Avoiding paper parks: A governance analysis of and policy recommendations for the Whale Sanctuary in the German North Sea for harbour porpoise conservation

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Keywords

- Harbour porpoises
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Abstract

Marine Protected Areas (MPAs) are essential for biodiversity conservation but frequently struggle to convert formal protection into tangible ecological benefits, resulting in so-called “paper parks”. This study applies the Marine Protected Area Governance (MPAG) framework to evaluate governance arrangements in the Whale Sanctuary (WS) of the German North Sea, with a focus on harbour porpoise (*Phocoena phocoena*) conservation. The governance system is characterized by decentralized, multi-actor participation, showing strengths in communication and stakeholder engagement, alongside weaknesses in legal enforcement and cross-jurisdictional coordination. Despite existing protections, harbour porpoise populations remain vulnerable due to intensifying anthropogenic pressures such as international fisheries, maritime traffic, and offshore wind farm developments, many occurring outside the direct jurisdiction of sanctuary authorities. Notably, the *Schutzlücke* - a protection gap in the first 150 meters from the shoreline - represents a critical spatial governance challenge. Policy recommendations include strengthening integrated regulatory frameworks, enhancing monitoring and enforcement, and implementing vessel speed restrictions during key calving periods. Additionally, this study advances the MPAG framework by advocating the integration of ecological indicators and explicit consideration of external pressures and cross-scale threats to better capture social-ecological system complexity. Such an expanded framework would link governance incentives directly to ecological outcomes, supporting more adaptive and resilient conservation strategies. These findings highlight the necessity of targeted governance reforms and comprehensive policy measures to avoid ineffective protection efforts and promote the recovery of harbour porpoises in the WS, offering both practical guidance and theoretical contributions to MPA governance in multi-use marine contexts.

1. Introduction

Marine Protected Areas (MPAs) are the most popular area-based tool for protecting and restoring marine ecosystems (Groud-Colvert et al., 2021; Worm, 2017). IUCN defines an MPA as "a clearly defined geographical space, recognised, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008). MPA coverage has rapidly expanded in recent years (Groud-Colvert et al., 2019; Humphreys and Clark, 2020), from 0.5% of global marine area in 2004 (Toropova et al., 2010) to 7.7% in 2020 (UNEP-WCMC and IUCN, 2021). The recent adoption of the 30x30 Target (protecting 30% by 2030) will further accelerate and incentivize implementation of MPAs around the world (CBD, 2022).

However, this rapid development may come at the expense of MPA effectiveness. In pursuit of reaching the 30x30 target, many MPAs were found not to achieve their conservation goals (Gill et al., 2017; Edgar et al., 2014) and are oftentimes described as 'paper-parks' (Rife et al., 2013; Halpern, 2014; da Silva, 2019). Critics have suggested that countries focus on reaching numerical targets for MPA designation rather than on improving the quality of MPA protection (Grorud-Colvert et al., 2021). In fact, highly protected areas, where human uses are mostly completely forbidden, only make up 2.9% of global marine areas (Marine Conservation Institute, 2024). Trade-offs between conservation and exploitation of marine resources become evident, requiring a need to find strategies on how to best manage and govern multi-use areas. Challenges such as divergent stakeholder interests and objectives (Kaiser, 2005), non-inclusive decision-making and a lack of enforcement of rules (Wilhelm et al., 2014) are an expression of ineffective governance and management and often hinder effective MPAs. A global literature review by Di Cintio and colleagues (2023) identified "stakeholder involvement, increasing communication and awareness between specific stakeholder groups as well as ensuring appropriate enforcement and monitoring, control and surveillance" as leading factors for the success of MPAs. As complex social-ecological systems, the effectiveness of a MPA is strongly influenced by the behaviour, perception and acceptance of people (Bennet and Dearden, 2014) as well as by how well the MPA is embedded in a local context (Kriegl et al., 2021).

The German North Sea is known as one of the busiest and most industrialized seas in the world (Halpern et al., 2008, 2015; Emeis et al., 2015). Human utilization of the North Sea has intensified in recent decades, mainly driven by the development of offshore energy production, heavy shipping and continued fisheries, leading to substantial changes in the marine ecosystem (Emeis et al., 2015). Marine mammals that inhabit various North Sea ecosystems and migrate between them are particularly affected by these anthropogenic impacts.

In the North Sea, harbour porpoises (*Phocoena phocoena*) are the most common cetacean species (Hammond et al. 2002; Gilles et al., 2023) and the only endemic one in German waters (Benke et al. 1998, Scheidat et al. 2004, Siebert et al. 2006). Following a high number of harbour porpoise mother-calf couple sightings around the North Sea island Sylt in the 1990s, it was concluded that these coastal waters were used as a preferred calving area (Heide-Jorgensen et al. 1993, Sonntag et al. 1999). These waters were already part of the 1985 established National Park Wadden Sea Schleswig-Holstein (NTP). To protect the population, the data gathered were used to turn this part of the NTP into a Whale Sanctuary (WS). This legal change was possible since the precautionary principle was applied for the amendment of the National Park law (NPG) in December 1999. With a size of 1240km², it was the first whale sanctuary in Europe. The establishment of the WS extended the borders of the NTP to the 12 nautical mile exclusive economic zone (EEZ) border, where it adjoins the 2004 designated Sylt Outer Reef - East German Bight, one of the three marine protected areas under the governance of the federal government in the German North Sea. The NTP has a total extent of 4.380 m² and ranges from the Danish border in the north to the mouth of the river Elbe in the south. The location of the WS is shown in figure 1.

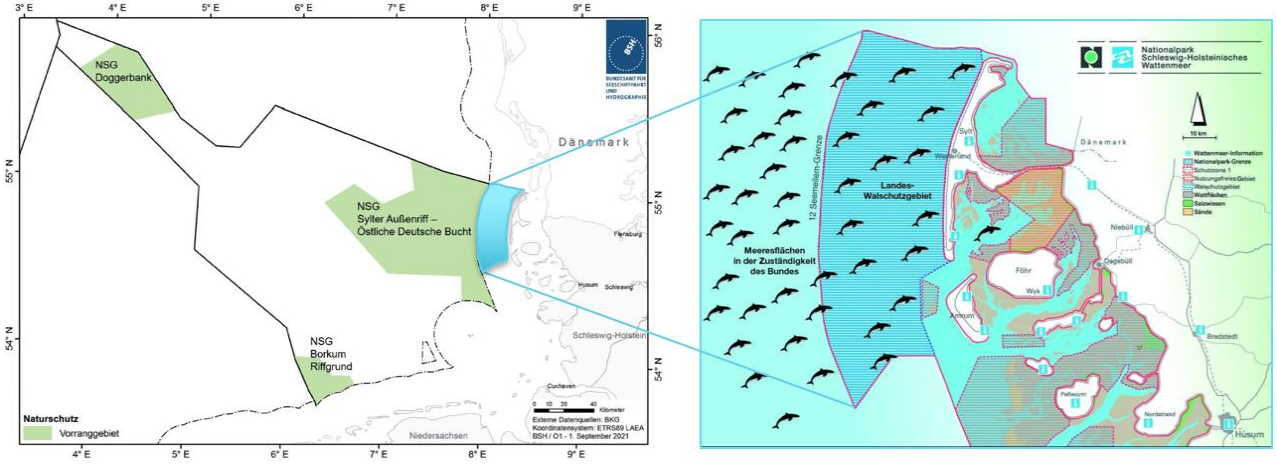


Figure 1. Map of the WS in the NTP (left: BSH, 2021; right: Natürlich Sylt, 2021).

Harbor porpoise conservation in Germany is guided by a multi-level framework of national and international policies and conventions. At the national level, the Federal Nature Conservation Act (Bundesnaturschutzgesetz, BNatSchG) provides the legal basis for the protection of marine species, including harbor porpoises, through the designation of MPAs and the implementation of species-specific action plans. The NPG further reinforces these protections within designated areas like the Wadden Sea. Internationally, Germany is a signatory to several key agreements, including the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish, and North Seas (ASCOBANS), which is specifically focused on the conservation of small cetaceans like harbor porpoises. Additionally, the European Union's Habitats Directive (92/43/EEC) mandates the protection of harbor porpoises as a species of community interest, requiring member states to designate Special Areas of Conservation (SACs) and establish conservation measures. The European Marine Strategy Framework Directive (MSFD) also plays a critical role by setting targets for achieving 'Good Environmental Status' of marine waters, including the protection of marine mammals. Together, these policies and conventions create a comprehensive legal and regulatory environment aimed at ensuring the long-term survival of harbor porpoises in German waters.

