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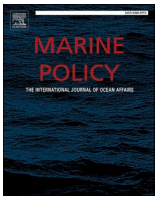

Full length article

Reassessing the management criteria of growing seal populations: The case of Baltic grey seal and coastal fishery

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ABSTRACT

The unintended consequences of marine mammal recoveries have created complex issues for resource managers to solve. In the Baltic Sea, the grey seal (*Halichoerus grypus*) population has increased rapidly during recent decades, and the conflict between seal conservation and fishery has escalated. Although the magnitude of economic losses varies depending on the type of fisheries, there is strong evidence that the grey seal population negatively impacts coastal fisheries and indirectly threatens the cultural heritage connected to it. The current management paradigm is biased towards the preservation of seal populations and it is failing to adequately consider socio-economic impacts of seal population. There is a need to strike a balance between seal conservation and the viability of coastal fisheries, taking into consideration local circumstances. This paper contributes to resolving this problem by assessing the existing governance arrangement. We conclude that the inconsistencies between and within different regulatory frameworks in HELCOM recommendations and European Union law are a structural constraint to tackling the problem. Further to that, some of the existing management criteria applicable to Baltic grey seal population need to be revisited by giving more consideration to regional conditions within the Baltic Sea. For instance, if the data shows that the Baltic grey seal population in its core distribution area has reached a sustainable status and is no longer at risk, then the use of peripheral areas as an indication of inadequate state of the entire Baltic Sea grey seal population is questionable.

1. Introduction

The unintended consequences of marine mammal recoveries have become a major concern in many regions creating difficult trade-offs for natural resource managers to address [11]. Many seal populations have responded favourably to reductions of commercial hunting and culling [52]. The Baltic grey seal (*Halichoerus grypus*) population is a good example of the challenges in the management of a quickly growing marine mammal population.

The grey seal, the most common seal species in the Baltic, is distributed in the entire Baltic Sea with main distribution area along the coasts of central Baltic (Fig. 1). Historical hunting records show that during the period of 1900–1975 the population was severely depleted first due to extensive hunting [22,40] and then due to high concentration of hazardous substances in the water [30]. There is marked uncertainty of how large the population was in the early 1900 s [40] suggested, based on hunting statistics, that it ranged between 30,000 to 200,000 individuals whereas [22] estimated it around 88,000 to 100,000 individuals.

In the mid-1980 s the Baltic grey seal population began to recover rapidly, with an annual growth rate of about 10% [27]. Since the beginning of 2000 s, the growth rate in the main distribution area has

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been around 5%, with considerable yearly variation in number of counted seals (Fig. 2; Annex 1). Recently, the population has increased also in the southern Baltic [19] with the annual increase of about 17% from 2003 until 2019 [2]. In 2021, almost 42,000 grey seals were counted in aerial surveys in the Baltic Sea. Because the counted numbers include 60–80% of all individuals [27], the overall population size in the Baltic Sea in 2021 is estimated from 52,000 to 69,000 individuals.

In parallel with the growing grey seal population, seal-induced catch and gear damages have increased in the Baltic coastal fisheries [39,41, 42,65], causing significant costs to coastal fishers [68]. [60] collected, in collaboration with 15 Fisheries Local Action groups in six countries within the Baltic Sea-basin, from a total of 175 Baltic Sea fishers their estimates of seal induced economic losses in 2018. In Finland the average loss per fisher was €20,465 (n = 79 fishers), in Sweden €19,834 (n = 66), in Estonia €5451 (n = 15) and in Germany €2562 (n = 15). It is noteworthy that the foregone revenues go beyond observed costs and include various types of hidden and indirect costs [10,18,41,42,50,68, 64].

The losses caused by seals seriously affect job satisfaction among coastal fishers by adding to a feeling of powerlessness regarding the future of the fishery [33,4]. The willingness to exit fishery increases with increased seal damages [8], and many fishers are giving up. This has wide implications for coastal villages, for whom the loss of fisheries livelihoods threatens their identity and cultural heritage [33]. In the Baltic region, seals are considered by fishers to be the biggest threat to their livelihood [60,68].

Various non-lethal mitigation technologies such as seal-proof fishing gears and seal-deterring devices have been developed and applied to protect the fishing sector from the impact of seals [31,43,44,45,46,51, 59,65]. Although these technologies help to reduce the catch losses in specific fisheries, they are often costly and technologically complex. It is not surprising that the fishing sector as well as locals in traditional fishing villages prefer to control the number of seals to mitigate the damages and losses [66].

