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# Maritime Spatial Planning and the blue, zebra mussels. A case study for the Polish coastline based on the overview of existing examples from Canada and Australia

## Planowanie Przestrzenne Obszarów Morskich oraz omułek jadalny i racicznica zmienna. Studium przypadku dla Polskiego wybrzeża oparte na zestawieniu istniejących przykładów z Kanady i Australii

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**Abstract:** Poland is at the beginning of Maritime Spatial Planning process which is based on European Union Directive establishing the framework for maritime spatial planning. The Maritime Spatial Planning with the Ecosystem Based Approach is an example of a sustainable ocean management. Mussel cultivation in sea waters is an example of sustainable ocean management in which there is simultaneous use of water area for economical profit and also for environmental protection needed for proper harvest of blue and zebra mussels. Nevertheless, conditions for mussel cultivation on the Polish side of the Baltic Sea are harsh. Effective utilisation of knowledge of more experienced countries is a chance for Polish open water mussel farms to succeed. The example of Canadian and Australian implementing processes shows effectiveness of bottom-up perception of mussel cultivation development.

**Keywords:** blue mussel, zebra mussel, aquaculture, Ecosystem Based Approach, Maritime Spatial Planning

**Streszczenie:** Polska jest na początku procesu Planowania Przestrzennego Obszarów Morskich, do którego zobowiązała się w związku z przyjęciem Dyrektywy Parlamentu Europejskiego, ustanawiającej ramy planowania przestrzennego obszarów morskich. Planowanie Przestrzenne Obszarów Morskich wraz z Podejściem Ekosystemowym jest właściwym przykładem zrównoważonego zarządzania morskiego. Hodowla omułka na morskich wodach jest przykładem takiego zarządzania, w którym przestrzeń wykorzystywana jest jednocześnie do osiągania zysku ekonomicznego oraz ochrony środowiska – koniecznej do poprawnej hodowli omułka jadalnego i racicznicy zmiennej. Niemniej, warunki do uprawy omułka na polskiej części Morza Bałtyckiego są trudne. Efektywne wykorzystanie wiedzy doświadczonych krajów jest szansą sukcesu dla polskich farm omułkowych na morzu. Przykłady procesów implenetacyjnych Kanady i Australli pokazują skuteczność oddziaływania oddolnego w rozwoju hodowli omułka.

**Słowa kluczowe:** omułek jadalny, racicznica zmienna, akwakultura, Podejście ekosystemowe, Planowanie Przestrzenne Obszarów Morskich

## Introduction

This paper tries to find an answer to what extent blue and zebra mussel farming can potentially be enhanced under Polish maritime spatial planning. Poland is at the beginning of the Maritime Spatial Planning implementation process. However, there are countries around the world already operating with their own version of MSP, where within it an aquaculture sector functions. Canada and Australia serves as an examples to answer the question previously

mentioned. The research method is mainly limited to comparative analysis.

The following paper is composed of four parts. In the first one, the key concepts are defined. The second part is the brief description of aquaculture in Poland. In the third part the experiences from other countries are introduced. The last part, conclusions, highlights the research findings.

## Maritime spatial planning and ecosystem based approach

The modern world has an ever-growing resources need. The need for the maritime resources is increasing whereas maritime areas, understandably, cannot expand. This leads to an increasing competition for space. Nowadays, without holistic approach to marine resources management, it is certain that sustainable development is impossible. Such approach is needed to shape anthropogenic pressure on marine environments and to give most advantageous solution for economy, environment and society [1]. This holistic approach is contained in an ecosystem based approach. The term *ecosystem approach* was first applied in a policy context at the Earth Summit in Rio in 1992. The Summit decided that environment demands are as important as social and economic demands. It is due to the fact that goods and services are obtained from ecosystem. Therefore, protection of ecosystem when an economy is progressing enables potential area to satisfy present generation without expense of future generations [2]. This approach, as a natural source management, recognizes humans as an integral component of the ecosystem [3]. Hence, the ecosystem based approach is a holistic integrated management of human activities.

The Maritime Spatial Planning is public and strategic planning process of analysing and allocating the spatial and temporal uses of water areas for human activities. It is a comprehensive, integrated decision making process with perspective for future uses that has to fulfil economic, social and ecological objectives. The Maritime Spatial Planning is a primary process which needs to function well by adopting the "ordered by steps" approach. This order has to logically sequence marine activities to achieve the balance between various competing uses. Therefore, there has to be more precise and detailed process with comprehensive narration to achieve a well-functioning process. Also, the Maritime Spatial Planning sets narration which has to include major aims of different competing activities with a spatially focused perspective so that there would be an efficient organisation which will benefit all who will conduct the process in an integrated manner [4].

In the European Union, legislation like *Integrated Maritime Policy*, *the Habitats Directive*, *Marine Strategy Framework Directive* indicates the sustainable development of EU sea areas. Moreover, the Directive *establishing the framework for maritime spatial planning* (MSP) [5] is also one of, if not the most, important legislative initiative introducing sustainable development policy. Therefore, the European Union recognises the need to address conflicting or competing uses of ocean or sea resources in form of comprehensive planning and managing water areas. As stated in the EU Directive "the main purpose of maritime spatial planning is to promote sustainable development and to identify the utilisation of maritime space for different sea uses as well as to manage spatial uses and conflicts in marine areas". The MSP Directive also defines that "healthy marine ecosystems and their multiple services, if integrated in planning decisions, can deliver substantial benefits in terms of food production, recreation and tourism, climate change mitigation and adaptation, shoreline dynamics control and disaster prevention". In addition, the MSP Directive defines that "in order to promote the sustainable growth of maritime economies, the sustainable development of marine areas and the sustainable use of marine resources, maritime spatial planning should apply an ecosystem-based approach". Therefore, the Maritime Spatial Planning is a future oriented process which requires a dynamic analysis to evaluate the way of implementation. The MSP is relaying on a governance and stakeholder actions. It is a holistic approach addressing social, economic and environmental objectives that needs significant amount of data to function. The role of the Maritime Spatial Planning is to be a key instrument for an EU integrated marine policy. This joint approach with the Ecosystem based approach is a relatively new framework for sustainable ocean management. The mussels and ecosystem services as a part of marine resources need to be included in the sustainable ocean management so that they could be an important ingredient of the Maritime Spatial Planning process.

