The different uses of sea space in Polish Marine Areas: is conflict inevitable?

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Jan Marcin Węsławski[1,⋆]
Jacek Urbański[2]
Lucyna Kryla-Staszewska[2]
Eugeniusz Andrulewicz[3]
Tomasz Linkowski[3]
Emil Kuzebski[3]
Włodzimierz Meissner[4]
Zbigniew Otremba[5]
Joanna Piwowarczyk[1]

[1] Institute of Oceanology,
Polish Academy of Sciences,
Powstańców Warszawy 55, PL–81–712 Sopot, Poland;

e-mail: weslaw@iopan.gda.pl

⋆corresponding author

[2] Geoinformatics Laboratory,
Institute of Oceanography,
University of Gdańsk,
al. Marszałka J. Piłsudskiego 46, PL–81–378 Gdynia, Poland

[3] Sea Fisheries Institute,
Kołłątaja 1, PL–81–332 Gdynia, Poland

[4] Avian Ecophysiology Unit,
Department of Vertebrates Ecology and Zoology,
University of Gdańsk,
al. Legionów 9, PL–80–441 Gdańsk, Poland

[5] Gdynia Maritime University,
Morska 87, PL–81–225 Gdynia, Poland

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Abstract

Seven major types of sea space use (Nature Protection Measures, Fisheries Exploitation, Geological Exploitation, Recreation, Large Infrastructures, Navigation, Military uses) in the Polish Marine Areas are presented in terms of how much space is used (km^2) for each use and the degree of overlap among the different uses. The greatest degree of conflict is noted with regard to Nature Protection (which overlaps with 60% of the areas used for Recreation and Geological Exploitation), and Fisheries Exploitation (which overlaps with 60% of the areas used for Nature Protection, Recreation, Infrastructure and Navigation). On the other hand, Fisheries Exploitation areas are the least disturbed by other users, and its major competitor is Nature Protection, which claims 20% of the areas used by fisheries. A GIS–based map that illustrates the degree of conflict is included, and the authors suggest participatory management as the proper way to minimize conflicts over sea space use and to promote the effective protection of natural resources.

1. Introduction

One of the basic rules in both ecology and evolution is that two species cannot use the same resource (niche) in the same place and at the same time (habitat). The stability and resilience of ecosystems and biodiversity rely on the strategy of avoiding competition (conflicts). Stressful situations such as climate change, natural disasters or human pressure can push stable systems into new states, in which, during the change process, a number of conflicts for space among species can arise. The sea space is three-dimensional (depth), and time might also be considered a factor facilitating the better division of space among users. Understanding the division of space among ecosystem components is a core part of the science of ecology (Krebs 1994). Humans are important users of marine space: our use is partly dictated by natural processes (opportunistic), and in part we modify the sea space ourselves.

The expansion of human activities towards coastal and open sea areas has been rapid in recent years, which is why Marine Spatial Planning has become an emerging field in both management and science (Douvere 2008, Zaucha & Jakubowska 2008, Douvere & Ehler 2009). Human expansion and its associated ecosystem modifications are happening at the same time that major, natural/semi-natural environmental changes are occurring, generally under the heading of 'Climate Change'.

Ongoing climate change in the Baltic Sea was reviewed thoroughly by HELCOM (2007), and there are indications that phenomena like decreasing sea salinity, increased temperature, increased local stratification, decreasing oxygen availability in deeper parts of the sea, progressing eutrophication and the settlement of alien species are becoming more commonplace. All these processes may modify sea space use.

Increasing industrial and recreational pressure in a shallow seabed is evident in the southern Baltic, where wind farms, pipelines, marinas, oil rigs etc. are either already in operation or in the planning stages. These types of activity have been analysed partially in a number of local reports (Andrulewicz et al. 2003, 2010, Szefler & Furmańczyk 2007, Otremba & Andrulewicz 2008) and in German, Danish and Swedish case studies (Buck et al. 2004, Larsen & Guillemette 2007) published in the mainstream literature. The combination of environmental change and sea use change renders space management issues more urgent, and this calls for precise, scientifically-based information (Jones 2001, Pedersen et al. 2009).