The management regime of grey seal population in the Baltic Sea was established in an ecological and socio-economic situation quite distinct from the one found today. This study reassesses the criteria set in place by public institutions governing seal management in the Baltic Sea. The primary objective is to verify whether a new balance between management of grey seal populations and coastal fisheries is attainable. In

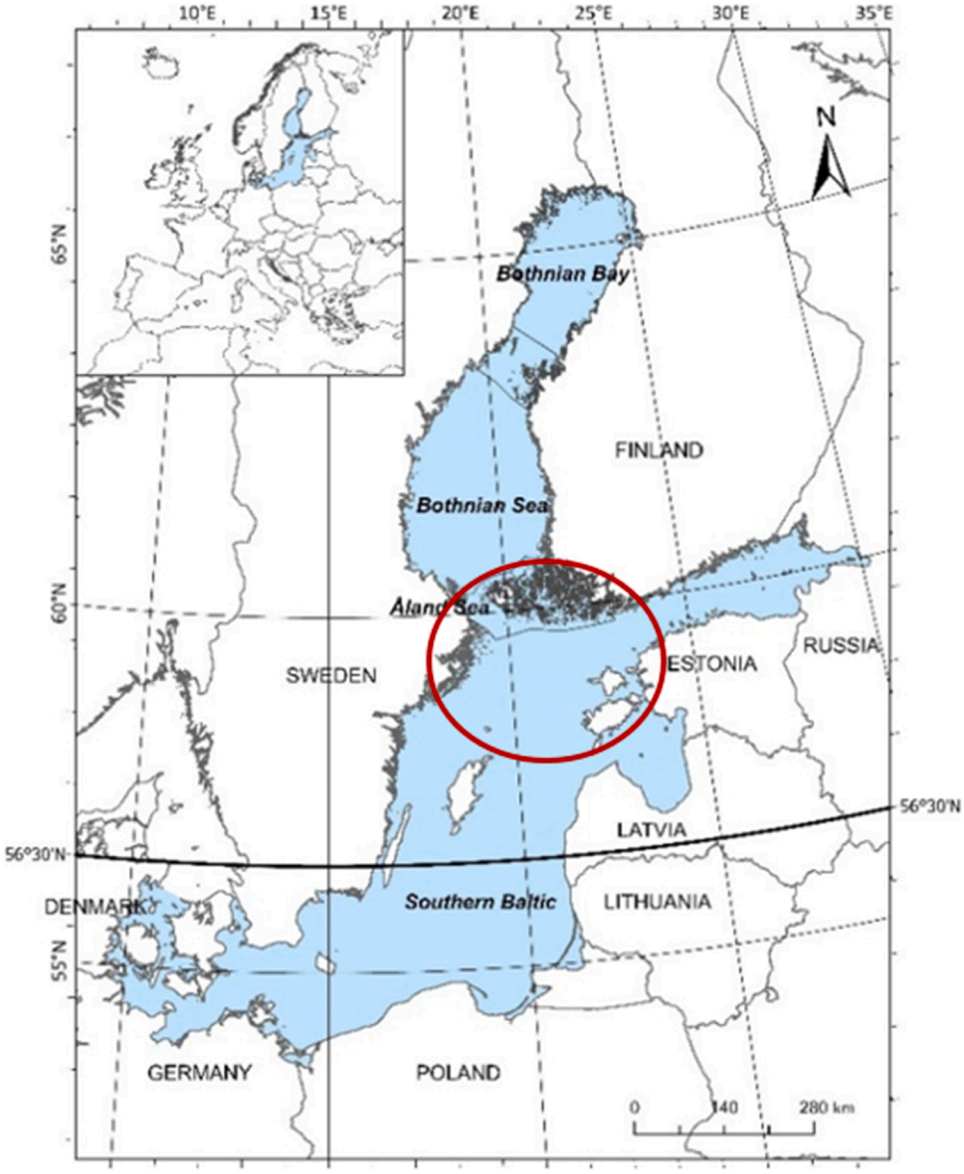

Fig. 1. Map of the Baltic Sea. The main distribution area of Baltic grey seal population is marked with a red circle (according to [69]). The latitude 56°30'N marks the line below which is the southern Baltic Sea.

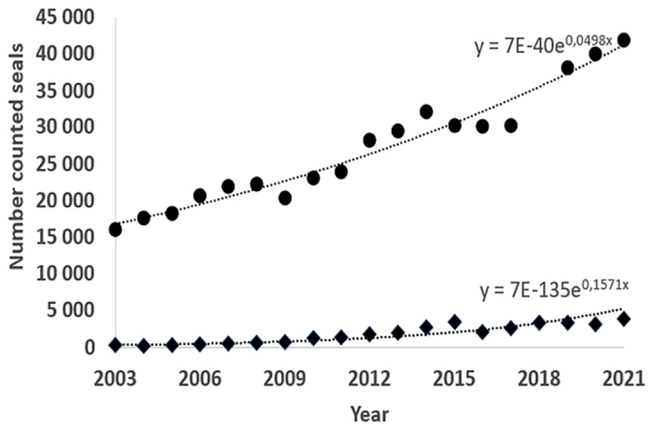

Fig. 2. Number of grey seals counted in joint inventories in 2003–2021 in the entire Baltic Sea (dots) and in southern Baltic only (squares). The dotted lines show the exponential regression.
Data collected from yearly info-releases by the Natural Resources Institute Finland [3].

doing so, we rely on the principles of marine ecosystem-based management (e.g. [49]) and on the concept of sustainable development [6,62]. We propose that the overall goal should be the long-term sustainable management of the grey seal population by considering ecological, economic and social dimensions of the seal-fishery conflict, thereby enabling thriving coastal fisheries to feed the region's consumers and sustain the coastal economy and culture.