Despite existing policies and conservation efforts, harbour porpoise abundance in the German North Sea is declining. Their population had drastically reduced over past centuries but has recovered since hunting was largely abandoned by the mid-20th century. Four North Sea-wide surveys SCANS I-IV in 1994 (289,000 harbour porpoise individuals; Coefficient of Variation (CV) = 0.14; revised from Hammond et al., 2002, 2017), 2005 (355,000; CV = 0.22; revised from Hammond et al., 2013), 2016 (345,000 individuals; CV = 0.18; Hammond et al., 2017) and 2022 (339,000; CV = 0.17; Gilles et al., 2023) showed that harbour porpoises populations have stabilized in recent years, with current numbers estimated at around 339,000 individuals (Gilles et al., 2023). However, the last monitoring report assessing causes of harbour porpoise death showed that their population in German waters is not in a good condition and that their habitat continues to deteriorate (Siebert et al., 2023). Life expectancy is decreasing (ibid.) and most harbour porpoises in the German state of Schleswig-Holstein die before reaching maturity (Kesselring et al., 2017) at an age of 3-5 years (female). The overall trend for harbour porpoises in the German North Sea shows a decline of 1.79% per year (ibid.). A particularly strong population decline of 3.79% annually between 2002 and 2019 was detected in the MPA Sylt Outer Reef, which is adjacent to the WS (Gilles et al., 2023). A recent geographic shift of harbour porpoises towards southern waters of the North Sea became evident (ibid.) with numbers slightly increasing in the southern part of the German North Sea close to the MPA Borkum Reef Ground (Nachtsheim et al., 2021). In 2019, approximately 28,000 harbour porpoises were estimated to live in the German North Sea (Gilles et al., 2009; Nachtsheim et al., 2021). The region around the Sylt Outer Reef and the WS is of national importance and significance to harbour porpoise reproduction (ibid.). Given the decrease of harbour porpoises and the critical ecological role

of the WS in harbor porpoise conservation, understanding and scrutinizing its governance structures, alongside its legal designation, is essential to ensure the protected areas long-term effectiveness, resilience, and success in navigating the challenges of conservation and human activity in the region.

MPA governance includes a diverse portfolio of institutions that combine into differing complex and multifaceted approaches to managing marine resources and ecosystems, reflecting the evolution of governance debates over time. As Jones (2014, p.125) notes, "steering human behaviour through combinations of people, state and market incentives in order to achieve strategic objectives" provides a comprehensive definition of governance that moves beyond ideological arguments about which approach is 'best'. This perspective aligns with the growing recognition that effective governance models should integrate top-down (state regulation), bottom-up (community-based), and market-based (economic incentives) approaches. In the context of MPAs, governance encompasses the structures, institutions, and processes that determine decision-making, action-taking, and resource management (Bennett & Dearden, 2014a). It involves the integration of various stakeholders, legal frameworks, and management strategies to achieve conservation objectives while balancing human activities. The effectiveness of MPA governance is increasingly challenging in our interconnected and changing world, requiring a combination of approaches to promote resilience and adaptability. Critical questions in MPA governance research include the shaping of behaviors by governance institutions, ideal governance structures, processes of institutional change, roles of different actors, and the design of governance to fit diverse contexts and adapt to changing circumstances (Ostrom, 1990; Young, 2002; Armitage et al., 2012). Addressing these questions is crucial for developing effective, acceptable, and supportive environmental governance policies and processes, ultimately enhancing the social and ecological outcomes of MPAs.

A tool to empirically analyze the governance of marine resources in a protected area in a structured and replicable way is the Marine Protected Area Governance framework (MPAG; Jones, 2014; Jones & Long, 2021). By holistically assessing the governance system of a MPA, shortcomings and strengths of a system can be identified, and recommendations developed for a more effective MPA governance that meets the objectives of the respective MPA. The MPAG framework provides valuable insights into marine governance effectiveness and equity and offers practical applications for managers. It has so far been applied to more than 50 case studies around the world (Jones & Long, 2021).

The MPAG framework is grounded in the concept of coevolution, emphasizing the integration of top-down, bottom-up, and market-based mechanisms to create synergistic incentives that enhance the overall effectiveness of MPA governance (Jones, 2014). This integrated approach is illustrated in the MPAGs classification of governance steer sources, which identifies three key types: state steer, market steer, and people steer (Jones, 2014). Each of these steer types contributes uniquely to the governance of MPAs, as outlined in table 1.

Table 1: MPAG perspectives on sources of governance steer (Jones, 2014; p.64)

Steer type	**Decisions taken by**	**Characteristics**
State steer	Governments and regulatory agencies	Top-down decisions by state through laws and regulations, drawing on expert advice
Market steer	Markets and economic systems	Decisions on basis of economic rationality through markets and/or implemented through economic incentives, including property rights

People steer	Civil society: people, social networks and related organizations	Bottom-up decisions through deliberations amongst individuals, community/non-governmental organizations and social/family networks

This classification of governance steer perspectives underscores the MPAG framework's recognition of diverse approaches to MPA governance. Building on this understanding of varied governance mechanisms, the MPAG adopts a synecology perspective. The importance of diversity in systems for resilience is acknowledged, as in ecology (Holling, 1973). The rationale for fostering diversity in governance incentives mirrors a parallel development in ecology: Diversity in species and functional groups, with a complex web of interactions among them, supports ecosystem stability. This synecological approach emphasizes the relationships and interactions among different components, rather than focusing on individual elements in isolation. This can be applied to developing MPA governance frameworks. In social-ecological systems, so the MPAG argues, the implementation of a diversity of incentives enhances the resilience of a given MPA governance system (Jones et al., 2024). Incentives here are defined as "particular types of institutions that are instrumentally designed in relation to an MPA to encourage actors (i.e. people involved) to choose to behave in a manner that provides for certain strategic policy outcomes, particularly conservation objectives, to be achieved" (Jones & Long, 2021; p.3).

As part of the MPAG project, Jones in collaboration with the United Nations Environment Programme (UNEP) and a group of governance experts, developed a set of variables/criteria that are used across various case studies to assess the governance structure and its effectiveness (Jones, 2014):

1. Context of the MPA:

   This gives an overview of the socio-economic and political situation, in which the MPA is embedded. Local and national contexts can strongly influence why particular governance approaches are appropriate and effective. Different metrics are included, including Per capita Gross Domestic Product (GDP), Human Development Index (HDI), unemployment rate and population below poverty line. Since this information is mainly relevant for comparing MPAs (see MPAG case study comparisons: Jones and Long, 2021) which this study does not aim for, this element will not be considered in our analysis.

2. Objectives of the MPA:

   MPA objectives may be stated and specified formally in legal documents and/or outlined in more informal ways and/or documents.

3. Drivers and conflicts:

   The driving forces and conflicts that the MPA faces are described. This includes main sectoral activities that could impact MPA features and potentially undermine the fulfilment of the objectives of the MPA as well as the driving forces behind this.

4. Governance approach:

   Here, a basic understanding of the governance arrangements of the MPA is provided. Due to the legal instrument or policy document(s) by which the MPA is officially designated and contributing to national or state law/policy, MPAs often are constituted in some form of institutional hierarchy. The description includes these linkages, relevant laws and policies and identifies the actors involved.

5. Effectiveness:

The effectiveness score is based on the degree to which local impacts of human activities that are likely to undermine the achievement of the MPAs objectives have been addressed and reduced. It is evaluated subjectively on a scale from 0 (no use impacts addressed) to 5 (all impacts from local activities completely addressed).

6. Incentives employed and needed:

   During the development of the MPAG framework, 36 incentives were identified as relevant for effective MPA governance. These incentives are categorized according to economic, communication, knowledge, legal context and participation(see table 2). Since incentives are context-dependent, not all 36 of them are applicable to this case study. The definitions for the relevant incentives for this study are included in table 3.

Table 2. Five categories of incentives, their definition, relevant governance mode and list of incentives in each category (Jones, 2014, adapted according to Jones & Long, 2021; p.8)

Incentive category	Definition	Relevant governance mode	Incentive number and name
Economic	Using economic and property rights approaches to promote the fulfilment of MPA objectives	Market-based	1. Payments for ecosystem services 2. Assigning property rights 3. Reducing the leakage of benefits 4. Promoting profitable and sustainable tourism 5. Promoting green marketing 6. Promoting alternative livelihoods 7. Providing compensation 8. Investing MPA income/funding in local communities 9. Provision of state funding 10. Provision of NGO, private sector and user fee funding
Communication	Promoting awareness of the conservation features of the MPA, the related objectives for conserving them and the approaches for achieving these objectives, and promoting support for related measures	Supporting all three approaches	11. Raising awareness 12. Promoting recognition of benefits 13. Promoting recognition of regulations and restrictions
Knowledge	Respecting and promoting the use of different sources of knowledge (local-traditional and expert-scientific) to better inform MPA decisions	Supporting all three approaches	14. Promoting collective learning 15. Agreeing approaches for addressing uncertainty 16. Independent advice and arbitration

Legal	Establishment and enforcement of relevant laws, regulations etc. as a source of 'state steer' to promote compliance with decisions and thereby the achievement of MPA obligations	Top-down (state steer)	17. Hierarchical obligations 18. Capacity for enforcement 19. Penalties for deterrence 20. Protection from incoming users 21. Attaching conditions to use and property rights, decentralization, etc. 22. Cross-jurisdictional coordination 23. Clear and consistent legal definitions 24. Clarity concerning jurisdictional limitations 25. Legal adjudication platforms 26. Transparency, accountability and fairness
Participation	Providing for users, communities and other interest groups to participate in and influence MPA decision-making that may potentially affect them, in order to promote their 'ownership' of the MPA and thereby their potential to cooperate in the implementation of decisions	Bottom-up (people steer)	27. Rules for participation 28. Establishing collaborative platforms 29. Neutral facilitation 30. Independent arbitration panels 31. Decentralizing responsibilities 32. Peer enforcement 33. Building trust and the capacity for cooperation 34. Building linkages between relevant authorities and user representatives 35. Building on local customs 36. Potential to influence higher institutional levels

7. Cross-cutting themes:

In this section, governance themes that have emerged in many MPA case studies are discussed. Following Jones (2014) the role of leadership and of NGOs and equity issues play an important role in promoting effective governance in social-ecological systems. The first two themes were identified as relevant in this study and will be discussed.