## Blue and zebra mussels

"The Maritime Spatial Planning can serve as one operational tool for implementing the ecosystem based approach to actual planning process, and therefore enhance the sustainable Blue Growth" [6; 90]. This cooperation model can identify and map most of the sustainable sites, even in case of lack of space which normally would lead to conflicts. This strategic approach will deliver long-term benefits by providing more equitable situation between or within different sectors. Therefore, the MSP is a very important tool for small scale sectors like aquaculture, and for blue growth in general [7]. Moreover, the MSP helps to minimalize or avoid conflicts with other potential users and helps in finding synergies.

Globally, the marine aquaculture has developed significantly over recent decades. This sector provides protein, food security, investments, income, jobs and, additionally, natural water purification. Nevertheless, the aquaculture newcomer entrepreneurship in the open waters will play a minor role at the beginning. The main barrier for its development is the limited availability of suitable space and harsh environmental conditions. It would be a very high risk investment. In order to become economically attractive and vital business in the EU market area, an aquaculture sector needs expensive infrastructure facilities, which are not affordable for aquaculture alone. Therefore, there is a need to create facilities which will be integrated with other sectors. A unique example is the offshore wind farm sector

in case of the possibility to provide a multifunctional co-manage infrastructure, which by negligible impacts of wind farms and aquaculture on each other is essential to provide commercially viable open water aquaculture [8].

The growth of the mussel industry can serve many purposes: developing aquaculture production, supporting spatial planning and managing mussel as a mitigation tool. Mussels can improve coastal water quality by collecting nutrients. "Numerous pilot studies have proven that the establishment of mussel farms has dramatic effects on water clarity, increasing light penetration and leading to a significant decline in chlorophyll-*a*" [9; 78]. In 2004, the town of Lysekil in the south-west Sweden interpreted the EC sewage directive in a different way. The nitrogen removal of a sewage treatment plant was replaced by mussel farming which resulted in almost 100% N removal – the EU directive requested only 70%. Moreover, the phosphorous was recycled back to land with no additional costs [9; 97]. Therefore, mussels by fulfilling the role of a filter feeder can purify water from eutrophication and at the same time broaden human diet as an edible seafood.

One of the mussels that are edible and can purify water are the blue mussels. Cultivation of the blue mussel requires four variables: phosphorous, salinity, latitude and turnover. "Areas of high growth of blue mussel are associated with high turnover rates, high salinity and high total phosphorous level, while areas of low growth were associated with low salinity and low turnover" [10; 5927]. Moreover, blue mussels (*Mytilus edulis*) are an edible mussel and their colours can differ from blue black to brown. Blue mussels prefer areas of high salinity, they are also durable – they are able to withstand temperature extremes, resist dehydration during low tides. Each mussel is able to filter 2-3 litres of sea water per hour.

"The zebra mussel is one of the biggest invasive pests in the world's freshwaters" [11; 253]. Zebra mussels are also an edible mussel; their colour can differ – black or brown with white to yellow zigzagged patterns. One zebra mussel can filter 1-2 litre of water each day. Also, it impacts other spices. For example, population of phytoplankton and zooplankton declined by 40% and 30% in the Hudson River when zebra mussel was spreading. On the other hand, gammarid shrimps can benefit from this situation. Nevertheless, zebra mussels increase water clarity through declining populace of phytoplankton and by that facilitate establishment of macrophytic vegetation which as a result creates more habitat invertebrates like Turbellaria and Trichoptera. Zebra mussels tolerate water with ph>6.9, however growth and reproduction can be constrained by low temperatures and environmental pollution like cadmium [11]. Zebra mussels are capable of colonizing hard and soft surfaces. They feed on planktons, therefore clears water. Substantial improvement of biological and chemical quality of water will cause zebra mussel populace to spread.

Blue and zebra mussels can serve as examples of blue growth strategy and the ecosystem based approach. In summary, mussel cultivation is an initiative which offers economic activity, provides employment and simultaneously is compatible with ecosystem based approach. The Maritime Spatial Planning process enables multifunctional co-management between sectors which mitigates conflicts. Therefore, the MSP can be an opportunity for small scale enterprises which fulfil objectives of sustainable development.

## Baltic Sea Region

Even though mussel farming in this sea would be an operational, simple, flexible and cost-effective method to mitigate the negative effects of water pollution, there are only few areas suitable for mussel cultivation. Moreover, the lack of economic incentives hinders mussel farming on the Baltic Sea where no significant income can be generated from nutrient harvesting. Therefore, mussel cultivation is a difficult task on the Baltic Sea. The most promising mussels on the Baltic Sea are the blue mussels and zebra mussels. The Baltic Sea distinguish itself from other seas by the brackish conditions and low salinity. Hence, only in the south western part of the Baltic Sea blue mussels can reach the size of 4-6 cm. In other parts of the sea these mussels can progress to just one fourth of this size. On the other hand, zebra mussels can be relatively common due to preferring shallow coastal lagoons, estuaries, gulfs and inlets. Blue mussels require small water currents, infrequent occurrence of drift ice in winter, water depth of 10-30m, salinity not below 4 PSU [9; 93]. In case of zebra mussels' cultivation criteria, conditions need to be adjusted to enclosed coastal areas. Therefore, salinity should be below 1.5 PSU, water depth less than 2m.

Sustainable marine aquaculture in Baltic Sea region offers several possibilities, like generating and transferring knowledge, creating jobs and enabling to meet regional demands of high quality food products [9]. Nevertheless, the Baltic Sea is almost enclosed, quite shallow with unique characteristics that above all is a fragile ecosystem. The salinity of the Baltic Sea depends on the yearly saltwater inflow events from the North Sea. Therefore, the salinity is declining from the Western part of the Baltic Sea to the Eastern part. It is due to very small linking to the North Sea and large water supply from many rivers [12]. The Baltic Sea can be a stressful area for small fragile economic activities. Hence, there is an urgent need to implement the MSP process in the increasingly competing Baltic Sea Region.