2. Potential threats to Baltic grey seal population

There are potential threats to the Baltic grey seal population that need to be understood as a basis for the existing management criteria. These include ecosystem changes, hunting, incidental catches, and the risk of depletion of genetic diversity.

2.1. Ecosystem changes, and the amount and quality of prey

Being top predators in the Baltic Sea ecosystem, seals are exposed to various ecosystem changes and variations in climate. These pressures can affect the food abundance and quality, critical habitats, and levels of harmful substances. The breeding success of grey seal is greater on ice than on land [34]. Hence, in the long run climate change may have negative impacts on stock. Nonetheless, during the last decades there have been several warm winters with low ice coverage, but the population has been growing relatively steadily (Fig. 2). It is noteworthy that the population has grown also in the southern Baltic Sea even though these areas lack ice cover [19].

The availability and quality of food resources affect birth rate and mortality of seal pups, and consequently, population growth rate and numbers [48]. Baltic herring (*Clupea harengus*) is the main, but not the only, food resource for the Baltic grey seal [21]. Herring is affected by ecological conditions and also by commercial fishing [37]. The blubber thickness of grey seal is correlated with the weight of herring, indicating that seal body condition can be related to the condition of its key prey species [36].

2.2. Hunting

Hunting has been the major human pressure on seal species in the Baltic Sea. Hunting was banned in whole Baltic in the 1970 s when the seal populations were at the lowest. A limited hunting was introduced in 1998 in Finland to protect fishing gears and catches. Soon after, Åland (an autonomous region of Finland) and Sweden followed. Estonia started hunting in 2015. Since 2014 shooting of grey seals has been permitted in Denmark under special license in cases where there are substantial economic losses.

In 1998–2021, a total of 13,775 grey seals were hunted by Estonia, Finland, Åland and Sweden from a total allowable quota of 36,611 animals (Fig. 3). Overall quota fulfilment in 1998–2021 was 37.6% (details in Annex 2). The reasons for the marked quota-underutilization include strict hunting regulations, high costs of hunting, and the EU trade ban on seal products, enforced in 2009, that has reduced the motivation for hunting. The continued growth of the population suggests that the present hunting pressure does not pose a risk to the Baltic grey seal population (see also [38]). However, if the quotas had been reached fully, hunting apparently could have had a more visible effect on population growth in particular during the last few years with higher quotas.

2.3. Incidental catches

In early 2000 s, the number of grey seals incidentally caught by the Baltic fisheries was estimated at approximately 2000 individuals annually [63]. There is little data on current catches, but [38] observed that in the northern Baltic Sea incidentally caught seals frequently were small pups (in spring) or sub-adult and adult males (in autumn). The gillnet fisheries of cod in the southern Baltic are thought to cause relatively high incidental catch of grey seal [32]. However, gillnet fishing effort of cod in the Baltic decreased by 44% from 2009 to 2018 [16]. It is noteworthy that seal-safe pontoon traps that are currently widely used especially in salmon fishing in the northern Baltic have a wire grid that effectively prevents seals entering fish-chamber where they could drown [31,59]. Incidental catches of grey seal need more monitoring.

2.4. Loss of genetic diversity

Grey seal females, like all other seal species, have a strong site fidelity, i.e., they give birth in the same place as they themselves were born [57]. Rest of the year, grey seals are more widespread and may travel long distances across the Baltic Sea [56,58]. Furthermore, juveniles disperse widely during their first year [24,5,53]. Hunting occurs mainly in the core distribution area of population, and is prohibited during the breeding time. It can be argued that hunting could cause disproportionate effects on local population structure and genetic diversity. However, there is little evidence that local subpopulations exist in the Baltic Sea despite the breeding site fidelity of females.

3. International governance of the Baltic grey seal population

There is an international framework of institutions and legal norms that govern the management of seal populations globally. These include the Convention on Migratory Species (CMS) of the United Nations, a

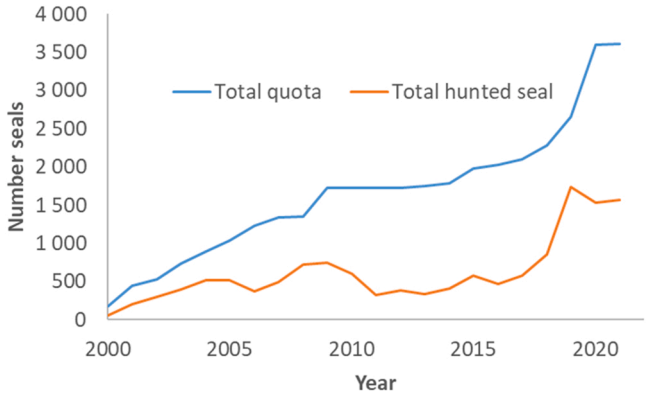

Fig. 3. Total quota and number of grey seals yearly hunted in 1998–2021 in the Baltic Sea. The figure is based on combined data presented in Annex 2.

treaty also known as the Bonn Convention, and the Council of Europe's Convention on the Conservation of European Wildlife and Natural Habitats in 1979, also known as Bern Convention. In this study, however, the attention is devoted to two other institutions and their norms: the Baltic Marine Environment Protection Commission (HELCOM) and the European Union (EU), because their role is critically important in the management of seals in the Baltic Sea. This section introduces the HELCOM and EU frameworks on the management of seal populations in the Baltic Sea.