This study tests the applicability of the MPAG framework to a conservation case, with specific focus on harbour porpoises in the German North Sea. There is also a need for an equivalent approach to assess the governance of biodiversity conservation. By employing the MPAG framework in the context of marine mammal conservation, this study offers a novel application that bridges the gap between general MPA governance analysis and species-specific conservation efforts. This approach not only enriches the body of literature on MPA governance with a focus on a high-income region, but also provides actionable insights for enhancing the effectiveness of protected areas designed for the conservation of vulnerable marine species like harbour porpoises.

2. Methodology

In this study, the MPAG framework was employed to deconstruct and analyze the governance of the Whale Sanctuary in the National Park Wadden Sea (Jones, 2014).

Following the empirical method that Jones suggested for MPAG analyses (ibid.), this study draws on primary qualitative data. Semi-structured interviews were held with various stakeholders knowledgeable on and experienced with harbor porpoises, their conservation and WS governance. 14 interviews with 17 interviewees from the marine conservation field, non-governmental organizations, the municipality of Sylt, the Wadden Sea National Park Authority (NPA), the German Federal Defence, the water police, and individual experts were conducted between January to December 2023. The interviews were conducted in sections each addressing the different topics in MPAG analysis: Protected area management and administration, drivers and conflicts, participation, economics, and outlook. The questions addressed the current governance arrangements of the WS for harbour porpoise conservation, and its effectiveness. This primary data was coupled with a document analysis. Documents included legal texts, monitoring reports, other articles and recent updates with information on the WS and harbour porpoise conservation. Informal talks were also conducted to provide additional information. Most interviews were audio-recorded (with permission) and transcribed. Notes were taken when audio-recording was not wanted or possible. The transcripts and notes were coded in MAXQDA to assess the governance structure and to identify emerging themes. A code was established for every incentive in the MPAG and text marked when the respective incentive was found to be employed and/or in need of strengthening. As further themes emerged, additional codes were utilized. This manual coding approach allowed the author to interact with and relate to the data, making it easier to trace the unfolding themes (Basit, 2003). Once the data was collected, the elements of the MPAG, which are relevant to this study, were assessed.

3. Results and Discussion

This section presents the results of the application of the MPAG to the WS and is structured accordingly.

3.1 Objectives of the MPA: The WS aims for a protected area where harbour porpoises can thrive while supporting broader conservation efforts in the NTP. The objective of the WS is to protect and preserve harbour porpoises and their habitats by reducing risks for the species, particularly for their calves, through a ban of gillnet use, speed limits for boats and other forms of excluding human uses (e.g. offshore wind production). Specifically, the goals are:

- Habitat protection: Ensure that the Wadden Sea, a crucial habitat for marine life including harbour porpoises, remains a safe and healthy environment. This includes safeguarding the areas where they find food and rest.
- Minimize disturbance: Reduce human-induced disturbances, such as shipping traffic and industrial activities, that could negatively impact harbour porpoise behaviour and well-being. The sanctuary helps to mitigate these threats and provide a quieter, less disruptive environment for them.
- Biodiversity conservation: Maintain and enhance the overall ecological balance of the Wadden Sea, which is a rich and diverse ecosystem. Protecting harbour porpoises contributes to the health of the entire marine ecosystem.
- Research and monitoring: Facilitate scientific research and monitoring of harbour porpoise populations and behaviours in a relatively undisturbed setting. This information is crucial for developing effective conservation strategies and understanding the role of them within the complexities of the entire marine ecosystem.

3.2 Conflicts and drivers

Harbour porpoises in the North Sea are threatened by a diversity of human activities and impacts: Fishing, sand extraction, offshore wind farms, maritime transportation, tourism, military activities and pollution. These anthropogenic conflicts will be explained in more detail in the following section.

Fishing

The Wadden Sea is a productive fishing ground. Fisheries can lead to conflicts with harbour porpoises and their conservation (Northridge et al., 2020). Fishing represents a threat to harbour porpoises because of bycatch and reduced prey availability. Bycatch in fishing gear, especially in gillnets, is one of the primary threats to harbour porpoises (Siebert et al., 2001; Read et al., 2006; Ijsseldijk et al., 2018). Of 20 examined harbour porpoise deaths in the German North Sea seven showed signs of entanglement, of which five ended as bycatch (Siebert et al., 2023). Furthermore, fisheries pose a substantial threat to food supply for harbour porpoises. Harbour porpoises feed on small fish (<30cm; Benke et al., 1998; Gilles et al., 2008a; Andreasen et al., 2017) and as small and endothermic predators they have a high energy demand and need to feed constantly. Through fishing pressure and other environmental impacts in the North Sea, much of their prey such as sandeel, herring and goby is less available.

In order to reduce the risk of bycatch, visibility of fishing nets to harbour porpoises can be increased. Acoustic devices were developed to deter harbour porpoises from fishing nets by sending out acoustic signals so that nets can be perceived by harbour porpoises as an object. So-called pingers were shown to scare away harbour porpoises. However, the emitted signal sounds add yet another source of noise to the already noisy environment. In contrast, porpoise alert (PAL) devices that are installed on fishing nets use the same frequency on which harbour porpoises communicate (133kHz), to imitate and emit warning signals. While the latter method has been proven successful in the Western Baltic Sea (Culik, Conrad & Chladek, 2017) it was less effective in the North Sea. Despite existing regulations on the use of pingers (acoustic deterrent devices) on fishing nets, bycatch remains a significant threat to harbour porpoises (Dawson et al., 2013).

Noise pollution

Noise pollution is a significant threat to harbour porpoises, particularly in areas like the North Sea, where human activities are prevalent (Frankish et al., 2023). Harbour porpoises heavily rely on their acute sense of hearing for echolocation, which they use for navigation, foraging and communication. The introduction of anthropogenic noise to their environment and frequent noise exposure can disrupt these critical functions, behaviour, and in severe cases lead to acoustic trauma and death. Acoustic trauma can result in a loss of orientation and starvation. Of 20 examined harbour porpoises stranded in German waters in 2022-2023, two were suspected of having suffered acoustic trauma (Siebert et al., 2023).

Noise is emitted by a variety of human activities and maritime transportation in particular has been known to alter the soundscape of the ocean. The NTP is used by shipping vessels to reach ports of international importance such as Hamburg, international transit traffic, commercial fishing, military, research vessels, ferries and supply traffic to the islands, excursion boats as well as other industrial vessels such as those for gravel extraction. Military activities include the use of sonar, exploration or blasts, that can also impact and alter structures of the seabed.

In addition to these traditional sources of noise, the construction of offshore wind parks (OWPs) has been a contributing factor for the past two decades (Voß et al., 2021; Benhemma-Le Gall et al., 2021). The North Sea wide construction of OWPs created a lot of underwater noise (more than 160db), in particular through

ramming the foundations of wind farms into the seabed. To reduce the impact of this, conservation measures have been developed and are in place: Porpoise deterrent devices are used before ramming occurs and big bubble curtains are placed around the foundations to reduce underwater noise travel. Noise nonetheless, continues as a serious threat to harbour porpoises as supply boats regularly travel with high speed from the mainland to the OWPs. To support the operations of the OWP Butendiek, located inside the MPA Sylt Outer Reef and adjacent to the WS, a high-speed corridor was established that directly passes through the WS.

Sand extraction

Sylt is a sandy barrier island and its 40km of west coast very vulnerable to erosion, in particular due to rising sea levels. Due to the immense power of wind and waves from the North Sea, Sylt loses around one million m^3 of sand per year. To prevent beach and dune erosion, Sylt is reliant on foreshore and beach nourishment. Since 1984, regular dredging and sand deposition has been applied along the west coast with sand taken from a depth of 15-30m from an area 8km off the coast, which lies in the middle of the WS. The sand is used to nourish the beach on the island as well as a reef approximately 400m seaward, where the offshore surf zone diminishes wave impact but it leads to changes in the sea habitat that harbour porpoises rely on for prey. A study on the effects of sand extraction on harbour porpoises in the WS in 2008-2009 showed minor effects (Diederichs et al., 2010). Noise (150dB in 300m distance) was found to exceed the hearing threshold of harbour porpoises (ibid.) leading to an avoidance of the vicinity of the impact area for about three hours. The long-term effects of sand extraction on the marine ecosystem in the WS are not yet well understood.