"One of the key species of the Baltic Sea, the blue mussel *Mytilus edulis*, is of great importance to the ecosystem, e.g. for its filtering function and for creating new habitats for other organisms in the mussel beds" [13; 224]. As a sensitive ecosystem, the Baltic Sea faces severe consequences from pharmaceutical release. Nonetheless, the Baltic sea blue mussels take up the pharmaceutical substances with negative effect [13]. Hence, beside economical attribute of the aquaculture sector on the Baltic Sea, there can be also an environmental attribute. However, declining natural resources due to human pressure and growth of production cost (being a consequence of seafood products add value) is a major concern for producers and public authorities. Therefore, there is a need to harvest less and sell better which

can be too difficult for a new attendee in the Baltic Sea. Nevertheless, the conjunction of particular policies, environment protection or water purification and populace needs can be a valuable factor to develop the aquaculture sector in the Baltic Sea and simultaneously fulfil the required EU Directive mentioned above. Exposure to sea waves is determining the failure of blue mussel farming, hence this variable can be only considered on partly or fully enclosed water areas. The Baltic Sea is a relatively young marine ecosystem which connects the North Sea by the *Öresund* and the Danish Belt. The blue mussel besides ecological importance, provides an important link by cycling nutrients between the benthos and the pelagic organisms and acts as a food source for many fish and bird species. Therefore, the blue mussels are base for many organisms [14].

Despite the aquaculture sector being compatible with EU directives concerning sustainable development and the Maritime Spatial Planning process; the condition of the Baltic Sea is challenging for mussel cultivation. Promotion of blue mussels or zebra mussels can serve environment, but requires significant effort from stakeholders.

## Aquaculture in Polish sea waters as part of the MSP process

The Maritime Spatial Planning is a new issue in Poland [15]. Sea space in Poland is the Minister's responsibility and is administered by his local maritime administration – the Directors of Maritime Offices in Szczecin, Słupsk and Gdynia. The main regulation concerning spatial planning in Poland is the Act on *Sea Areas of Poland and maritime Administration* – it regulates the planning of a sea space. Due to the maritime resources conflicts on the European seas, the MSP issue is accelerating to a full-grown functioning process in the EU Member states. On the Baltic Sea Region Vasab-HELCOM working group has been created, with Poland taking part, which was established to ensure cooperation among the Baltic Sea Region countries for coherent regional Maritime Spatial Planning processes in the Baltic Sea [16] [17]. Poland is at the beginning of the MSP process, but has its own specific structure of planning. The Polish MSP will allocate areas for specific use and also manage those areas (e.g. for environmental protection). In case of the whole Polish sea there will be a strategic plan, but in special cases, like areas with escalating spatial conflicts, there will be a specific plan [18]. This conditions allow to include the mussel cultivation in the Polish MSP and by that, create a frame for development of the aquaculture sector in Poland.

The Polish sea waters provide difficult conditions to cultivate mussels [9]. "Several studies have addressed the potential use of zebra mussels in water quality remediation or sewage sludge treatment" [9; 87]. More beneficial for Polish scenario is cultivating the zebra mussel. Potential use of zebra mussel could be a remediation for water quality in the Polish coastline. "The establishment of zebra mussels and subsequent retention of nutrient has likely counteracted the effects of eutrophication in many inland waters, few studies have quantified this" [9; 87].

The eutrophication is one of the biggest threat in the Baltic Sea Region; Poland has the highest input in this eutrophication. Moreover, the Vistula and Oder rivers were responsible for 25% of total riverine nitrogen and 37% of total riverine phosphorus input to the Baltic Sea in 2000. Nutrient concentrations and loads in both rivers showed significant decline trend in the period 1998-2008. Nevertheless, the EU directives and the HELCOM declarations are aiming to significantly reduce nutrient emission to the river basins and then to the Baltic Sea [19]. Reduction only by conventional methods is ineffective and there is a need to include innovative methods. One of this innovative method is aggregating the aquaculture to an existing system. Moreover, linking habitats protection with the aquaculture and the environmental monitoring would be one of the biggest promising maritime sectors in Poland. This potential sector besides filtering function, creates also jobs, like for Polish fishermen who unceasingly lose their economic independence nowadays [20]. As mentioned above, there is potential in the zebra mussel cultivation to purify water.

Based on the [19] *Study on blue growth, maritime policy and EU strategy for the Baltic Sea Region. Country fiche Poland*, the mariculture sector added value in Poland is about 1 million euro, where the value of fishery sector for consumption is 706 million euro. Also, the fishery sector is shown as a mature sector whereas the mariculture is recognised as a minimal importance sector. Nevertheless, the mariculutre sector in this study (2013) qualified to the nine maritime economic activates with the biggest potential in future in Poland [20]. Sea mariculture sector technically does not exist as a consistent sector in Poland nowadays, but it would be an innovative option in the Polish sea.

Poland has a significant experience in freshwater inland aquaculture (fig. 1), where carp and trout are nationally considered as the most important aquaculture species. Carp farms are distributed throughout Poland. By contrast, trout farms are mostly located in the north in the Baltic Sea coast and in the areas with clear cold water in the south of the country [12]. Therefore, there are entrepreneurs associated with aquaculture sector in Poland who have appropriate knowledge of economic conditions of aquacultural market (fig. 1).