3.1. HELCOM recommendations

HELCOM coordinates the management of marine mammals in the Baltic Sea. Under HELCOM Article 15, Contracting Parties must conserve natural habitats and biological diversity and protect ecological processes. They should adopt subsequent instruments containing appropriate guidelines and criteria, which may focus on fisheries management and marine mammal conservation. HELCOM makes Recommendations on how the guidelines and criteria are to be implemented by the Contracting Parties through their national legislation. The Contracting Parties are not in breach of HELCOM should they depart from these recommendations, as these recommendations are not in themselves legally binding. However, these recommendations do provide a privileged means of interpreting their obligation under Article 15, and thus are not absolutely devoid of legal value.

In Recommendation 27–28/2, adopted in 2006 concerning conservation of seals in the Baltic Sea area, HELCOM sets out the general management principles for seal populations [25]. The document states that "the grey seal population of the Baltic Sea remains below the theoretically calculated population level when compared to the beginning of the 20th century, and that the current carrying capacity levels are not known". It is noteworthy that in 2006, when the HELCOM recommendation was adopted, the Baltic grey seal population was estimated at 26,000–34,000 individuals [27]. Since then, the population has about doubled and expanded also to the southern part of the Baltic Sea [19]. The Baltic grey seal population was at its lowest, around 4000 individuals, in late 1970 s [22].

For all Baltic seal populations, [25] proposed three key management objectives: **(i)** the populations sizes should recover to carrying capacity levels, **(ii)** populations should expand to suitable breeding distributions in all Baltic regions, and **(iii)** seals should attain a health status that secures the continued existence of the populations. With these recommendations as an umbrella, the Baltic countries have adopted seal management plans with a general objective of having a favourable conservation status of populations.

The Specific Reference Levels form an integral part of [25] principles, and for population size, these reference levels are defined as:

- **Target Reference Level**: the level where the growth rate starts to level off and the population asymptotically approach the current carrying capacity level (e.g. 0.8 K);
- **Limit Reference Level** (the Safe Biological Level): the Minimum Viable Population Size, which is to be defined for each of the management units; and
- **Precautionary Approach Level**: the level where the populations are at maximum productivity level.

HELCOM [25] points out that "for all Baltic seal populations below the Precautionary Approach Level, no allowances for deliberate killing should be issued". The recommendation adds that "for populations between the Limit Reference Level (the Safe Biological Level) and the Precautionary Approach Level, licenses for anthropogenic removals can only be issued if a significant positive long-term growth rate can be observed, and if licenses for anthropogenic removals are issued, special care has to be taken so that the positive long-term growth rate is not jeopardized". Further, HELCOM recommends that "for populations between the Precautionary Approach and the Target Reference Levels, and for population above the Target Reference Level, licenses for anthropogenic removals can be issued provided that the long-term objectives of the General Management Principles are not compromised". Aside from these recommendations, HELCOM has also put forward supplementary recommendations which are summarized below.

HELCOM [27,28] evaluates the status of the marine environment based on population trends and abundance of the three species of seals that occur in the Baltic Sea. Good status is achieved for each species when (i) the abundance of seals in each management unit has attained a Limit Reference Level (LRL) of at least 10,000 individuals to ensure long-term viability; and (ii) the species-specific growth rate is achieved indicating that abundance is not affected by severe anthropogenic pressures. This recommendation acknowledges that the abundance of the Baltic grey seal population is clearly above the LRL of 10,000 individuals. However, the report notes that the population does not achieve good status regarding population growth rate and reproduction in the entire Baltic Sea when evaluated against the criteria of a minimum 7% annual increase. Nonetheless, the report notes that the population growth rate seems to reduce, which suggests that the population is approaching the carrying capacity.

The State of the Baltic Sea report [28] notes that good status is not achieved in the southwestern Baltic, and consequently HELCOM considers that the status of the entire Baltic grey seal population is not at a good level (*HELCOM considers the Baltic Sea is one single management unit for grey seal)*. The report states that the good status of seal populations is achieved when the distribution of the species is close to pristine conditions. It further states that if that cannot be achieved due to irreversible long term environmental changes, good status is achieved when all currently available haul-out sites are occupied. The report also notes that the overall status of Baltic grey seal population is estimated as not good since the indicators of reproductive and nutritional status do not achieve the threshold values. The report further notes that the low reproductive and nutritional condition of grey seal may be connected to density dependent effects if the population is approaching its ecological carrying capacity. HELCOM thereby eventually acknowledges that the Baltic grey seal population in the core distribution area may approach the carrying capacity.