Pollution

Pollution, both chemical and plastic, is one of the main indirect causes for harbour porpoise death. Chemical pollutants, such as heavy metals and persistent organic pollutants (POPs), accumulate in the marine food web and can cause various health issues in porpoises, including immunosuppression, reproductive failure, and increased susceptibility to diseases. Plastic pollution, including microplastics, can be ingested by porpoises, leading to physical harm, blockages and exposure to toxic substances. Correlations between pollutant levels and pathological findings are present, making harbour porpoises less resilient and more vulnerable to other dangers. In the last assessment of dead harbour porpoises in the North Sea, mercury and polychlorinated biphenyls (PCBs) levels (partly) exceeding threshold levels were found in three and five individuals, respectively (Siebert et al., 2023).

Tourism

The NTP is the most attractive and popular tourism destination in Schleswig-Holstein (SÖM Report, 2019), drawing significant attention to the ecosystem but thereby also contributing to increased human activity in the region. While sailing is the only tourism activity in the outer WS, the coastline is used for a variety of recreational uses such as swimming and surfing. Swimming and surfing (including kite- and wingsurfing) are allowed along the west coasts of Sylt and Amrum and have been identified as not harmful for harbour porpoises by themselves. Speedboats are prohibited in the WS but exemptions are possible. For the annual Windsurf World Cup that takes place in the waters of the WS, an exemption is granted every year. This exemption for speedboats and other equipment, which are otherwise restricted in the Wadden Sea, is made because of the events' international importance, drawing a substantial amount of athletes and spectators onto Sylt, which is beneficial for the economy on the island. Besides speedboats, motorized surfboards, which currently are under development, could pose a potential threat to harbour porpoises in the near future. Water sports other than surfing also require special exemptions under the NTG. Compared to the activities

mentioned beforehand, other tourism activities play a lesser role for harbor porpoises. Impacts from maritime transport and offshore energy production increase and aggregate pressures.

3.4 Governance approach

The WS is government-led with some degree of decentralization. Figure 2 shows how involved government and non-government stakeholders are linked. There are a number of authorities at different administrative levels with different responsibilities that closely collaborate with local nature conservation NGOs (see figure 2).

The WS is part of the National Park Wadden Sea Schleswig-Holstein (NTP). It is managed by the National Park Authority (NPA; Nationalparkverwaltung) in Tönning. Since 2008 the NPA is a division of the State Agency for Coastal Protection, National Park and Marine Conservation (LKN.SH), which in turn is an agency of the Ministry for Energy Transition, Climate Protection, Environment and Nature (MEKUN) of the German state of Schleswig-Holstein (SH). The LKN.SH acts as the highest nature conservation agency and appoints a state representative for nature conservation. The higher nature conservation agency is the State Office for the Environment, which is on the same hierarchical level as the NPA. The state representative supports and advises the nature conservation authorities and mediates between them and civil society. Upon request, projects and measures must be discussed with the state representative for nature conservation. The lower nature conservation agency in Schleswig-Holstein are the administrators of the two districts Nordfriesland and Dithmarschen.

The WS is governed under a clear legal framework relating to international, regional, European and higher state governmental levels as described above. Since the WS is part of the NTP, it falls under the management of the Trilateral Wadden Sea Cooperation (TWSC) set up by the Netherlands, Germany and Denmark. The Integrated Management Plan for One Wadden Sea World Heritage (SIMP), which the TWSC was assigned to create when accepting the extension of the Wadden Sea World Heritage property in 2014, was adopted in May 2023 (Wilhelmshaven Declaration). The SIMP acts as an umbrella for existing plans and policies such as the Wadden Sea Plan (WSP) from 2010 (adopted in 1997 (Stade Declaration) and updated in 2010 (Sylt Declaration)) and national National Park Acts. In Germany, the coastal federal states are in charge of implementing the Federal Nature Conservation Act with respect to marine conservation (BNatSchG). The NTP in SH was established in 1985 and is protected under the National Park Act (NPG).

NTP Decisions are taken by the NPA, which is appointed by MEKUN. The NPA fulfills the responsibilities of the higher and lower authorities. Due to the geographical location of the WS off the islands Sylt and Amrum, the responsible board of trustees (BoT; Kuratorium) is that of the district of Nordfriesland. The BoT, which includes the district administrator as executive board, two representatives chosen by the district council, five representatives from municipalities bordering the NTP, the state representative for nature conservation, two representatives from supporting conservation NGOs, representatives from various sectors and others, consults the NPA in important decisions. The NPA is, among other responsibilities, tasked to (1) teach the public and carry out educational work, (2) plan and execute ecological monitoring and to (3) regulate the support of the nature conservation NGOs for the NTP.

The NGO Schutzstation Wattenmeer is the responsible institution for the coastal waters that include the WS. Other local and international nature or marine conservation NGOs back the work of the Schutzstation Wattenmeer and give support in the implementation of measures.

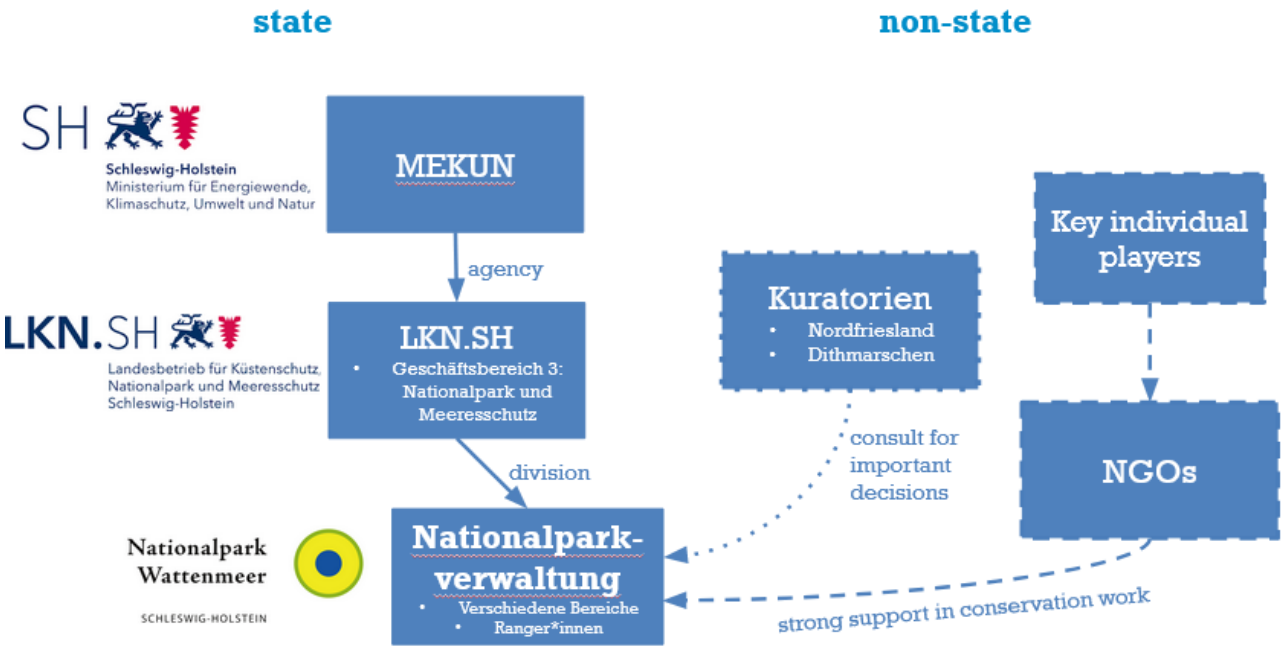


Figure 2. The most important stakeholders relevant in the governance of the WS. The Nationalparkverwaltung (NPA) (bottom left) holds administrative responsibility.

3.5. Effectiveness

For the WS, a governance effectiveness score of 3 ("Some impacts completely addressed, some are partly addressed"; Jones, 2014, p.104) is assigned. The score reflects the largely existing efficacy of the WS but underlines that there is need for improvement.

3.6. Incentives

The incentives that were found to have been effectively employed and those in need of strengthening in the WS are summarized in table 3. Incentives were numbered in line with the numbering of the 36 incentives in Jones, Murray and Vestergaard (2019; see table 3). Some of the incentives were found to not be used in the WS and therefore do not appear in table 3.

Table 3: State of the incentives in the Whale Sanctuary (in line with the MPAG incentives framework). Definitions and numbering of incentives in line with Jones, Murray and Vestergaard, 2019; p.41-53. Y = Yes, N = No, Y* = used but in need of strengthening; N* = not used and in need of implementation.