The aim of this paper is to test the following hypothesis:

1. Nature Protection Measures in the Polish Marine Areas (PMA) are not in conflict with planned commercial uses of the sea space, since protection focuses on areas of little interest to commercial users; additionally, where overlap does occur, it can be negotiated.

An alternative hypothesis is as follows:

2. Nature Protection areas are of importance for various commercial users, overlap is extensive, use types are mutually exclusive, and successful negotiations are unlikely.

2. Material and methods

Our approach was to collect the available information on sea space uses by various sectors and compare them with known data on the distribution of natural values. Critically reviewed, good quality maps and Geographic Information System (ArcInfo) were the basis for the comparisons. The sources of information are summarized in Table 1.

Table 1. Summary of information collected for this study

Type of information	Source
seabed habitats	after Węsławski et al. (2009), data at http://www.iopan.gda.pl
nature protection	compilation by the Geoinformatics Laboratory, University of Gdańsk, based on Ministry of Environment official data
large infrastructures	from the Polish Navy Hydrographic Bureau and the report by Szefler & Furmańczyk (2007)
navigation	official maps from the Polish Navy Hydrographic Bureau
fishery exploitation	based on the Sea Fishery Institute's data base and its estimate of the value of commercial catches in PMA

The assessment of the overlapping interests of different users was produced in two stages:

1. the space claimed by each user was calculated;
2. space use overlap was calculated for each pair of users (without repetition), creating 16 conflict maps;
3. the percentage of conflicting space overlap was calculated.

Uses of the PMA map (Figure 1) was produced using Local Statistics (SUMA) from 15 maps reclassified to a 0–1 index map. Levels of interactions among space users in PMA were taken on an expert approach basis.

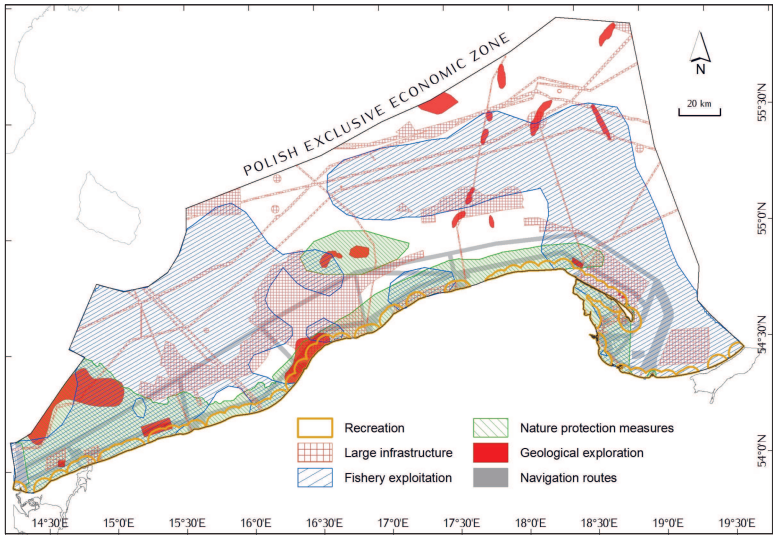

Figure 1. Uses of the PMA

3. Results

The main types of sea space uses (Figure 1), their areas, and the percentage of PMA space they occupy are listed below:

Nature Protection – this includes all NATURA 2000 marine areas (Birds and Habitats Directives), Marine Reserves, National Parks and Marine Landscape Parks. There are 6438 km^2 of such areas in Polish sea waters (20% of the PMA). Sea birds are the resource of most social concern (charismatic species) and the one that is assigned the largest protection area. Polish Marine Areas are important wintering grounds for birds from Scandinavia and northern Russia, the key areas for wintering bird protection being Puck Bay, the Pomeranian Bay and the Słupsk Bank. Five key

Table 2. Key habitat types protected by EU regulations (habitat numbers refer to Annex 17 of the Habitat Directive)