3.2. EU legal framework

As all the Baltic coastal states, except the Russian Federation, are members of the European Union, the legal regime of the EU is binding on them. There are three EU legislative acts that are relevant for seal population management: the EU Habitats Directive, the EU Marine Strategy Framework Directive, and the Regulation on trade in seal products.

3.2.1. EU Habitats Directive

In the law of the European Union, the Habitats Directive (HD) [13] sets the objectives of promoting the maintenance of natural habitats and biodiversity while also considering economic, social, cultural and regional factors. The HD forms the foundation for the EU strategies on the management of seals. Annex II of the Directive requires EU Member States to maintain all the marine mammals that occur in European waters at "Favourable Conservation Status" (FCS). The conservation status will be taken as 'favourable' when following criteria are satisfied.

- Criteria 1: Population dynamics on the species indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats:
- Criteria 2: The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future:
- Criteria 3: There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis:

The task of identifying the conservation status is passed to the individual countries. In the evaluation of the status, the Favourable Reference Value (FRV) is central. FRVs consist of Favourable Reference Population (FRP), Favourable Reference Range (FRR) and Favourable Reference Areas (FRA). The FRP is defined as the "population in a given biogeographical region considered the minimum necessary to ensure the long-term viability of the species".

3.2.2. EU Marine Strategy Framework Directive

The Marine Strategy Framework Directive [54] strives to obtain "ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable". MSFD aims to achieve Good Environmental Status (GES) of the EU's marine waters, and to protect the marine resource base upon which economic and social activities depend. GES is at the core of MSFD, and it includes all the seal species in EU area.

EU Member-States can define areas for the seal assessment as stated in the Commission decision 2017/848 [15]. These areas can be either the entire region, or sub-divisions of it. In the Baltic Sea, Member-States decided to follow the HELCOM assessment area, which is the entire region. Among the relevant criteria (Criteria and methodological standards, specifications and standardised methods for monitoring and assessment of essential features and characteristics and current environmental status of marine waters under point (a) of Article 8(1) of Directive 2008/56/EC), one must consider:

- The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.
- The population demographic characteristics (e.g., body size or age class structure, sex ratio, fecundity, and survival rates) are indicative of a healthy population which is not adversely affected due to anthropogenic pressures.
- The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.
- The habitat has the necessary extent and condition to support the different stages in the life history of the species.

From the above, it is important to highlight that the MSFD criteria follow the HD criteria but also include the mortality caused by fisheries. Those criteria and methodological standards are to ensure consistency and allow for comparison, between marine regions or subregions, of assessments of the extent to which GES is being achieved.

In 2018, Member States had to update the GES assessments performed under MSFD Directive Article 8. In the Baltic Sea, GES related to seal species has not been achieved in 70% of the countries, and was unknown or not assessed in 30% of the countries (https://water.europa.eu/state-of-europe-seas/state-of-biodiversity/marine-mammals).

3.2.3. EU trade ban on seal products

The EU introduced in 2009 a general ban in the placing of seal products on the EU market in response to public concerns about animal welfare aspects of seal hunt [14]. The trade ban applies both to EU-produced and imported seal products. This regulation was intended to support conservation efforts of Atlantic seals from the pressure of commercial hunting and stop what was considered as cruel hunting methods. The regulation allowed trade in seal products derived from indigenous communities as well as seals hunted under marine resource management. The latter exception was withdrawn when the regulation was amended in 2015 [12]; this amendment was the result of a ruling by the World Trade Organization, leaving only the exception for indigenous communities. Although the EU trade ban does not aim to manage the seal populations per se, it can be considered a protective measure as it impacts on the incentive to hunt.

4. National governance of the Baltic grey seal population

In the HELCOM Baltic Sea Action Plan adopted in 2007, the Contracting Parties committed to finalize by 2012 national seal management plans as part of the measures taken to safeguard the long-term viability of the seal populations. In 2012, the management plans were either ready or well underway in those countries where there are marked numbers of grey seal [26]. The 2021 update of the Baltic Sea Action Plan [29] mentions the goal to finalize and implement national or local conservation and/or management plans for grey seals by 2023. Each HELCOM Contracting Party would need to enact specific legislation to enforce conservation measures described in the plan. However, the existence and dissemination of such plan does serve as a means to fulfill general obligations of international cooperation, and are thus illustrative of how the management of seals is achieved under HELCOM's framework. Each plan will be reflective of the context of the Contracting Parties.

Currently, Finland, Åland, Sweden, Estonia and Denmark have management plans for seal species in the Baltic Sea. The central objective of these is to reach and maintain a favourable conservation status of seal populations according to the requirement of the EU Habitats Directive and HELCOM recommendations. The Finnish and Swedish plans state that once the long-term well-being and viability of seal population is ensured, socio-economic factors can be accounted for to a higher extent in the management process [1,2]. In Åland the regional government requires that the population of grey seals should be at a level where damages and effects on fishery are reasonable. In all countries hunting is strictly prohibited in the special seal protection areas where most grey seals gather during breeding time and moulting. In Finland and Åland the management plan stresses the value of grey seal as a valuable natural resource that should be utilized in a sustainable way. National management plans include rules and recommendations that the countries have enforced in their legislations. National plans differ between the countries but the overall aim is about the same. They are largely based on the HELCOM recommendations.