Incentive (number and name)	Definition (Jones, Murray & Vestergaard, 2019; p.41-53)	Used	How/Why
Economic			
2. Assigning property rights	Assigning or reinforcing property rights for certain areas and resources to appropriate groups of people to promote ownership, responsibility, stewardship, rational self-interest in sustainable exploitation, etc.	Y	Property rights of the WS and the adjacent land are assigned on different governance levels. The WS is part of the NTP, which belongs to the German state of Schleswig-Holstein. The EEZ just outside of the NTP belongs to the Federal Republic of Germany. The coastal area encompassing the first 150 meters from the MTHWL belongs to the respective municipalities and is not part of the NTP. The NGO Schutzstation Wattenmeer has on-site responsibility for the WS, through which stewardship of lower institutional level is encouraged.
4. Promoting profitable and sustainable fishing and tourism	Promoting sustainable exploitation through various fisheries management approaches, particularly providing a refuge for exploited populations in no-take zones to safeguard and enhance harvests in adjacent fishing grounds through spillover/export, insurance against uncertainty, etc.	Y*	The WS is not promoting sustainable fisheries. The occurrence of harbour porpoises is being used by the municipality and official tourism company to promote whale watching from the coast, a potentially sustainable activity. Harbour porpoises are promoted as one species of the 'Big Five' of the NTP. The main tourist season is in summer, when abundance of harbour porpoises is high and mother-calf pairs can be spotted in the WS. There are no commercial boat tours offering whale watching tours and there is no known case of harbour porpoises being harmed by surfers. A range of additional tourist offers exist that specifically focus on harbour porpoise education, the WS and marine conservation. In 2016-2017, an educational whale path was built on Sylt. Locals and tourists can bike along the 22 information boards along the west coast and become 'harbour porpoise experts'. Moreover, two geocaches exist on the island of Sylt that specifically focus on harbour porpoises and contribute to responsible tourism.
5. Promoting green marketing	Promoting the 'green marketing' of appropriate tourism, fisheries, etc. within the MPA to increase profits and income, including market premiums for well	Y	The WS benefits from the broader green branding of the Wadden Sea National Park, in the context of its status as a protected area and UNESCO World Heritage Site, which is highly attractive and effective among tourists. Visitors particularly value activities such as walking along the sea, experiencing nature, and swimming. Green marketing is promoted through whale watching from shore, highlighting marine wildlife including harbour

	conserved natural resources and tourist/diver user fees.		porpoises. These efforts encourage sustainable tourism practices and raise awareness about the importance of conservation within the WS.
9. Provision of state funding	Ensuring that sufficient state funding is available to support the governance of the MPA, particularly in relation to enforcement and economic incentives, while ensuring that such funding does not allow the state to 'capture' MPA governance by undermining the balance of power.	Y*	State funding is allocated for the governance of the WS through the broader NTP budget. While there is no dedicated funding line exclusively for the WS, the existing budget supports overall management activities. To effectively monitor activities that threaten harbour porpoises and enforce related regulations, additional human resources and capacity-building are necessary. Increasing funding would enhance the presence and enforcement capabilities of authorities within the WS, complementing existing ranger roles.
10. Provision of NGO, private sector and user fee funding	Seeking corporate, NGO and private funding through endowments, donations, etc. to support the governance of the MPA, while ensuring that such funders cannot 'capture' MPA governance through an inappropriate degree and type of influence, and that the MPA becomes financially sustainable through a diversity of income sources so that it is not critically vulnerable to the withdrawal of NGO funding. Funding can also be raised through 'user fees' on individuals or businesses using the protected area for diving, recreational fishing, etc., potentially also serving to manage user numbers.	Y*	The NTP is seeking endowments and donations. The NTP Foundation Schleswig-Holstein supports projects that improve protection of the NTP and that can have positive indirect effects for harbour porpoise conservation. Until now, no project was funded that directly links to the WS. To improve financial sustainability and reduce vulnerability to shifts in funding sources, further diversification of income streams - potentially including user fees - should be explored.

Communication			
11. Raising awareness	Using social and local media, TV and radio and other approaches to overcome 'out of sight, out of mind' barriers by raising the awareness of users, local people, relevant authority officers, politicians, etc. about the aesthetic values, ecological importance and vulnerability of the protected area's biodiversity.	Y*	Awareness is raised using various types of media and outreach activities and seems to be effective. Several years after the establishment of the WS tourists and residents knew similarly much about the NTP, and had positive attitudes to the NTP (Legler, 2006). Local media, TV and radio inform about harbour porpoises, the WS and the NTP in general and local conservation NGOs and museums offer family-friendly guided tours, exhibitions and educational activities on Sylt and Amrum. Awareness of harbour porpoises and their challenges in the NTP in particular is raised through the whale education trail that spans the west coast of Sylt. The NPA and NGOs use social media to share latest news and activities. Despite these efforts and existing channels, more awareness-raising is needed to achieve full acceptance and effective protection without trade-offs for anthropogenic uses. Cases exist where individuals falsely assume that certain uses are prohibited in the NTP when they are actually allowed (e.g. sailing).
12. Promoting recognition of benefits	Promoting recognition of the potential resource benefits of the conserved areas in terms of profitable and sustainable fishing, insurance/resilience, etc., while being realistic about such potential benefits and not 'over-selling' them.	Y	The benefits of the WS often are communicated alongside general information about harbour porpoises and the WS. This is particularly the case for the whale education trail. Results of scientific studies about e.g. the abundance of the harbor porpoise population are made known to the public through media mostly. Knowledge of the benefits that arise from the WS can improve acceptance among the local community and support from the tourism sector. Among the citizens of the two islands, the acknowledged harbour porpoise presence has generated a sense of pride and recognition of value.
13. Promoting recognition of regulations and restrictions	Promoting recognition of and respect for the MPA's regulations and restrictions, including the boundaries	Y	Websites, leaflets, information and notice boards communicate the recognition of regulations and restrictions in the WS. Since the number of part-time fishermen on Sylt is low and the islands are small, information is also disseminated mouth-to-mouth. Since no rule-breakings have been recorded, it is assumed that users are aware of the regulations and boundaries.
Knowledge			
14. Promoting collective	Promoting mutual respect among local people and scientists of the	Y*	With various platforms available for collaborative research and stakeholder exchange there are opportunities for collective learning between the relevant stakeholder to discuss

learning	validity of their respective knowledge, and promoting collective learning and the integration of different knowledge bases through partnership research, research/advisory groups, participative geographic information systems, participative workshops, etc.		and learn. Joint porpoise monitoring is conducted by scientific institutions in collaboration with NGOs, and public talks, nature centres, and school outreach in the region promotes understanding of harbour porpoises, their biology/ecology and threats. The high acceptance and willingness of local actors to cooperate with the NTP as well as joint participation in various projects underlines the openness to learn and exchange between stakeholders from different sectors. As a collective learning outcome there is a growing shared understanding of noise, bycatch, and ship traffic threats. Mutual respect between actors could be improved as tensions persist, especially around fishing restrictions vs conservation demands. The integration of local/traditional knowledge from a fisher's perspective, and the employment of participatory research methods such as participative geographic information systems would enhance this incentive.
16. Independent advice and arbitration	Seeking independent advice and/or arbitration in the face of conflicting information and/or uncertainty.	Y*	There is some use of independent scientific input but no formal independent arbitration mechanism for conflicts. Independent ecological consultancies and researchers conduct monitoring (e.g. marine mammal surveys pre OWF construction) in specific contexts (e.g. permissions for offshore wind power generation) but independent assessments are not integrated into long-term WS governance. A dedicated scientific advisory board or neutral arbitration body for evaluating conflict, competing interests or uncertainties does not exist in the NTP SH.
Legal			
17. Hierarchical obligations	International, regional, national and local legal obligations that require effective MPA conservation, including the potential for top-down interventions.	Y	Several international, regional and national agreements and policies include legal obligations that must be met. For the WS, these obligations relate to the establishment, zoning, and monitoring of the WS and allow for top-down enforcement. Mandatory protection of harbour porpoise habitats under EU law has led to the formal designation of the WS as a Natura 2000 site.
18. Capacity for enforcement	Following the principles of decentralization, ensure that sufficient government capacity, political will, surveillance technologies and financial	Y*	The WS shows a partial capacity for enforcement that supports harbour porpoise conservation but faces significant limitations in resources, technology and jurisdictional reach. Enforcement, controlling and sanctioning in the NTP are carried out by the water protection police. The water protection police operate on two boats that are used alternately to patrol the WS for three days each with a few days of break in between. The