Habitat	Area (km^2) in PMA	Percentage of protected area in PMA
sandflats not covered by sea water 1140	1	100
seagrass beds 1120	48	100
large shallow inlets and bays 1160	105	100
sandbanks slightly covered with water 1110	5233	89
offshore reefs 1170	689	47

protected marine habitats in the PMA are listed in Annex 17 of the EU Habitat Directive. Their share of the sea space and the percentage of protection are presented in Table 2. They range from extremely small (less than 1 km^2 of periodically dry sandbanks in the PMA) to very extensive areas (over 5000 km^2 of shallow submerged sandbanks). Apart from the offshore reefs, more than 50% of the areas of all the other habitats are protected. In addition to birds, sea mammals are also the focus of nature conservation. As there are no established breeding populations of sea mammals in the PMA, the spaces considered to be of importance include areas where seals rest; these remote areas are difficult of access and include small sand bars at the mouth of the River Vistula and off the Słowiński National Park coast.

Fishery Exploitation – this includes all areas exploited by the commercial fishery (cod, herring, flatfish, sprat, salmon, sea trout) from both small open boats and the largest trawlers. The fishery exploits 20 202 km^2 (62% of the PMA). The increasing importance of recreational fishery is difficult to illustrate on the map since most of this activity is concentrated at specific points (e.g., shipwrecks, large stones) that are not available to trawling and where the probability of catching large cod is higher. The deployment of fixed gear (for flounder, salmon, trout, cod, pike perch) is concentrated around the Vistula mouth and along the outer part of Puck Bay. Fixed gear poses serious threats to sea mammals and seabirds; attracted to this gear by the readily available food resources, the animals become entangled in them. It is estimated that some 17 000 birds die in fishing nets every year in the Gulf of Gdańsk alone (Stempniewicz 1994). Drowning in fishing nets is the main mortality factor among seabirds along the Polish coast. In the last two decades losses due to oil pollution have been negligible (Meissner et al. 2001). Because of the trends in Baltic Sea evolution towards warmer, eutrophic, oxygen-poor waters (HELCOM 2007), pelagic trawling for sprat has been increasing in importance, whereas the

size of demersal fish catches is diminishing. Nevertheless, catching efforts may be intensified to compensate for dwindling resources; hence, more space will be used for such efforts.

Geological Exploitation – gas extraction (oil rigs), sand and gravel extraction, and future amber extraction are included, with a total of 1233 km^2 designated for this use type (4% of the PMA area). While the southern Baltic Sea has some documented crude oil resources, they are estimated as being limited. At present, the exploration for and exploitation of crude oil and gas deposits are concentrated at four drilling platforms – Petrobaltic, Baltic Beta, PG-1, and a new platform, D-6, in the Russian EEZ (Kaliningrad Oblast), where extraction began in 2006.

Recreation – this includes all coastal sea bathing areas, beaches, windsurfing and sports involving small boats. 1391 km^2 are used for this (4% of the PMA area). The most common recreational activities in Poland are sunbathing, swimming and spending time on the sandy beaches. Yachting is less popular in Poland than in Germany and the Scandinavian countries, but motor boating, windsurfing and diving (mainly in Puck Bay) are gaining in popularity.

Large Infrastructures – this includes harbours, pipelines and planned wind farms and the surrounding navigational safety zones; a total of 6356 km^2 are used for these purposes (20% of the PMA). Electricity transmission lines require space. Because of its extended longitudinal shape, the Baltic Sea is particularly suitable for energy transfer between various coastal countries, as well as between the mainland and islands. There are currently nine high voltage direct current (HVDC) transmission lines in operation. One of them, the SwePol Link, lies in the Polish Marine Area. Connecting Poland and Sweden, this 245-km-long link (600 megawatts) is one of the world's longest HVDC cable connections.

The number of new constructions in the Polish Marine Area and consequently, the pressure these place on the natural environment will grow rapidly. At present, the following are in the planning stages:

- wind turbine farms (approximately 1500 offshore stands);
- a liquid natural gas terminal;
- a new shipping route between the city of Elbląg and the Gulf of Gdańsk;
- a gas pipeline connecting Norway and Denmark with Poland;
- a new electrical power station in Gdańsk.