In Denmark, Germany, and Poland there is a ban on seal hunt with the only exception in Denmark where a small quota allowed in 2018–2020 the killing of a few grey seals to protect fisheries around Bornholm. In Poland and Germany, grey seal is strictly protected with no permits of activities that might cause scaring or distress. In Latvia and Lithuania, no seal management plans are foreseen because of the lack of breeding stock and haul-out sites which would need to be protected. Nonetheless, grey seals perform feeding migrations through the territorial waters of these countries and are interacting with fishery. In Russia, there is no management plan for the marine mammals regarding the Baltic Sea.

5. Inconsistencies in the governance of Baltic grey seal

This section casts a critical look on the governance frameworks of the Baltic grey seal population by identifying discrepancies between HELCOM recommendations and the EU legal framework, stemming from inconsistencies within each of their management criteria. It is important to note that from a governance perspective, the EU and HELCOM are separate institutions, and their policies may not always be compatible [61].

5.1. Inconsistencies in HELCOM recommendations

This study suggests that the goals and the recommendations of HELCOM are no longer fully relevant given the current situation. There are inconsistencies that are linked to three main issues: carrying capacity, population size, and population growth rate.

5.1.1. Carrying capacity

HELCOM [25] recommends that the Baltic grey seal population

should increase until it reaches carrying capacity. There is, though, no unambiguous basis for this recommendation. Hence, it is not clear what the current carrying capacity is and it is not specified by HELCOM. The only available numeric estimate for carrying capacity, presented by Blomquist et al. [9], is 54,600. This is apparently un underestimation because the population most likely has already exceeded that level. Kauhala et al. [35] noted that the decreased pregnancy rate suggests that grey seal population in the northern Baltic Sea may be close to the carrying capacity. Furthermore, the concept of a carrying capacity is highly theoretical and context specific. It depends on ecological conditions and human actions, and these tend to vary. The amount of food available for seals varies yearly and in the long-term. Clearly, the carrying capacity cannot be any fixed number of animals.

5.1.2. Grey seal population in the southern Baltic Sea

One of the goals of [25] is that the grey seal population should expand to all suitable breeding areas in the Baltic region. [27,28] notes that some known historic grey seal haul-out sites in the southern Baltic are currently not used, and some have vanished. According to [19], on the German Baltic coast there are in practice no haul-out sites for grey seal breeding while increasingly more resting grey seals can be observed there. They also note that in the coastal areas of the southwestern Baltic Sea various human activities, such as vessel traffic, are intensive and causing disturbances. It can be argued that using the situation in the southern Baltic as an indication of inadequate state of the entire Baltic grey seal population is questionable and misleading. The amount of breeding grey seals in the southern Baltic Sea may not reach much higher abundance unless the breeding sites are restored, and human disturbances are markedly reduced.

5.1.3. Population growth rate and the carrying capacity

HELCOM requires a minimum 7% annual increase in population size in Baltic grey seal population until the carrying capacity is reached. When the carrying capacity is reached, the HELCOM target changes to a requirement that no decrease greater than 10% should occur during a 10-year period. The source of conflict is that there is no unanimous agreement when the carrying capacity has been reached. HELCOM has not defined the carrying capacity of Baltic population but notes [27,28] that "the growth rate of the Baltic grey seal population has levelled off in recent years, suggesting that grey seal is approaching the carrying capacity". Hence, it is not realistic to assume that the population in the northern Baltic Sea can continue to grow at a rate of 7%.

5.2. Inconsistencies in the EU legal framework

There are inconsistencies also in the EU legal framework. The assessments of progress towards good environmental status (GES) under MSFD differs in many respects from the Favourable Conservation Status (FCS) goal of HD, as the requirements and assessment scales differ [23]. The definition for FCS under the HD is markedly more detailed than the GES of the MSFD, and includes historical, future as well as spatial components. An important difference is also the fact that HD evaluations are carried out on a national basis whereas MSFD evaluation, as it concerns wildlife species, is for populations or management units and is thus independent of national boundaries, and includes a regional component mentioned above. The HD allows member countries to make their own interpretations of the requirements [47].

It is important to note that it is not the MSFD itself that has an inconsistency of spatial scale; rather, EU Commission Decision 2017/848 suggests as scale of assessment beyond coastal waters, subdivisions of the region or subregion, divided where needed by national boundaries. Baltic coastal states decided to follow HELCOM scale of the entire region instead of national boundaries. The existence of inconsistent approaches is a separate challenge from the assessment scales, but it is linked to it since conclusions may differ depending on where they are applied. Further to that, the MSFD allows for sustainable levels of human activity. Hence, while for the HD the favorable reference value is aiming towards pristine conditions, for MSFD there is the possibility for a nuanced approach that includes hunting and fishing for example.

