish government has to take decisions. As in Belgium no structural cooperation regarding marine issues exists (Cliquet *et al.*, 2004), solutions to this problem are more difficult.

Assuming that the political will exists to ban activities such as trawling in MPAs, the relation with the fisheries policy of the European Community (EC) is likely to cause additional

problems. Fisheries belong exclusively to the competence of the EC, within the framework of the Common Fisheries Policy (CFP). The principal text is Council Regulation (EC) N° 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the CFP. Environmental issues on the other hand, are shared between the EU and the member states. Furthermore, the EC Treaty requires that environmental matters are integrated into other policy domains, such as fisheries. It is not clear to what extent the member states have legal authority to take measures for the restriction of fishing activities within the framework of marine nature conservation, and whether such measures can be taken through the CFP. Four possible options exist: 1. fisheries can only be restricted by the EC within the framework of the CFP; 2. fisheries can also be restricted by member states within the framework of the CFP; 3. restrictions to fisheries as a tool for MPA protection is seen as a nature conservation measure and is taken by the individual member state; 4. nature conservation measures are taken by the EC.

The European Commission's position is that fisheries management measures should be decided in the context of the CFP, given the fact that fisheries is an exclusive Community competence. This also applies to measures regulating fishing activities to protect a Natura 2000 site (European Commission, 2007). However, it could be argued that the limitation of fisheries, solely for the protection of a habitat or species, is an environmental regulation. In such a case, measures can be taken by either the EC or by member states as part of their environmental policy. The final decision of the appropriate legal basis will eventually have to be taken by the European Court of Justice. Until now, there is no clear case law that provides the appropriate legal basis for fisheries measures, as a nature conservation tool (Owen and Chambers, 2004).

If limitations of fisheries in MPAs have to be taken within the framework of the CFP, then the question remains whether member states have some competence to take those measures. According to the Fisheries Regulation, the member states have some powers to regulate fisheries, be it within the context of the CFP. These measures are, however, limited in time or space and are considered as being too limited to fulfil the requirements under the Birds and Habitats Directives (Owen, 2004). Moreover, it was stated recently that a development of a longer-term EU management view, including the reconciliation of fisheries and conservation

objectives is necessary to reach sustainability in the marine environment (Hiddink *et al.*, 2008a).

Both MPA-management and management of other sectors (e.g. fisheries) are regulated at local as well as at international levels. The international character of marine areas together with the complex relationship between habitat deterioration and commercial fisheries make it difficult to define responsibilities in the broader framework of marine ecosystem management. The application of the systems approach for the Belgian coastal environment was useful to identify the difficulties in the decision making process, mainly because of competences that are scattered over the international, national and regional regulations.

MPA-management often lacks a thorough monitoring programme which makes it difficult to assess the effect of an MPA. Although in Belgium there is a legal obligation for permanent monitoring in the MPAs, there is no specific monitoring programme yet.

Impacts

The ecological impacts of an MPA are expected to be positive and evaluation should be coupled to the defined policy objective. This evaluation approach should be undertaken regularly based on a monitoring scheme. As fisheries appear to be an important issue with regard to both ecological impacts and at the decision making level, it is probable that the policy objectives –especially the habitat conservation objective– are difficult to comply with. On the one hand, some authors point out that habitat destruction might not be a major cause of decreasing fish populations, as they refer to the natural variability in fish populations that generally occurs on a time scale of decades, which is similar to that for technological improvements in fisheries (Steele and Hoagland, 2003, 2004). Overexploitation is then caused by the ‘ratchet’ effect described by Ludwig *et al.* (Ludwig *et al.*, 1993): unlike natural predator populations, which generally respond to declines in their food sources with rapid declines in population size, fishing fleets do not rapidly shrink in response to diminishing prey. This viewpoint is still under discussion (Zeller and Russ, 2004). On the other hand, beam trawl impacts on habitats have been observed and areas with a more complex biogenic structure and higher biodiversity, such as high density patches of tube dwelling polychaetes, are known to suffer from beam trawl activities.