All these projects are in various planning stages, and there is no guarantee that they will be completed; however, for the purposes of this

paper, they are included as components of maritime and coastal spatial planning.

Navigation – shipping routes, anchorages and harbour approaches claim 2182 km^2 of space (7% of the PMA area). A new concept, not included in the preceding calculation, is the projected sea route between the river port of Elbląg and the Gulf of Gdańsk. The proposed shipping channel for the city and port of Elbląg will cut across the Vistula Spit and pass through the Vistula Lagoon. However, this route, as well as others, is already in conflict with nature conservation measures in place for the Vistula Spit (HELCOM BSPA) and the Vistula Lagoon (NATURA 2000).

Military uses – military areas are marked on navigation charts issued by the Polish Navy Hydrographic Bureau. They are closed temporarily for exercises, and closures are announced long before the exercises are due to begin. Military uses are not in serious conflict with nature conservation, although they may be in temporary conflict with navigation and fishery. Proposals for new large scale constructions ought to be consulted with the military authorities, in accordance with Polish Law.

Overlapping interests – Overlapping uses are illustrated in Figure 2 and Table 3. The major potential conflicts for space are between Nature Protection Measures (NPM) and Fishery, which operates in 62% of protected areas. For Geological Exploitation (GE), the major obstacle is NPM, since 70% of areas important as regards sea mining are protected. Recreational areas are used also by NPM (76%) and Fishery (65%).

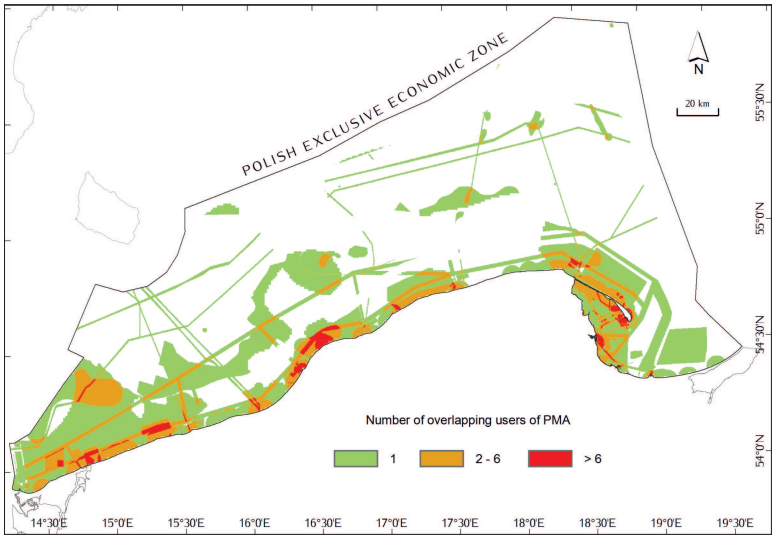

Figure 2. Overlapping users (from the data in Table 4)

Table 3. Percentage overlap of conflicting uses of the sea bed in the Polish EEZ (see also Figure 1). The numbers indicate, e.g. that 62% of the Nature Protected Measures (NPM) area is also used for Fishery Exploitation (FE), and that Geological Exploitation (GE) claims 13% of the NPM

	NPM	FE	GE	R	I	N
Nature Protection Measures (NPM)	-	**62**	13	16	12	17
Fishery Exploitation (FE)	20	-	3	5	19	7
Geological Exploitation (GE)	**70**	47	-	9	17	10
Recreation (R)	**76**	**65**	8	-	19	12
Large Infrastructure (I)	13	**61**	3	4	-	7
Navigation routes	51	**68**	5	7	20	-

For Large Infrastructures and Navigation, the major competitor for space is Fishery, which uses over 60% of the respective areas (Table 4). The least competition for space comes from GE, Recreation, Infrastructure and Navigation, since these users utilize less than 20% of other users' space. Interactions between sea space users do not always conflict (e.g. recreation is positively linked with infrastructure such as marinas and similar facilities); these types of interactions are presented in Table 4.