Unfortunately, conditions for the development of aquaculture are not such favourable in case of the Polish coast which leads to disparity between inland and coast/sea distribution of aquaculture activity [21]. The Polish coastline has only few bays and lagoons and mostly does not provide protection against strong waves. The best conditions for aquaculture facilities are at the Puck Bay, which is inside of Gdansk Bay, at Vistula Lagoon and Szczecin Lagoon. All mentioned areas are under Natura 2000 protection with all the associated constraints to the aquaculture. Salinity at 7 per thousand in the Polish sea area is the most stressful salinity for aquatic organisms which have to spend relatively much energy to regulate their osmotic balance. Nevertheless, the well-balanced aquaculture activity can be the cultivation of zebra mussels on almost enclosed water areas [12]. This would be beneficial for polluted Polish coastline. Despite economical difficulty to gain profit by harvesting mussels, this

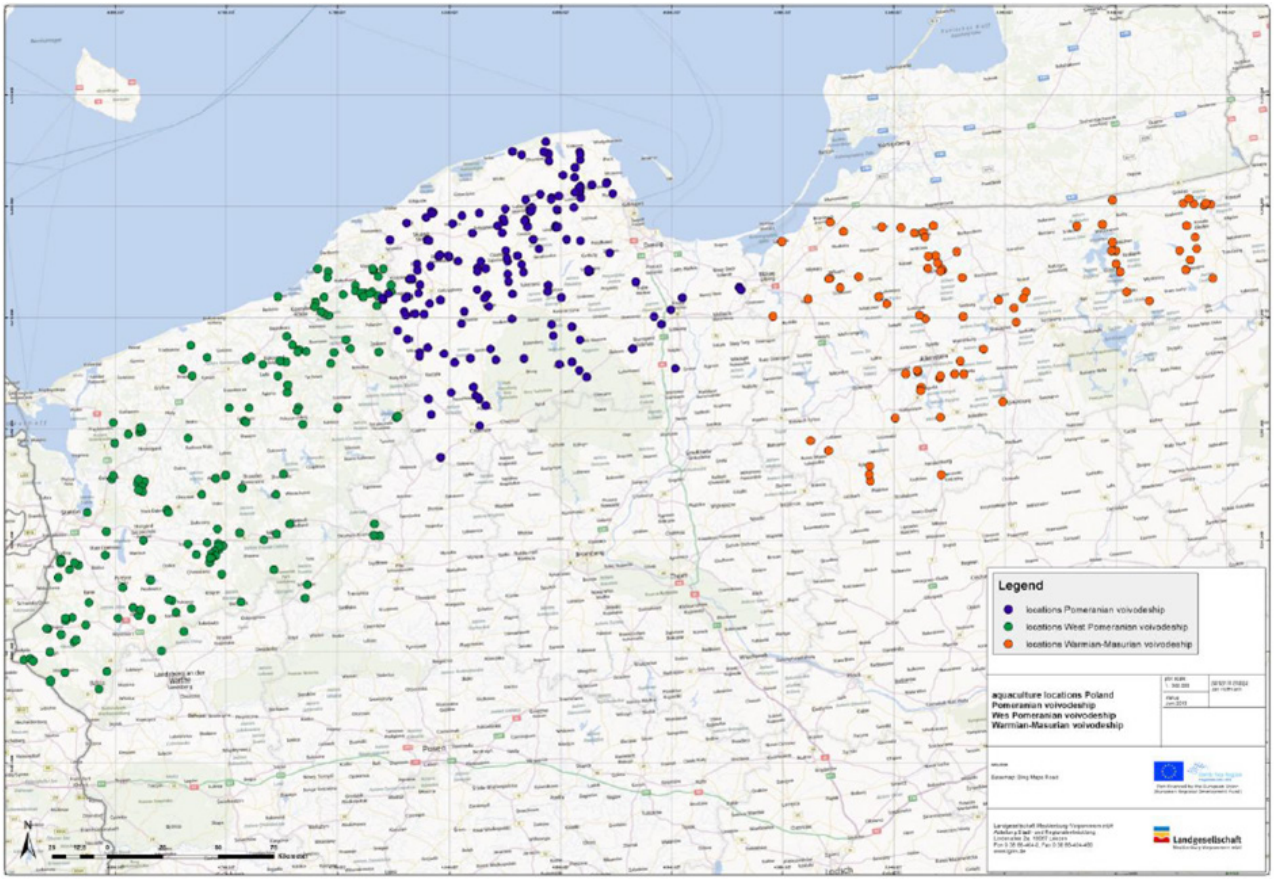


**Fig 1.** Location of inland aquaculture in Poland
Source: Aquafima – Integrating Aquaculture...: 13.

kind of aquaculture activity would certainly have a big impact on water purification in this area. Yet a comprehensive use of mussel farms requires a holistic approach which can be possible to achieve by using the Maritime Spatial Planning tool combined with the Ecosystem based approach. Maximising mussel farming in Poland would be beneficial, however there are many constrains. Therefore, the development of mussel sector in the Polish sea area is very challenging. It should be built on experience of other countries.

## Experience from other countries

Development of mussel cultivation under the aquaculture sector would give measurable benefits on the Polish coastline in the form of water purification and job creation in degraded areas. It would be a positive add on to functioning sectors by supplementing actions through cooperation which would also strengthen cooperating stakeholders. This holistic approach can be achieved by the Maritime Spatial Planning. However, lack of experience in implementing such fragile sector may cause more harm than good.

This overview presents selected examples of existing practices worldwide integrating mussel cultivation in management practices of marine ecosystem. The samples were selected in accordance with the time and the experience of the spatial planning process. Canada was the first country implementing ocean management [22] with regard to enforcement of the *United Nations Convention on the Law of the Sea*. Australia implemented the ocean management later with a complex procedure. These samples visualize altering approach to aquaculture sector in the Integrated Ocean Management. Australia and Canada are one of the first countries in the world that had to face the difficulty of implementing these processes. Their experience is essential in regards with lack of previous examples or knowledge in managing such processes. The pioneer actions of these countries showed obstacles which countries just starting the implementing process like the Maritime Spatial Planning can overcome now.