	resources are available to ensure the effective and equitable enforcement of restrictions on local and incoming users, including related pressures from fisheries and tourism market forces.		two boats are located in the ports of Büsum and Husum. Although the police show a high presence in areas closer to the mainland (Wadden Sea area), more logistical, human and technical resources are required to survey the whole area of their responsibility, which includes the open waters of the WS. To control the speed of boats, the water protection police use the Vessel Monitoring System (VMS). It, however, only controls violations that were reported externally before. These enforcement gaps undermine the credibility and fairness of regulations, potentially impacting stakeholder trust.
19. Penalties for deterrence	Effective judicial systems for proportionately penalizing illegal resource users in a way that provides an appropriate level of deterrence and helps address conflicts that would otherwise undermine marine conservation objectives.	Y	Schleswig-Holstein has a judicial system for penalizing transgressors. The legal procedures as well as the misdemeanors are defined in respective laws. The penalties for violating the NPG result in fines specific to the NPG.
20. Protection from incoming users	Providing for a degree of legal protection from incoming users, particularly non-local fishers, poachers, etc., as well as tourism developers, recognizing that exploitation by incoming users often poses a major threat to local biodiversity and resources.	Y*	Although the NPG clearly states which human uses are allowed in the NTP (for example, the exclusion of offshore wind farms in the WS), the WS cannot be fully protected from some incoming users with regards to fisheries. Legally, the NTG is not able to protect the part of the WS beyond the three nautical mile coastal zone from neighboring states, meaning that fishermen from Denmark and the Netherlands are allowed to fish with gillnets inside the WS, while German-flagged vessels are banned from this. The prohibition of incoming fisheries can only be negotiated on EU-level under the European fisheries law (Common Fisheries Policy, CFP). In terms of tourism development pressure, large-scale infrastructure such as ports is legally restricted within the NTP boundaries, offering strong protection from physical development.
21. Attaching conditions to use and property rights, decentralization, etc.	Agreeing performance standards, conditions, criteria and requirements related to the MPA's conservation objectives and attaching them to user & property rights, participatory	Y*	By law, regular and continuous monitoring is an important and mandatory task of the NPA with reporting obligations to be fulfilled. The monitoring and evaluation program is carried out trilaterally with the Netherlands and Denmark for joint conservation purposes. It includes numerous physical, chemical, biological and socio-economic parameters. The public must be informed about the results. For harbour porpoises, North Sea and Wadden Sea-wide ecological monitoring programs exist and Porpoise Detectors (PODs) have been

	governance structures, etc.		established in different locations in the NTP since 2011. However, performance indicators are not linked to specific policies and conservation objectives and explicit standards tied to specific user activities are rare. The ecological monitoring outcomes do not instantly lead to any changes in access or use rights and are not linked to conditional access or adaptive management measures. Gillnet bans are applied only to German vessels under current rules, discriminating between users on the basis of their nationality - rather than their impact on conservation.
22. Cross-jurisdictional coordination	Legal or other official grounds for coordination between different authorities, and between conservation and other government agencies/law enforcement units, to address cross-jurisdictional and cross-sectoral conflicts in order to support the achievement of MPA objectives, e.g. watershed management by pollution authority, fish stock management by the fisheries authority, forestry management by the forestry authority, recognizing that the environment authority with responsibility for MPAs often does not have direct jurisdiction over other sectoral activities that can impact the MPA's conservation features.	N*	Cross-jurisdictional coordination in the governance of the WS is limited. The NPA does not have direct jurisdiction over many sectoral activities that significantly affect conservation outcomes and the protection of harbour porpoises in particular. Several important policy areas are directed by external authorities, other than the NPA which is responsible for (porpoise) conservation. Their decisions are not necessarily aligned with the WS's ecological objectives and are beyond the authority of the NPA: ● Maritime traffic in the WS is regulated by the federal government under the German Traffic Regulations for Navigable Maritime Waterways (SeeSchStrO), not by the NPA. The recently adopted North Sea Navigation Ordinance (NordseeBefV, 2024) explicitly designates a high-speed corridor for service vessels transporting goods and personnel to nearby offshore wind farms, cutting directly through the WS. This presents an increased risk of acoustic disturbance and ship strikes for harbour porpoises. ● Surfing regulations, including zones where the activity is allowed or restricted, are also determined under the NordseeBefV rather than by the NPA, limiting authority over potential disturbance to marine mammals in the WS. ● Fishing activities fall under the jurisdiction of the Common Fisheries Policy (CFP) of the EU. The CFP allows certain gear types - such as gillnets and trawls - that are known to be particularly harmful to harbour porpoises due to bycatch risk. It also permits non-local (foreign or non-resident) vessels to operate in the same zones where local fishers face restrictions, undermining place-based conservation efforts. While formal legal frameworks exist for coordination between the NPA, federal ministries, and international bodies (e.g. within the Trilateral Wadden Sea Cooperation) - in practice, many sectoral policies are developed and implemented in silos, with limited ecological integration or responsiveness to marine mammal protection needs.

23. Clear and consistent legal definitions	Clarity and consistency in legally defining the objectives of MPAs, general and zonal use restrictions, jurisdictional boundaries, roles and responsibilities of different authorities, etc.	Y	The WS is designated as a marine protected area under the NPG and Natura 2000. The protection of harbour porpoises is explicitly referenced as a conservation objective. The NPG clearly defines the objectives, legal boundaries, general and zonal use restrictions, including provisions for access, activities, and nature conservation priorities as well as roles and responsibilities of the NPA. These are anchored in state laws and based on the HD and form the legal basis for the WS.
24. Clarity concerning jurisdictional limitations	Promoting clarity and transparency concerning the jurisdictional limitations of MPA legislation, i.e. recognizing which driving forces, activities and impacts cannot be directly addressed by the MPA legislative framework and exploring alternative means of addressing such factors.	Y*	The clear and consistent legal definitions (see incentive 23) also refer to the jurisdictional limitations of the WS. It is clear which activities - such as shipping, fisheries, and offshore wind development - fall outside the authority of the NPA. While this legal clarity is strong, the communication of these limitations to stakeholders is often insufficient. As a result, users may perceive the NPA's inability to act on issues like bycatch or underwater noise impacting harbour porpoises as a lack of will rather than a lack of legal authority to take decisions. This incentive is only partially realized since coordination mechanisms and insufficient outreach are lacking. Improved inter-agency engagement and stakeholder communication would strengthen governance and reduce misunderstandings.
25. Legal adjudication platforms	Employing legal, customary law and other formal and widely respected decision-making platforms to address and regulate legal conflicts as required.	Y*	The European Court of Justice (ECJ) holds legal authority over all MPAs in the EU designated under the HD, including the WS, and the mere potential for referral to the ECJ can serve as a deterrent against non-compliance. Formal legal adjudication platforms, such as national courts of law and the ECJ at EU level, are available to address conflicts related to conservation obligations. However, within the WS, these mechanisms are rarely used to resolve specific management conflicts, such as those involving the impacts of shipping or fisheries on harbour porpoises. There is no dedicated mediation or arbitration body within the WS framework, and legal processes tend to be slow, complex, and resource-intensive. As a result, while legal adjudication is possible and respected, its practical application in supporting day-to-day management remains limited. Strengthening informal conflict resolution or advisory structures could complement formal legal tools and enhance conservation outcomes.
26. Transparency, accountability	Establishing legal provisions to transparency, accountability and fairness in MPA management	Y*	Legal provisions are embedded in the governance of the WS by the NPG, the HD, and in broader environmental legislation. Fundamental questions and long-term planning decisions must be made in consultation with the BoT, where user groups can formally

and fairness	processes, e.g. statutory requirements for public access to information, appeals, public hearings.		raise objections. The minutes of BoT meetings - held approximately two-four times a year - are published on the NTP's website and publicly accessible, however, not always in a timely manner. The NPG also requires that agreements must be archived and made available to the public. While these mechanisms formally support transparency, the establishment of the BoT has also led to the channeling of critical discussions away from broader public forums, potentially excluding wider public input. Such enclosing of deliberation processes can reduce perceptions of fairness and participatory legitimacy, especially in relation to controversial issues such as marine traffic or fishing impacts on harbour porpoises.
Participation			
27. Rules for participation	Clear rules on participation from different groups and the representation of all user groups in participation processes in a manner that minimizes the undue influence of particular vested interests.	Y	There are clear rules for stakeholder participation in the governance framework of the WS, particularly through their participation within the BoT. The type and number of representatives per user group in the BoT is defined in NTG §8. The BoT includes representatives from various stakeholder groups - such as nature conservation, fisheries, tourism, local municipalities, and scientific institutions - ensuring a broad spectrum of voices in decision-making processes. This structure is intended to provide balanced representation and prevent dominance by any single interest group.
28. Establishing collaborative platforms	Developing participative governance structures and processes that support collaborative planning and decision-making, e.g. user committees and participative planning workshops, and including training to support such approaches.	Y	With the 1999 amendment of the NPG, numerous collaborative platforms, working groups, and cooperative projects were established to actively involve users of the WS. The governance framework includes the BoT as a key participatory body, alongside various working groups that support collaborative planning and decision-making. Collaboration among different stakeholders functions effectively, exemplified by the Wilhelmshavener Declaration of May 2023, where state agencies, experts, and local and regional organizations from Schleswig-Holstein and the trilateral partnership with the Netherlands and Denmark jointly developed the Single Integrated Management Plan (SIMP) for the Wadden Sea. Additionally, a joint participative working group between the counties of Nordfriesland and Dithmarschen was formed to advance this shared goal. While training initiatives to empower stakeholders could be further expanded, the existing participatory governance structures and processes demonstrate strong collaborative engagement, fulfilling the incentive's requirements.