These inconsistencies within the EU legal framework highlight the challenge of governing, changing ecological realities such as the increase of seals and their growing impact on human activities. The geographical reference for the data that is used may alter the perception of the problem, and that is an issue from the standpoint of HELCOM and MSFD since they assess the whole region, thus distorting realities that vary between north and south of the Baltic Sea. On the other hand, the scale used by the HD raises other issues; while Germany and Poland are located in the south and benefit from a similar status inside their boundaries, for Sweden this may be difficult to govern due to the long latitudinal length of its coast. This serves to highlight how EU laws governing the problem can resolve problems for one Member State and create problems for another.

The productivity of the sea and intensity of fisheries have changed dramatically over the past decades and pristine conditions are seldom achievable. Therefore, target levels should be realistic and account the real situation. The GES criteria of the MSFD accepts that ecosystems are not pristine and that human activities exist. Nonetheless, guidelines for the implementation of MSFD recommend that threshold values for the criteria used in the assessment should be consistent with the Favourable Reference Population and Range values established under HD. How these are aligned is not clear. [23] note that GES criteria of MSFD are consistent with the HELCOM management framework and the core indicators for seals, but in many cases in contrast with the FRP of HD approach. These discrepancies can be a major cause of concern and confusion in practical application of EU Directives [7].

Furthermore, [23] note that by using the MSFD GES criteria and HELCOM core indicators, the Baltic grey seal population is in good environmental status regarding population trends and abundance. However, when evaluated by the HD, the required spatial scale is limited to the national level which causes the species to fail FRP in the countries which the species has recently re-colonised, i.e., in Denmark, Germany and Poland.

6. Discussion

The fundamental problem in the Baltic seal-fishery conflict is that although grey seal population has markedly increased and is currently not under threat, a further increase of the population is still prioritized by HELCOM and EU. This is done at the expense of economic and social sustainability. Thereby the conflict is expected to continue as serious and there is further risk that more fishers will leave the fishing livelihood. The current governance arrangement is not compatible with thriving and profitable coastal fisheries. The management criteria for seals are in conflict with the goals of the EU common fisheries policy (CFP) that seek to ensure a reasonable standard of living for those dependent on the fishing industry [17].

Grey seal predation on fish stocks in the Baltic Sea is substantial and many of the stocks affected by seals are very important also to fishery [21]. In case the management of grey seal population would follow the principles of the ecosystem-based management, this predation should be taken into account. In ecosystem-based management the general goal is to maintain the entire ecosystems in a healthy, productive and resilient condition. All species, including protected species, are taken into account in the management.

We argue that existing goals and management criteria of Baltic grey seal population are unrealistic and overly ambiguous under the current ecological situation. The optimal management of seal-fishery conflict requires reassessment of existing governance arrangements. A sustainable solution requires taking into consideration and balancing the views and perceptions of fishing sector, coastal communities, and the conservation sector. Blomquist et al. [9] demonstrated that the optimal grey seal population in the Baltic Sea would be much lower than the current

population size. Their concept of optimal seal population takes into account the socioeconomic considerations, including issues related to the continuity of the livelihoods and cultural heritage of the archipelago and the coast [67].

We contend that the Baltic grey population largely meets EU Habitats Directive's criteria. If the current ecological conditions continue in the Baltic Sea, there is no reason to assume that the population would not be able to maintain itself as a viable component of its natural habitats. There is a sufficiently large habitat to maintain its populations on a long-term basis even with the progress of climate change. However, in the countries where the species has recently re-colonised (i.e., Denmark, Germany, and Poland) the population does not yet meet all the criteria. Because of such biological realities, the coastal States around the Baltic Sea have different policies on seal management and hunting. The status of the population in the southwestern Baltic should not be used as an indication that the entire population has not reached a favourable conservation status. It is also noteworthy that HD does not require population growth until the carrying capacity.

HELCOM recommendations contradict the objectives of Marine Strategy Framework (MSFD) and even the updated HELCOM Baltic Sea Action Plan [29] as both instruments state that environmental objectives should be implemented within the scope of an ecosystem approach. This implies that the major losses and damages to fisheries and fish stocks put in danger by the growing grey seal population should be accounted for in the management.

The EU trade ban on seal products remains a problematic hurdle. In EU, seals cannot be utilized in any other way than in the hunter's own household. This is effectively limiting all the potential socioeconomic benefits of hunting and contributes to the underutilization of hunting quotas. Furthermore, there are views that marine mammals should not be ignored as potential food resources as part of food security [20,70]. When a seal population is healthy, it represents a low-carbon and nutritionally high-quality resource to be exploited locally (see also [55]). All Baltic seal species are subject to regular monitoring and assessments, and in case a population would show undesirable development, the EU rules enable coastal states to close the hunt without delays. Hence, there are little risk for over-exploitation.