## Canada

In Canada, the Department of Fisheries and Oceans supports oceans and costal management in the Canadian Maritime Region. The Department's approach to ocean is outlined by *The Regional Ocean Plan* which was delimited as an integrated and ecosystem approach managing Canada's ocean. *The Regional Ocean Plan* is beyond *Large Ocean Management Area* covering greater area than established by the Department. *The Regional Ocean Plan* includes Scotan Shelf, Gulf of Maine, the Atlantic Coast of Nova Scotia and the Bay of Fundy. In the Maritime Regions, the department's Costal Management Division leads the *Integrated Oceans Management*

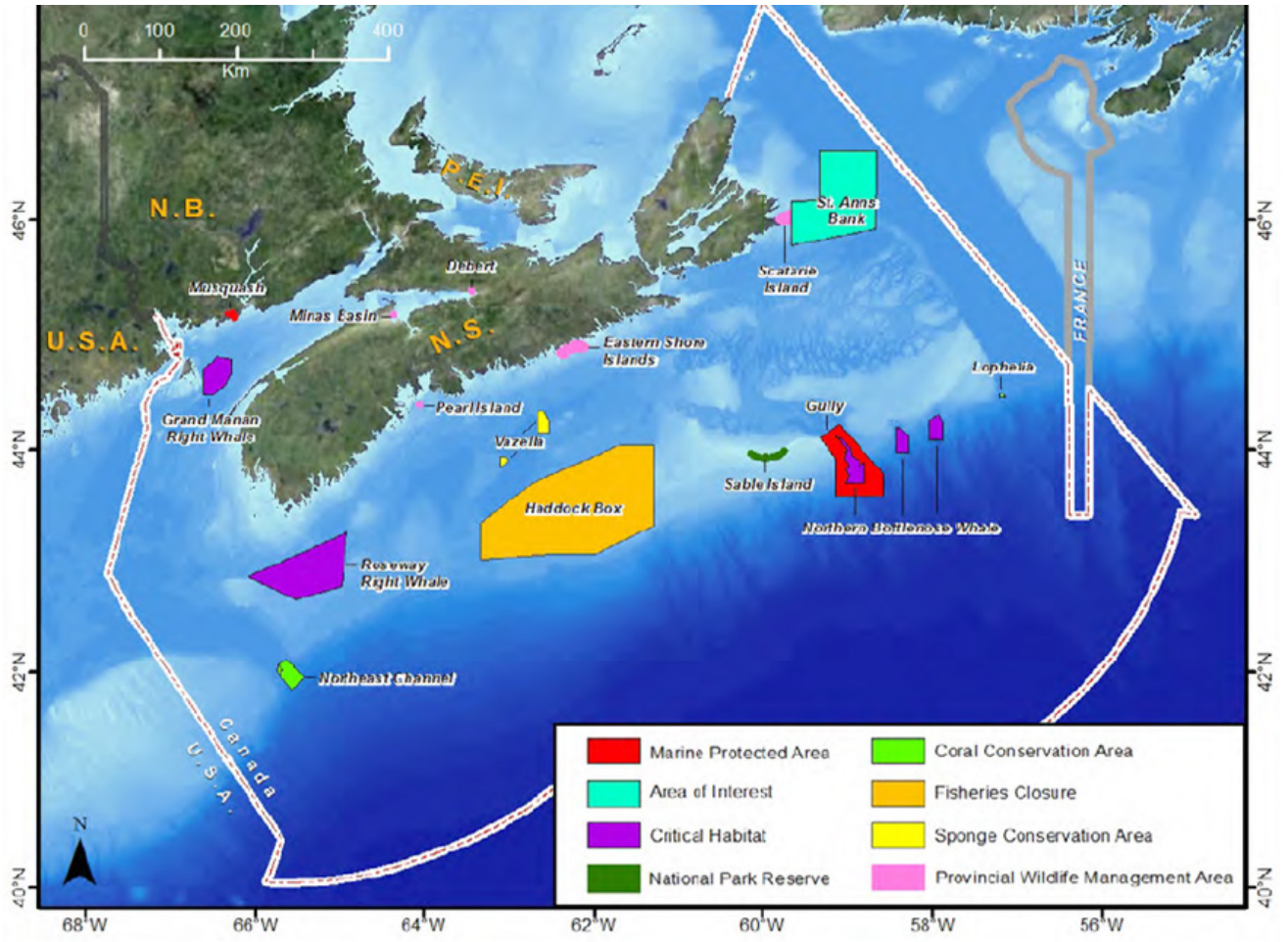


**Fig. 2.** Marine Protected Areas and other key conservation areas in the Maritimes Region
Source: Regional Oceans Plan 2014: 33

*Program*. The Division's role is to develop and implement Ocean and Costal Management, Marine Protected Area planning and management, and also to collaborate or engage programs. The Government of Canada established *Canada's Ocean Strategy* which sets out policy directions for ocean management in Canada. This maritime policy and control was determined by *Oceans Act*. Therefore, Canada by bringing up the *Oceans Act* in 1997 became the first ever country in the world to have comprehensive oceans management legislation which values conservation, management and exploitation of its marine resources [22].

The Canadian *Oceans Act* main principles are sustainable development and integrated resource management. It extended the Department's role in managing the use of marine resources and habitats. Therefore, this act provided a comprehensive legal framework for the government to manage oceans and marine resources. The *Oceans Management Strategy* was established as a next stage of this development [23]. The *Strategy* is a policy statement for the management of estuarine coastal and marine ecosystems. In this regard, *Strategy* needs to set out the policy direction for ocean management in Canada and take under consideration implementing program of Integrated Management. It is designed to provide policy direction for an integrated approach to ocean management, coordination of policies and programs across governments and an ecosystem approach to ocean resource management and environmental assessment [24]. A collaborative ocean and coastal planning process led and facilitated by Fisheries and Oceans Canada due to *Oceans Act* was Large Ocean Management Areas (LOMA). Its main role was to develop and implement an integrated management plan for five large marine regions across Canada. Nevertheless, since 2005 LOMA initiatives have been delayed or abandoned with only one of five management plans being endorsed by the Department [25]. *The Regional Oceans Plan* is a new approach for the Integrated Oceans Management Program. Its main goal is to focus on management needs and activities like ecosystem or risk management to address effective solution through adapted instruments and tools. Therefore, it facilitates integrated and ecosystem approaches to the management of Canadian oceans. *The Regional Oceans Plan* is an evolution of previous initiatives that were terminated in 2012 [22]. Unfortunately, after a decade of progress in creating ocean management the government failed to continue this process. The Eastern Scotian Shelf Integrated Management (ESSIM), which was a stakeholder driven plan, was terminated in 2012 due to lack of support from the government. The Department's initiative – Integrated Ocean Management showed that 8 out of surveyed 10 IOM stakeholders indicated the need for continued federal attention to science, planning and engagement of stakeholder

themes under integrated ocean management. The governmental capacity for social science research on the oceans is poor. There is a significant lack of support in a marine social-ecological system and in a sustainability of knowledge. This highlights that implementation of the *Oceans Act* has not been a government priority. Canada, as a world leader in ocean research and ocean policy failed to fully implement the *Oceans Act* [25].