Table 4. Level of interaction among space users in the PMA (*continued on next page*)

Uses		1 FIS-N	2 FIS-T	3 REC-B	4 REC-S	5 REC-A	6 REC-D	7 WM	8 CBL	9 MAR
fishery – nets	FIS-N	0	4	1	3	4	4	2	2	3
fishery – pelagic trawls	FIS-T	4	0	1	3	4	4	4	3	3
recreation – bathing, beach	REC-B	1	1	0	1	4	2	2	2	2
recreation – boats, wind-surfing	REC-S	3	3	1	0	4	2	3	1	0

Table 4. (*continued*)

Uses		1 FIS-N	2 FIS-T	3 REC-B	4 REC-S	5 REC-A	6 REC-D	7 WM	8 CBL	9 MAR
recreation – angling	REC-A	4	4	1	3	0	2	1	1	0
recreation – diving	REC-D	4	4	2	2	2	0	1	1	0
offshore wind turbines	WM	2	4	2	3	1	1	0	1	4
cables, pipelines	CBL	2	3	2	1	1	1	1	0	1
marinas, piers	MAR	3	3	2	0	0	0	4	1	0
bird protection	BPR	3	2	3	3	3	1	3	1	2
sea mammal protection	SMPR	4	2	3	3	3	1	2	1	3
habitat protection	HP	2	1	1	1	1	1	4	3	4
gravel, sand extraction	GSE	4	4	4	3	4	3	4	4	4
gas extraction, rigs	GE	4	4	4	4	4	3	4	4	4
offshore amber extraction	AE	4	4	4	4	4	3	4	4	4
shipping routes	SR	2	4	4	2	3	4	3	1	0
military areas, exercises	ME	2	4	4	4	4	4	4	4	4
interaction	mean	2.8	3.0	2.3	2.4	2.7	2.1	2.7	2.0	2.2

		10 BPR	11 SMPR	12 HP	13 GSE	14 GE	15 AE	16 SR	17 ME
fishery – nets	FIS-N	3	4	2	4	4	4	2	2
fishery – pelagic trawls	FIS-T	2	2	1	4	4	4	4	4

Table 4. (*continued*)

Uses		10 BPR	11 SMPR	12 HP	13 GSE	14 GE	15 AE	16 SR	17 ME
recreation – bathing, beach	REC-B	3	3	1	4	4	4	4	4
recreation – boats, wind-surfing	REC-S	3	3	1	3	4	4	2	4
recreation – angling	REC-A	3	3	1	4	4	4	3	4
recreation – diving	REC-D	1	1	1	3	3	3	4	4
offshore wind turbines	WM	3	2	4	4	4	4	3	4
cables, pipelines	CBL	1	1	3	4	4	4	1	4
marinas, piers	MAR	2	3	4	4	4	4	0	4
bird protection	BPR	0	0	0	3	2	3	2	2
sea mammal protection	SMPR	0	0	0	3	3	4	2	2
habitat protection	HP	0	0	0	4	4	4	1	1
gravel, sand extraction	GSE	3	3	4	0	4	4	4	4
gas extraction, rigs	GE	2	3	4	4	0	4	4	4
offshore amber extraction	AE	3	4	4	4	4	0	4	4
shipping routes	SR	2	2	1	4	4	4	0	4
military areas, exercises	ME	2	2	1	4	4	4	4	0
interaction	mean	1.9	2.1	1.9	3.5	3.5	3.6	2.6	3.2

0 – positive, one user helps another; 1 – neutral, no antagonism, no benefit; 2 – slightly negative, avoidance is preferred; 3 – negative, threat of use loss; 4 – strongly negative, exclusive use.

4. Discussion

4.1. Major conflicts (nature protection, fishery exploitation)

All of the conflicts for space use presented above are well known from the literature the world over. The most common type of conflict is that between Nature Protection and other users (Pedersen et al. 2009). Nature protection measures are not very extensive in the PMA: just 20% of the area is designated for protection. In other EU countries, this figure ranges from 5 to 30%, and Lunney et al. (1997) suggested that 20% area protection should be the minimum standard for Europe.