Certain stakeholders such as fishermen may perceive economic impacts of MPA implementation to be negative. Nevertheless, the real economic impact on fisheries in Belgium would probably be low, as the economic value of the sector is very low. It is, however, important to mention that after a closure for fisheries inside an MPA, congestion on the remaining areas may occur (which can lead to gear conflicts and shifts to other target species), in the search to regain the economic loss for reduced fishing grounds. This may lead to sweeping environmental degradation outside the MPAs. Direct social implications relate to the restricted economic activities and its effects on employment, be it on a very local scale. Other social aspects relate to the opportunities that arise for scientific and educational purposes and to non-use values such as sense of place. These social impacts of MPAs are important for the public support for measures and require due attention. This debate, however, is beyond the scope of this article.

Conclusion

The flow chart that was designed as a mental mapping exercise resulting from a literature review illustrates (1) why MPAs originate, (2) how they are designated and (3) how they have various impacts in a temperate soft-bottom area. Policy objectives are easy to identify and relate in many cases to international legal obligations and commitments. The decision making process is the most complex phase during the MPA-process, as management of the MPA and that of other sectors are regulated both at a local and on an international level. Most difficulties arise because of the relation between fisheries and MPA-management. Not only conflicting interests, but also institutional differences are important bottlenecks in most cases. Although legal instruments are often established as a basis for the decision making process, they are generally weak as several competences are located in other sectors and/or other (international or regional) administrations. Monitoring programmes are necessary to evaluate the effectiveness of MPAs, but are often non-existing ('paper MPA'). The ecological impacts are a measure to quantify the effectiveness of the MPAs, while economic impacts have to be managed through consultation during the decision making phase. Activities limited in space and reliant less on biological production are easier to manage (e.g. offshore energy production and aggregate extraction) than fisheries. Social implications for MPAs are generally important to create a public support for MPA-measures. The 'MPA-process' in the

Belgian coastal environment proves to be very difficult, such that reaching the policy objectives with the current (legal) system is highly unlikely. In Belgium, difficulties occur with the integration of fisheries management into the MPA-management. Not only the more common challenges such as social implications of fisheries restrictions and the international fisheries regulations, but also the complicated system with dispersed competences between the different authorities fuels conflict. Therefore, MPAs designated in the Belgian waters can, at best, be considered as 'structural paper MPAs' in which it will be difficult to implement an MPA-management regime that has the desired impacts at socio-economic and ecological level. However, the application of the systems approach proved to be useful in providing insight into the complex interactions during the 'MPA -process', especially during the decision making phase. The conceptual flow chart visualizes a systems approach for the complex 'MPA-process'. This unifying concept is useful for policy makers and managers (1) as a communication tool to inform other sectors and the public at large and (2) as a backing during the 'MPA-process' that considerably enhances the prospects for success.

Post scriptum. The MPA-process is a very dynamic process. This is again shown in the Belgian case in which very recently the Belgian council of State annulled the designation of the SAC 'Vlakte van de Raan' following the complaint of Electrabel (see discussion). Currently, it is unclear what the consequences of this decision will be and if and when the federal government will re-designate this area as an MPA.

Acknowledgements

We thank Eric Stienen and Wouter Courtens of the Research Institute for Nature and Forests (INBO, Flemish Government) for valuable information related to birds of the BPNS. We are indebted to Jochen Depestele of the Institute for Agricultural and Fisheries Research (ILVO, Flemish Government) for the comments on an earlier draft. We wish to thank for the advice on both scientific content and language of Dr. John Baxter (editor) and for the invaluable referees' comments provided by Prof. Dr Richard Kenchington and Prof. Dr John Roff, improving the quality of this paper considerably. Els Verfaillie (RCMG, UGent) is thanked for the delivery of shape files. We are grateful for the remarks of Ulrike Braeckman and for the linguistic comments provided by Liesbeth Hiele. This publication further contributes to the Ghent University *BBSea* project (contract no. GOA-01G00705; <http://biology.ugent.be/bbsea>) and is part of the EU Coordination Action *ENCORA* (contract no. GOCE-518120; <http://www.encora.org>). The authors acknowledge the support by the *MarBEF* Network of Excellence 'Marine Biodiversity and Ecosystem Functioning' (<http://www.marbef.org>) which is funded by the Sustainable Development, Global Change and Ecosystems Programme of the European Community's Sixth Framework Programme (contract no. GOCE-CT-2003-505446). This publication is contribution number MPS-08027 of MarBEF. This study was also supported by the *Interreg IIIB Corepoint*-project (Contract no. ED084) and the first author acknowledges a fellowship from the Research Foundation – Flanders (*FWO-Vlaanderen*), Belgium.