*The Regional Ocean Plan* by supporting an Integrated Oceans Management Program approach is focused on goals important for cultivation mussels. The ecosystem approach in this approach defines ecosystem as a forefront of consideration in activity in which it is affected. In Scotian Shelf-Bay of Fundy, the bioregion of blue mussels' existence has been specified. *The Regional Ocean Plan* defines that the Department of Fishery and Ocean "will support efforts to promote intergovernmental cooperation and planning and stakeholder involvement in aquaculture" [22; 19]. The Oceans and Coastal Management Division's role is to provide maps, data and risk assessments. It did not contain valuable areas for aquaculture (fig. 2). Nevertheless, there are numbers of policies implemented by the Department of Fishery and Oceans that require support from other sectors within the department. In case of mussels, main document which interferes with *The Regional Oceans Plan* is *Sustainable Aquaculture Plan* [22].

On the Pacific coast of North America, in the Canadian British Columbia, there are four marine mussels species. Native, bay mussel and California mussel and non-native, cultured species blue mussels and Mediterranean mussel [26]. The other area of the blue mussel population is the area of Prince Edward Island. This area is considered as sustainable for mussel industry and blue mussels itself. Styela clava, a predator species to blue mussels was first identified there in 1998. It affects blue mussels by reducing the productivity of adult mussels and by filtering mussel's larvae. A study of these two species showed that high volume of Styela clava in Prince Edward Island more than likely increases predation pressure. Therefore, it reduces mussel larvae. This toughness may affect adult mussels' energy reserves and utilisation [27]. In the western part of Canada certain species of mussels are considered as a threat. Zebra and quagga mussels have a devastating impact on local facilities, salmon population and aquatic ecosystems. The federal government created new Aquatic Invasive Species Regulation which will give public services comprehensive response to invasive mussels [28]. These examples showed a different approach to mussels in Canada. The impact of zebra mussels on local areas was devastating when important for the industry blue mussel's effect, in comparison with predator species, was reduced.

In Canada, mussel industry appeared on the east coast during the 1970s and expanded rapidly in Prince Edward Island during the 1990s. This progress resulted in reaching the position of primary leading shellfish species in Canada [29]. With lack of government priority for Ocean Management, sustainable development of mussel environment is in mussel industry's hands. There is no direct regulation in Canadian version of a Maritime Spatial Planning process to promote cultivation or conservation of mussels. Nevertheless, mussels as a part of Canadian aquaculture are cultivated by private sector and, as presented above, already are a part of Canadian environment.

## Australia

"The release of Australia's Oceans Policy in 1998 was recognised in Australia and internationally as a milestone in marine resource management" [30; 1]. It was a first Australian policy including commitments of the *Law of the Sea* Convention, which besides including the ecosystem based approach, integrated sectorial and jurisdictional interests by adopting a new comprehensive method. In 1998 the Australian government released the Australia's *Oceans Policy* and *Specific Sectorial Measures*. The Policy named the *Regional Marine Plan* the core method of implementing the ecosystem based principals of Australian Ocean Policy. Moreover, there were established new institutional arrangements like: National Oceans Ministerial Board, National Oceans Office, Regional Marine Plan Steering Committee and National Oceans Advisory Group. First *Regional Maritime Plan* was the South East region of Australia. The *South East Regional Maritime Plan's* (SERMP) role was to address the jurisdiction and planning in that part of Australia waters. In case of mussels, the SERMP indicated to "promote sustainable development of aquaculture in the Region by working with States and industry to provide planning and management guidance for aquaculture, taking into consideration the physical and biological requirement of the species to be farmed and of the receiving ecosystems" [31; 46]. The SERMP determined mussel farms positions (fig. 3), therefore it presented detailed sectorial information. The draft of SERMP was announced in 2003 [32].

The Australian government decided, due to reviewing the institutional framework of Oceans Policy implementation, to establish Regional Marine Plans under *the Environment Protection and Biodiversity Act 1999*. *The Marine Bioregional Plans* (MBP) have replaced the RMP. The main difference was that the RMP was focused on environmental and economic aspects while MBP focuses on environment issues and names the priorities of conservation with defining the key conservation issues. The MBP provides the platform for the National Representative System of Marine Protected Areas. The SERMP system with the Maritime Protected Areas has been reviewed and adjusted to adapt to the MBP [30]. *The Marine Bioregional Plan for the South-west Marine Region* shows different approach to the aquaculture. As stated in this Marine Bioregional Plan "the preparation of marine bioregional plans represents an important step towards genuine ecosystem approach to biodiversity conversation and marine resource management. The plans provide a basis for the recognition and valuation of the many essential and largely irreplaceable ecosystem services provided by Australian marine environment" [33; 2]. The conservation values report cards describe the species and places protected in this marine environment. They are a supporting document of the South-west Marine Region (fig. 4). Key ecological features are elements that are regionally important for