In our case study, Fishery is the main competitor with Nature Protection areas, which reflects the situation in other regions in the Baltic and elsewhere (Jones 2001, Podolska et al. 2009). Geological exploitation (gravel and sand extraction) areas are in conflict with NATURA 2000; this is obvious since shallow sand banks are a special habitat type (no. 1110) that is protected by the EU Directive, and these are also areas suitable for sea mining (Jegliński et al. 2009). Nature Protection is in intense competition with Recreation in shallow coastal bays (bathing, marinas, windsurfing). On the other hand, Recreation is concentrated in the short summer season (July and August), whereas the most important period for seabird protection is the winter season, since the PMA is important for migrating and overwintering sea ducks from Scandinavia (Durinck et al. 1994, Olsson et al. 1999, Meissner et al. 2009). Surprisingly, internal conflict can arise within the field of Nature Protection, since the protection of some species, primarily large carnivores such as the grey seal, is contradictory to the protection of other valuable species, which are mainly prey such as salmon and reintroduced sturgeon. Similar conflicts have been described in a number of locations worldwide (Fanshawe et al. 2003, Hansson et al. 2007, Graham et al. 2009, Guillemot et al. 2009). The delineation of an effective area for species protection is one of the key issues in land species conservation, and this has also been introduced recently as an element of measures for the protection of marine species (Levin et al. 2009). The absence of proper habitats or the lack of proper areas can lead to the failure of conservation programmes, as was the case with the river dolphin in Hong Kong (Liu & Hills 1997). Key protected marine species (harbour porpoises and seals) do not have local populations in the PMA, but they used to occur sporadically in these areas as visitors from the north-eastern (grey seals) and western Baltic (harbour porpoises). According to a review of historical records (Ropelewski 1952) neither species has ever been abundant in the PMA: in the early 20th century people were offered a bounty for every seal they shot, but in fact no more than ten such payments were made annually.

Marine mammals are sighted in the Vistula mouth, less frequently in the protected areas of the coastal Słowiński National Park (Skóra & Kuklik 2009); both areas are covered by NATURA 2000. Areas of special value where marine mammals are recorded also tend to be physically unstable; such sites include sandy islets that are changeable in that they can be dry or covered by the sea at various times of the year, which makes them difficult objects for planned protection. The importance of the occurrence of marine mammals is supported by public concern, but it also poses difficulties for the fishing industry, which is often limited by conservation measures such as bans on certain types of gear and requirements for instrumentation to deter these animals. This is why interactions between marine mammals and fishery are often the focus of sea management publications (Karlsson et al. 2005, Hansson et al. 2007, Matthiopoulos et al. 2008). Detailed knowledge of marine mammal migration routes and resting sites obtained through satellite telemetry helps to locate usually well-defined areas and minimize conflicts (Sjoberg et al. 2000).

The nearly uniform character of the PMA means that Fishery Exploitation, which is mainly pelagic, is very widely distributed. This is why it is the main user of sea space in the PMA (over 60%). As the user of the largest amount of space in the PMA, Fishery Exploitation naturally disturbs other users. This is especially true of Navigation since as much as 68% of the space used for this purpose is also used by Fishery. The maritime regulations are clear enough, but they have yet to designate this conflict of space as significant because of the current intensity of shipping in the PMA. A new factor is recreational fishery, which is fast becoming a more important competitor for commercial fishery in the Baltic and other areas (Samples 1989, Fock 2008).

Geological Exploitation and Large Infrastructure are users that can alter marine habitats physically through the destruction ensuing from construction work within habitats or the complete removal of benthic habitats. Such loss is of special importance for seabirds, as the most numerous among them are benthic feeders (Meissner et al. 2009). These two heavy industrial users in the PMA have strong competitors in Nature Protection and Fishery, which is also a common problem in Brazilian (Jablonski & Filet 2008) and European waters (Douvere 2008). To some extent the infrastructures may provide habitat for biofouling species (Wilson & Elliot 2009), but compared with the over 3000 wrecks of ships located in the area (Polish Navy Hydrographic Bureau), the new infrastructures will be of minor importance as a hard substrate source.