The conflict between seal conservation and coastal fishery in the Baltic Sea is complex and there are no easy solutions, but nonetheless, solutions must be found. The current balance is tilted towards the conservation concerns while pressures over economic activities and culture of coastal communities associated with fisheries are largely ignored. The Baltic grey seal population has reached a sustainable status and the protection should not be the sole and primary objective of the management. There is an urgent need to find an optimal balance between the sustainable size of grey seal population and the viability of the coastal fishing sector while at the same time promoting a balanced co-existence of seals and humans. Such a system ought to provide trade-offs acceptable to all key stakeholders. This is ultimately a human-to-human conflict.

In conclusion, institutions involved in the governance of grey seal population management should reassess their management goals and criteria with a view of creating flexible regimes that more harmoniously respond to local concerns. Such actions could eventually lead to a new management approach on seal populations and a more harmonious balance with other legitimate interests.

Author Statement

All authors have made a substantial contribution to the concept and design of the article, drafted and revised the article and approved the version to be published. The authors declare there is no conflict of interest. The views and opinions expressed herein are those of the authors and do not necessarily reflect those of their affiliations.

Data Availability

Data will be made available on request.

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Appendix

Annex 1. Yearly census of grey seals in 2003–2021 in the Baltic Sea. In 2018 no census was conducted in the Finnish Archipelago area. During 2021, 406 seals were counted in Poland and 136 in Germany (those numbers are not included in the table). Data collected from yearly releases by the Natural Resources Institute Finland (Luke), https://www.luke.fi/fi/seurannat/merihyljelaskennat-ja-hyljekannan-rakenteen-seuranta/harmaahyljekanta-2022.

Year	Bothnian Bay and North Quark	Sea of Bothnia	Central Sweden	SW Finnish archipelago	Gulf of Finland	Estonia	Southern Baltic (Swe, Den, Pol & Ger)	Total
2003	710	855	3980	6880	673	2700	335	16133
2004	1330	870	3900	7735	870	2690	245	17640
2005	1265	606	4462	8040	880	2660	348	18261
2006	789	1159	5350	9870	756	2340	435	20699
2007	1049	1834	6349	8516	803	2890	550	21991
2008	1340	2483	4721	8308	965	3874	637	22328
2009	1154	1460	5804	6701	1040	3441	795	20395
2010	642	1288	7508	8361	615	3476	1249	23139
2011	1667	1494	8494	5994	1417	3541	1334	23941
2012	1042	2647	10224	8285	888	3365	1804	28255
2013	659	2014	10626	9248	642	4284	2023	29496
2014	1911	2464	9573	9493	1121	4932	2721	32215
2015	1607	2727	9422	8293	820	3968	3448	30285
2016	1347	2699	9217	9627	1065	4088	2073	30116
2017	2023	2119	11103	8092	770	3558	2603	30268
2018	867	2507	12174		164	5718	3363	
2019	1051	1636	12868	13033	1008	5145	3380	38121

(*continued on next page*)

(*continued*)

Year	Bothnian Bay and North Quark	Sea of Bothnia	Central Sweden	SW Finnish archi-pelago	Gulf of Finland	Estonia	Southern Baltic (Swe, Den, Pol & Ger)	Total
2020	2079	1999	10534	14757	2390	5150	3166	40075
2021	1202	2099	10486	15733	3068	5479	3869	41936

Annex 2. Hunting quotas (in numbers) and the reported number of grey seals hunted in the Baltic Sea countries in 1998–2021. It is noteworthy that the grey seal hunting season goes over two years. In this table, the latter year of the hunting season has been used to describe the annual catch. Data collected from official country statistics.

Year	Finland (mainland)		Åland		Sweden		Estonia		Total number of seals hunted
	Quota	Hunted seals	**Quota**	Hunted seals	**Quota**	Hunted seals	**Quota**	Hunted seals	
1998	30	16	0	0	0	0	0	0	16
1999	100	60	0	0	0	0	0	0	60
2000	100	30	84	30	0	?	0	0	60
2001	180	90	89	54	180	54	0	0	198
2002	230	130	156	95	150	79	0	0	304
2003	395	233	171	82	170	79	0	0	394
2004	490	291	232	150	170	81	0	0	522
2005	635	312	234	118	170	83	0	0	513
2006	675	157	390	103	170	107	0	0	367
2007	685	218	450	183	210	96	0	0	497
2008	685	360	450	228	220	130	0	0	718
2009	1050	470	450	146	230	129	0	0	745
2010	1050	350	450	145	230	103	0	0	598
2011	1050	165	450	90	230	74	0	0	329
2012	1050	177	450	115	230	94	0	0	386
2013	1050	134	450	104	250	103	0	0	341
2014	1050	184	450	115	290	110	0	0	409
2015	1050	157	450	123	430	283	53	10	573
2016	1050	185	450	73	480	202	42	10	470
2017	1050	232	450	72	560	263	45	9	576
2018	1050	213	450	128	740	499	37	18	858
2019	1050	316	450	343	1100	1060	58	20	1739
2020	1050	266	500	215	2000	1028	50	19	1528
2021	1050	413	500	207	2000	928	55	26	1574
Total	17 855	5159	8 206	2919	10 210	5585	340	112	13 775

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