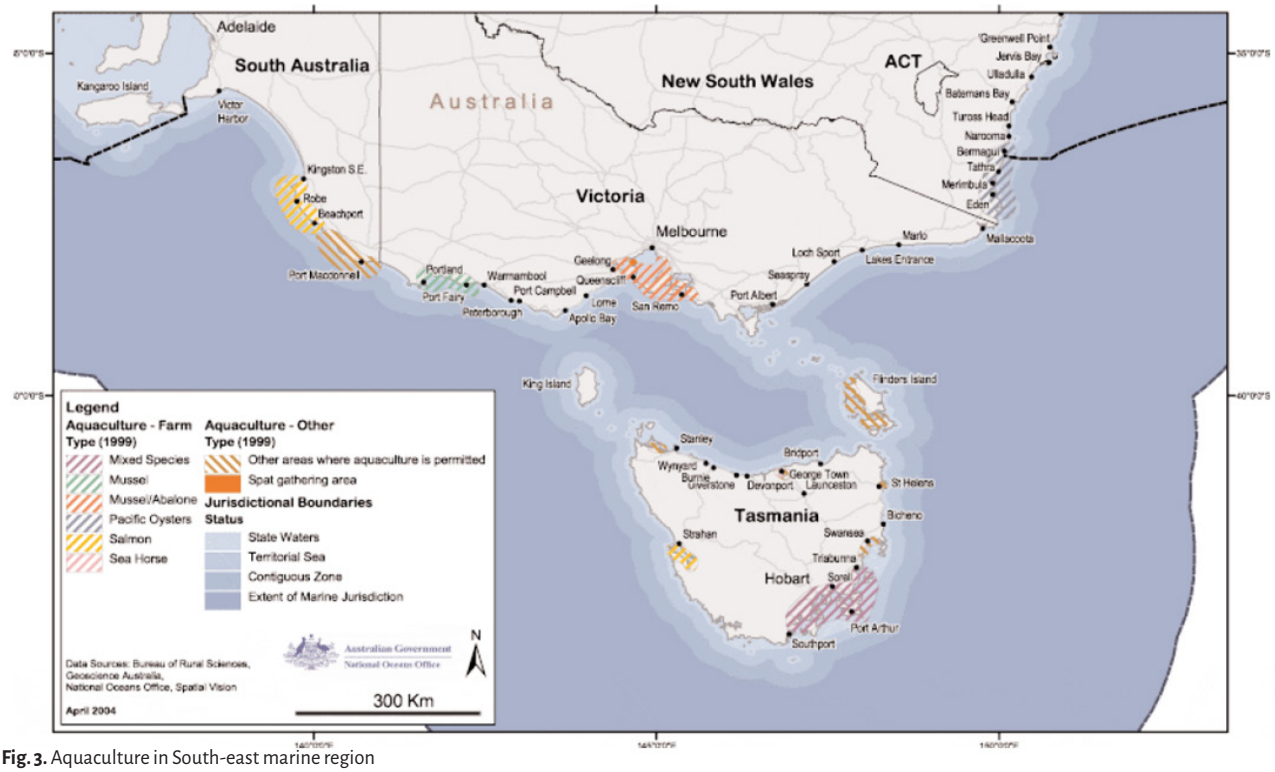


**Fig. 3.** Aquaculture in South-east marine region
Source: South-east Regional ... 2004: 26.

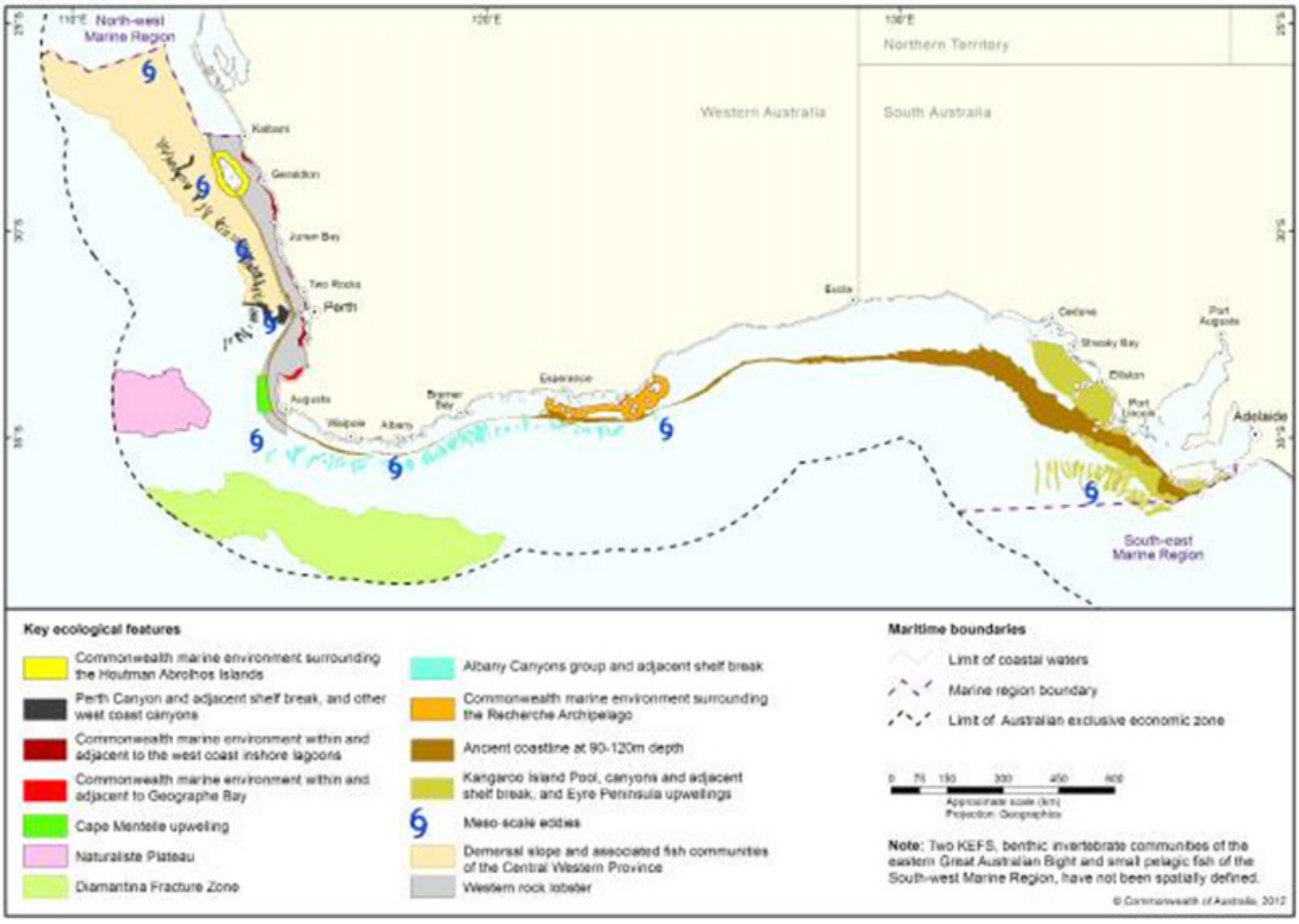


**Fig. 4.** Key ecological features of the South-west Marine Region
Source: Commonwealth marine environment... 2012:13


**Fig. 5.** Spatial distribution of Aquaculture in Eyre Peninsula in Australia.
Source: South Australian Aquaculture 2014: 5

biodiversity or the ecosystem function and integrity. The key ecological features are species that have special regional ecological role, species that are nationally or regionally important for biodiversity and last, areas or habitats that are nationally/regionally important [34]. The role of regional priorities is to inform decision-making about marine conservation and planning. The plan identifies 23 regional priorities where there are no blue or zebra mussels.