4.2. The changing situation

The Climate Change factor has an obvious influence on the uses of the Baltic Sea (HELCOM 2007). Fishery is declining while the Recreation and Infrastructure sectors are growing, and this is probably a widespread phenomenon in other European marine areas (Larkin 1996). Climate change and other natural stressors can heighten conflicts between sea users in many ways, e.g. major changes in the distribution of key benthic species (Beukema & Dekker 2005). For the Baltic the most common threats include the loss of habitats or populations (through habitat unification and loss of patchiness) and the concentration of exploitation efforts in limited areas (HELCOM 2007).

4.3. New challenges

New factors to be considered in the uses of the PMA include new types of environmental stress such as noise and magnetic fields produced by marine installations (Andrulewicz et al. 2003, 2010). New threats are also posed by terrestrial activity and can include pharmaceutical wastes released in discharge waters (Vieno et al. 2007) and extensive salt discharge from the ongoing construction of salt caverns on the Polish coast, which requires removing as much as 70 million tons of NaCl into the sea (see the information regarding this in the State Geological Survey (2010).

The linear relation between increased animal protein consumption in Baltic countries and nutrient discharge (Jansson et al. 1998, Humborg et al. 2007) indicates how difficult it will be to counteract eutrophication and maintain the quality of recreational waters.

Some constructions generate invisible environmental barriers (e.g. thermal, acoustic, magnetic), which can contribute to habitat fragmentation and obstruct the migrations of fish, birds and mammals; however, there are no precise case data from the PMA (Andrulewicz, personal communication).

4.4. Other uses

In terms of space claimed, minor users include the Military (testing and exercise grounds) and the Culture sector. The latter is relevant where public opinion is concerned about specific landscape types or the traditional use of marine resources. Although the Culture sector is not a direct user, it does bring a value to an area by providing opportunities for aesthetic, artistic, spiritual, religious and recreational enrichment (Rönnbäck et al. 2007); on the other hand, Culture may prevent other users from excessive commercial exploitation and may therefore strongly influence spatial management decisions.

The only marine landscape in the PMA of public concern is the coastal zone, specifically the open coast sand dunes and the rare moraine cliff landscape in Gdynia. There are indications that the public wants free access to places it regards as visually attractive, but which are also critical for animal protection, such as Ryf Mew, the offshore sandbars in Puck Bay. Scuba diving, while becoming increasingly popular in Poland, does not appear to pose any real threat to the protection of marine habitats or species. Aquaculture, a major competitor for sea space in other countries (Varjopuro et al. 2000, Buck et al. 2004), is not an issue in the PMA (there are no installations save a few experimental, research initiatives). Because of the physical character of Polish coastal waters with their low salinity, extreme seasonality and exposed areas, it is unlikely that sea farming will ever be of any significance in terms of sea space claims.

4.5. Public discourse

More than twenty years of experience with Marine Protection Areas and Environmental Economy leads to the conclusion that the participatory approach and stakeholder involvement, which includes drawing the wider public into discussions, is unavoidable and beneficial for space management (Agardy 2000, Dimech et al. 2009).

In the light of the aim of our study, we conclude that conflicts in the open sea part of the PMA are not critical, since at present there is enough space available to cater for all interests; such disputes that do arise can probably be managed through careful planning. In contrast, the small, enclosed area of Puck Bay is the most contentious site, since the uses designated there are mutually exclusive and require political decisions to be taken. The options are as follows:

- the area can be designated a hot spot of Polish marine biodiversity with the presence of charismatic animals (including the supported reintroduction of the grey seal and the harbour porpoise);
- the area can be designated the largest water recreation centre in the southern Baltic (it is already now a key national site for windsurfing);
- the traditional use of the fishing grounds can be maintained with the addition of new recreational fishing (with the supported reintroduction of pike and perch populations).

The choice between the three options is crucial, and a reasonable consensus should be reached as there is no possibility that seals and seabirds will co-exist on the beaches with the one million tourists that use this area annually, or with the fishermen, who will be deploying increasing amounts of gear among the surfers, speedboats and salt mine discharge pipelines.

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