31. Decentralizing responsibilities	Decentralizing some roles, responsibilities and decision-making authorities to local organizations through a clear management structure, while maintaining an appropriate degree of authority by higher level state organizations, to ensure that strategic conservation objectives are effectively met, being open and realistic about the degree of autonomy and influence that local people can expect.	Y	The NPA has passed part of its responsibilities in the management of the WS to local organizations. For example, a local conservation NGO is responsible for planning and implementing biodiversity monitoring along the west coast, including the WS area. In cases of harbour porpoise incidents, local responders, who are trained for marine mammal rescue, are contacted to handle the situation on-site. If a harbour porpoise strands on the beach, these responders secure the area from pedestrians and tourists and report the event to a specialized research institute. While local organizations have clear operational roles and contribute valuable local knowledge, strategic decision-making and broader management authority remain centralized within the state-level NPA, ensuring alignment with national and EU conservation objectives. This distribution maintains a balance between local involvement and top-down governance, with realistic expectations about the autonomy and influence of local actors.
33. Building trust and the capacity for cooperation	Building trust among individuals through transparency, face-to-face discussions, equity promotion, etc., and promoting cooperation and confidence that this will be reciprocated among MPA users.	Y*	Trust-building and cooperation among WS stakeholders are supported through transparent communication, regular face-to-face meetings, and inclusive participatory forums such as the BoT, which facilitate dialogue between local communities, user groups, scientists, and authorities. The annual socio-economic survey found that 85% of local residents feel proud of the NTP, demonstrating strong appreciation, acceptance, and positive attitudes toward its conservation goals. Many interviewees also noted good cooperation between organizations, the NPA, and other institutions, indicating a generally positive working environment based on mutual trust. Joint initiatives like the trilateral SIMP further reflect growing confidence and commitment to shared objectives, including harbour porpoise protection. Nonetheless, trust and collaboration can still be improved, especially among stakeholders with competing interests. This incentive is partly employed within the WS governance framework.
34. Building linkages between relevant authorities and user	Developing and strengthening linkages among relevant government authorities and key user representatives, including mutual trust, to promote the fulfilment of legal conservation	Y	The governance of the WS demonstrates strong efforts to build and strengthen linkages between government authorities and key user representatives through formal structures like the BoT and various working groups. Associations such as the German Fisheries Association, the German Windsurf/Kitesurf Association, tourism agencies and various conservation NGOs actively build connections to each other, and with authorities, and with representatives of other users, fostering regular interaction and coordination. These

representatives	objectives and build resilient governance structures.		linkages promote mutual trust and support collaborative decision-making, aligning diverse interests with official conservation objectives, including harbour porpoise protection. The trilateral Wadden Sea partnership further enhances governance resilience by connecting authorities and users across Germany, the Netherlands, and Denmark. While challenges remain, these well-established networks provide a solid foundation for effective governance and management.
35. Building on local customs	Promoting consistency with and respect for local traditions, customs, norms and practices, insofar as they are compatible with and contribute towards the fulfilment of legal conservation objectives, including scope for flexibility, negotiations and compromises.	Y	Local customs on Sylt mainly involve small-scale coastal fishing shaped by long-term experience with the marine environment. The WS governance respects these local practices where compatible with conservation goals. Combining local traditions with conservation is an objective of the NTP to enhance community acceptance, focusing on flexible adaptation rather than strict preservation. This helps balance cultural values with legal protections for species like harbour porpoises.
36. Potential to influence higher institutional levels	Promoting recognition and realization of the potential for the participative governance of a given MPA to influence the higher and wider statutory framework, processes and obligations, i.e. that local people can have an influence on higher level institutions as well as being influenced by them in a co-evolutionary manner.	Y*	Potential to influence higher institutional levels is provided through the BoT, which includes various stakeholder groups (see incentive 27) that by themselves do not hold decision-making power but through their involvement in the BoT can influence governance and management. Local organizations, including conservation NGOs and research groups, play active roles in monitoring and managing the WS, their knowledge feeds into broader decision-making processes. Through these and other participative platforms, representatives can influence policies at national and international levels, such as those under the EU HD and CFP. This creates a co-evolutionary dynamic where local experiences inform, and are shaped by, higher-level statutory frameworks. Nevertheless, some top-down regulations remain rigid, indicating room to further enhance bottom-up contributions within the WS governance system.

Table 4: Overview of incentives used, used but in need of strengthening and not used and in need of introduction, sorted by the five MPAG categories. In brackets is the type of governance steer.

Incentive and type	Incentives used (Y)	Incentives used but in need of strengthening (Y*)	Incentives not used and in need of introduction (N*)
Economic *(market-based)*	2. Assigning property rights 5. Promoting green marketing	4. Promoting profitable and sustainable fishing and tourism 9. Provision of State funding 10. Provision of NGO, private sector and user fee funding	
Communication *(top-down, bottom-up)*	12. Promoting recognition of benefits 13. Promoting recognition of regulations and restrictions	11. Raising awareness	
Knowledge *(top-down, bottom-up)*		14. Promoting collective learning 16. Independent advice and arbitration	
Legal *(top-down)*	17. Hierarchical obligations 19. Penalties for deterrence 23. Clear and consistent legal definitions	18. Capacity for enforcement 20. Protection from incoming users 21. Attaching conditions to use and property rights, decentralization, etc. 24. Clarity concerning jurisdictional limitations 25. Legal adjudication platforms 26. Transparency, accountability and fairness	22. Cross-jurisdictional coordination
Participation *(bottom-up)*	27. Rules for participation 28. Establishing collaborative platforms 31. Decentralizing responsibilities 34. Building linkages between relevant authorities and user representatives 35. Building on local customs	33. Building trust and the capacity for cooperation 36. Potential to influence higher institutional levels	

Of the 36 MPAG incentives assessed 12 were used, 14 used but in need of strengthening and one not used and in need of introduction. Nine incentives have been identified as not used and not needed for effective harbor porpoise management, and therefore not listed in table 3 and 4. This distribution reflects a governance system that still has significant room for improvement. The WS employs incentives across economic, communication, knowledge, legal, and participatory categories, underlining the importance of a functional integrity of various incentives from different governance approaches (top-down, market-based, and bottom-up). The high number of incentives that were found to require strengthening suggests that effectiveness is currently limited by gaps in implementation and enforcement. In the context of the global analysis of 28 MPAG case studies by Jones and Long (2021), the WS aligns with the broader trend where most MPAs utilize a core set of incentives but need to strengthen or introduce additional ones to improve governance effectiveness.

There is clear evidence that whilst bottom-up deliberative approaches are critically important for effective governance in the WS, top-down (state-led) approaches are needed to set boundaries for human and societal behaviour. This analysis shows that while bottom-up incentives are mainly well in place, the weakest incentive category is the legal one, despite hierarchical obligations being a core pillar of governance in the WS for harbour porpoise conservation. When fishers from neighboring countries enter the WS with fishing gear harmful for harbour porpoises, intervention by the state, such as for instance a European-wide policy amendment is required. This intertwines with needed and existing market-based approaches such as promoting sustainable tourism or the provision of funding to increase enforcement capacity to control and sanction activities in the WS, respectively. The strengths of one approach (in this case bottom-up) herewith counters the weaknesses of the other (in this case top-down). This refers to the concept of co-evolution of governance approaches, which aims to make the current governance arrangements more resilient, making the WS more effective by influencing human behaviour to reduce the impacts of anthropogenic activities on harbour porpoises (Jones, 2014).

To strengthen the governance of the WS, the most needed incentive to introduce is cross-jurisdictional coordination, which is in line with needs of other government-led MPAs (Jones, 2014). Mechanisms to integrate other sectoral policies to contribute to MPA effectiveness, rather than undermining it, are needed to coordinate across various jurisdictions whose sectors impact harbour porpoise and their conservation in the WS. Adopting an ecosystem-based approach is substantial. Examples for this are the NordSeeBefV, which includes the high-speed corridor that directly goes through the WS, as well as the CFP. Nature conservation must be equated with coastal protection and other sectoral goals and objectives.

The creation of a Harbour Porpoise Management Plan that pursues the conservation objectives of other regional and national legislatures may support cross-jurisdictional coordination. This plan should be based on the ecosystem-based approach and contain concrete conservation objectives that include a focus on uncertainty to successfully protect harbour porpoises in the WS and surrounding areas from anthropogenic impacts, today and in the foreseeable future. To develop this management plan, a joint working group across the various stakeholders can be set up and measures that increase trust incorporated into the deliberations.