Therefore, the MBP does not indicate the development of certain sectors but describes the importance of ecological features in a particular region which needs to be respected by authorities. This change shows how the Integrated Ocean Management is less precise in determining the usage of an area for certain sectors but more flexible for future shifts in particular areas.

The purpose of achieving the Integrated oceans management vision was to mitigate the pressures between competeting human uses and protecting the ocean environment and ecosystem. However, this has been provided on the state level where the majority of conflicts occurs in the coastal zone. The lesson learned throughout the years of implementation of the Integrated Ocean Management are: a) there was created too complex owenership of the policy process, b) there is a need of political and public tolerance for economic and social impacts, c) the vertically and horizontally integrated national system for marine conservation and management has a critical gap in management. Therefore, the vision of truly integrated ocean management has not been delivered. The Australian version of the Maritime Spatial Planning arranged too complicated governance of this process without evaluating the usefulness of the output [35]. Hence, the Australian authorities concluded that the process of implementing sectors, like aquaculutre, need to be structured from bottom-up perspective. In Tasmania aquaculture is a major industry where mussels are commercially farmed [36]. South Australia Marine Area is the most diverse aquaculture system in Australia. The coastal waters of Eyre Penninsula are the most dwelled by aquaculture farming in the South Australia. In this area mussel aquaculture industry is based on the blue mussels which are harvested after a period of 18 months at 10-11 cm length (fig. 5). The South Australian government is looking ahead to working with the aquaculture industry to ensure that the state remains forefront of Australian planning and development [37].

Mussels in Australia are cultivated by the private sector. In the south marine region of Australia, aquaculture sector has changed from being guided in the *Marine Regional Plan* to being stipulated in the *Marine Bioregional Plan*. Therefore, there can be concluded that the Australian version of the Maritime Spatial Planning is more environmental than socio-economical tool.

## Conclusions

Poland is at the beginning of the Maritime Spatial Planning implementation due to enforcement of the European Union directive [38]. The defined in the directive conjunction of the Maritime Spatial Planning and the Ecosystem Based Approach requires from the European Union Member States sustainable development of maritime areas which in this case is mussel cultivation. The Maritime Spatial Planning process in the time of increasing demand for ocean space coordinates space usage and creates ecologically responsible decision-making tool. It facilitates small stakeholders functioning in the sea. Nevertheless, the MSP process needs to be continuous, applicative and accessible in order to be adaptive for future changes. Implementing mussel cultivation in the Polish sea requires very fragile and experienced approach. Development of mussel cultivation under the aquaculture sector would give measurable benefits to the Polish coastline. The mussel industry enhances conservation and sustainability, reduces pollutants, contributes to food security and diversifies the economy of region. However, the Polish sea area provides stressful environment for the blue mussel farming and the only prominent cultivation would be the zebra mussel in partly or fully enclosed waters. The best conditions for the aquaculture though is at the Puck Bay, which is inside of the Gdansk Bay, at Vistula Lagoon and at Szczecin Lagoon. The development of mussel sector in the Polish sea area is very challenging, without expertise from other countries the initial adversity could be a barrier impossible to pass through.

It is necessary to consider the Canadian zebra case where zebra mussels became a threat. The potential growth of zebra mussel needs to be strictly followed. In Canada and Australia the mussel industry is private. The most influential group which developed mussel sector are the private entrepreneurs when simultaneously the government only stipulated this process. Canada did not prioritize their Ocean Management, while Australia developed a flexible approach. Canada and Australia are examples where the government needs to cooperate with existing mussel entrepreneurs to support mussel sector instead of guiding them. Nevertheless, mussels farming in the Polish part of the Baltic Sea can be beneficial mostly in case of compensating the environmental services. By supporting inland mussel industry to spread their businesses over open waters, this would create more immune stakeholders in Polish conditions than inexperienced new companies. The experience of Canada and Australia has shown that the more transparent, detailed information is transferring between interests in the Maritime Spatial Planning process, the more achievable development of the aquaculture sector is.

In Poland, Maritime Offices have legal power to manage the Polish sea. New, under preparation, Polish Maritime Spatial Plan need to take in account situations of sudden change. Despite the mussel industry not being a significant sector in the Polish sea, it can take part in initiating advance multifunctional use of one area. In order to create vital aquaculture business on sea, and likely viable, an integrated infrastructure facility used by both open sea aquaculture and offshore wind farms can emerge. Although this cooperation would be much more beneficial for aquaculture sector due to usage of expensive wind farm infrastructure, it is not a strain for wind farm sector. Therefore, this type of multifunctional use would be a promotion and encouragement for inland mussel entrepreneurs that would be worth an investment risk. There are other possibilities to promote mussel cultivation in the Polish sea than just zebra mussels on partly or fully enclosed waters. However, such initiatives promoting cooperation need to be included in the national Maritime Spatial Plan. Therefore, the MSP promotes the diversification of economic uses of the sea, but it needs bottom-up perception. Beyond shaping reality, the MSP process can also gently respond to changes imposing temporary mechanism as the remedies. Hence, the mussel cultivation in the Polish sea is possible, but it requires comprehensive knowledge to become commercially viable and also requires bottom-up perspective to be more compatible with the mussel sector needs.

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