Cross-cutting incentive themes

Role of NGOs

NGOs play a significant role in the monitoring of the WS. The NGO Schutzstation Wattenmeer is the legally responsible institution for conducting work in the areas falling under their responsibility as well

as running the educational center Nationalpark-Haus Arche Wattenmeer. They work alongside state, private, academic and local stakeholders to support the designation and management of the WS, the achievement of conservation objections as well as fulfilling the role as advocates of the WS and other areas of the NTP. They have been active in providing scientific information and educational activities. By offering information about as well as access to the ecosystem through nature tours around and on the island, they play a key role in engaging civil society, particularly locals, tourists, families and school classes. They are a strong player in raising awareness and promoting knowledge exchange. Through their formal role they contribute to a decentralized governance arrangement with strong ties to the NPA. Participation and self-governance is promoted through this inclusion of a non-state institution, increasing institutional diversity and thereby promoting governance resilience.

Role of leadership

A key individual that is respected by a majority of the local community exists. That person plays a particularly important role in communication-related elements and in bridging different institutions, thereby creating vertical and horizontal linkages. The biological and ecological knowledge this person contributes to deliberations and governance processes is vital for decision-making. Through entrepreneurial and innovative skills the expert supported the creation, funding and maintenance of educational activities on adjacent land.

Policy recommendations

Table 5 shows solution-oriented action knowledge based on the shortcomings of the governance of the WS as identified through the application of the MPAG. While many of the suggestions are high-impact and clearly reflect governance gaps, the attention to local realities shows practical grounding.

Table 5: Recommendations linked to MPAG incentives needing strengthening in the Whale Sanctuary

	MPAG incentive	**Recommendations**
need strengthening	4. Promoting profitable and sustainable fishing and tourism	● Change the protection status of the WS from II to I to allow for stricter conservation zoning and reduce anthropogenic activities ● Further develop alternative fishing gear (fish traps or pontoon lift traps instead of gillnet modifications such as pearl-nets) for coastal fisheries to reduce bycatch
	9. Provision of state funding	● Create a distinct funding line for the WS within the LKN.SH to dedicate more long-term funding to enable better enforcement ● Establish a second NTP ranger position, who is responsible for the marine environment only
	11. Raising awareness	● Engaging local communities, actors and tourists in educative information campaigns about the conflicts between harbour porpoises and human uses in order to increase acceptance

		and support for specific harbour porpoise conservation measures
	14. Promoting collective learning	● Establish a stakeholder learning network / forum for the NTP, with incentives for all affected groups and actors to share knowledge, discuss conflicts and co-develop solutions
	16. Independent advice and arbitration	● Form a multi- and transdisciplinary advisory board for the NTP to review policy impacts and mediate stakeholder disputes
	18. Capacity for enforcement	● Build capacity (funding, technical and human resources) for effective enforcement and sanctioning of violations, particularly to increase police presence in more distant offshore areas of the WS; monitor vessel activities on regular basis and sanction accordingly
	20. Protection from incoming users	● Amend the CFP to protect the WS from harmful fishing gear that is still in use by fishermen from neighboring countries
	21. Attaching conditions to use and property rights, decentralization, etc.	● Define, apply and publish performance indicator data to evaluate the effectiveness of management measures on harbour porpoise populations
	24. Clarity concerning jurisdictional limitations	● Raise awareness and clarity on the jurisdictional limitations of the NTG, specifically sharing information on which drivers and conflicts cannot be regulated under the NTG
	25. Legal adjudication platforms	● Ensure access to independent legal review and arbitration mechanisms for stakeholders affected by sanctuary regulations and conservation decisions
	26. Transparency, accountability and fairness	● Transparent communication to the public about the status and processes of MPA implementation, porpoise conservation successes and failures
	33. Building trust and the capacity for cooperation	● Organize meetings in an informal environment that bring together stakeholders from conflicting sectors to increase long-term common understanding
	36. Potential to influence higher institutional levels	● Establish an inclusive bottom-up platform or network with focus on harbour porpoise conservation to enhance the influence of local organizations
need introduct	6. Promoting alternative livelihoods	● Support the transition from fisheries to ecologically responsible tourism that can benefit harbour porpoises (e.g. guided walks along the dikes on Sylt for harbour porpoise watching)

	15. Agreeing approaches for addressing uncertainty	● Amend the NTG to include the precautionary principle for addressing uncertainty with regards to harbour porpoise conservation in the WS ● Create a harbour porpoise management plan including scenario analysis for addressing uncertainty
	22. Cross-jurisdictional coordination	● Create a harbour porpoise management plan including formulation of concrete conservation objection with measurable goals ● Equal focus of marine conservation and other anthropogenic uses
biological / ecological	Conservation-related measures	● Close the legal protection gap in the first 150m off the islands ("Schutzlücke") ● Increase speed limits and prohibit high-speed corridors ● Implement regulations to reduce impact of sources of noise (other than offshore construction) ● Consider seasonal variations in harbour porpoise abundance and distribution and implement appropriate conservation measures

Suggestions for advancing the MPAG framework

Marine Protected Areas (MPAs) are increasingly understood as complex social-ecological systems (SES), where the resilience of ecosystems and the sustainability of human uses are co-dependent. The MPAG framework (Jones et al., 2013; 2014) has proven valuable in identifying the strengths and weaknesses of governance arrangements in MPAs across different geographical and socio-political contexts. It focuses on the diversity and interplay of governance incentives - economic, legal, participatory, and knowledge-based - aimed at achieving compliance and effective conservation. Our case study of the WS in the German North Sea demonstrates two core limitations of the existing MPAG framework that merit attention: (1) the lack of integration of ecological and biological variables, and (2) insufficient attention to external drivers of ecological degradation.

1. Toward a social-ecological governance framework: *Integrate ecological and social variables*

The MPAG was originally developed with a focus on governance and compliance, aiming to support institutional effectiveness and stakeholder engagement. It is intentionally interdisciplinary but leans strongly toward the social science perspective. While this approach captures institutional diversity and context-specific management practices, it omits crucial ecological dynamics that are foundational to conservation success. As observed in the WS, the viability of conservation efforts - especially those targeting vulnerable species such as the harbour porpoise - depends not only on stakeholder coordination or enforcement, but also on incorporating knowledge of species biology, seasonal patterns, and ecological thresholds into governance decisions. Current applications of MPAG do not formally accommodate the integration of species-specific data (e.g. habitat use, abundance trends, migratory routes, acoustic sensitivity) or data on ecosystem processes (e.g. trophic dynamics, seasonal productivity) into its incentive-based structure. In the case examined here, the failure to account for seasonal variations in porpoise density and distribution risks misaligning policy measures such as vessel

speed regulations or temporal fishing bans with actual conservation needs. Without explicit acknowledgement of these ecological processes and their feedbacks with human and societal spatial uses, the effectiveness of conservation governance mechanisms and incentives may be undermined and at risk of being perceived as ineffective or unjust by local stakeholders with further risks to implementation.

To address this, we suggest that the MPAG framework is expanded to include a layer of biological/ecological indicators that connects governance incentives to expected or observed ecological characteristics and processes. Such a layer would draw on conservation effectiveness literature (Edgar et al., 2014; Gill et al., 2017) to track habitat quality, species population trends, and threat mitigation progress alongside governance assessments. This mirrors approaches used in adaptive management and evidence-based conservation, where ecological data play a pivotal role in shaping institutional responses. A possible way forward is to integrate the MPAG into a Theory of Change model, where governance incentives are explicitly linked to ecological objectives via mediating mechanisms like enforcement capacity, knowledge co-production, and participatory monitoring.

Addressing external drivers of MPA outcomes

A second key insight from the WS case is the profound influence of external drivers on outcomes within MPAs from beyond MPA boundaries. In this instance, the development of offshore wind parks (OWPs) adjacent to the MPA, and the creation of maritime transport lanes, introduces underwater noise pollution and habitat fragmentation that directly impact harbour porpoises within the sanctuary, while these activities are outside the spatial boundaries of the WS. The MPAG framework currently lacks an analytical space to evaluate such exogenous pressures. As marine species and ecological processes are not constrained by administrative borders, effective governance must consider cumulative impacts across jurisdictional and sectoral boundaries. The current inability of the MPAG to formally account for transboundary risks (e.g. mobile pollution sources, migratory species, transnational fisheries) reduces its explanatory and prescriptive power in such scenarios.

We propose that MPAG be expanded with a category for “external pressures and cross-scale threats”, which would interact with existing incentives such as “Cross-jurisdictional coordination” (incentive number 22), “Protection from incoming users” (20), and “Capacity for enforcement” (18). Such a category could be operationalized through tools like cumulative impact mapping, stakeholder analysis that include non-local actors (e.g. foreign fishing fleets), and ecological connectivity assessments. This aligns the MPAG with insights from resilience thinking and panarchy theory (Gunderson & Holling, 2002), which emphasize that governance systems must be adaptive not only to internal institutional dynamics, but also to external shocks and slower-changing variables like climate change or infrastructural expansion. This adaptation, which is visualized in figure 3, also resonates with Ostrom’s (2009) framework for analyzing social-ecological systems that emphasizes cross-level interactions and polycentric governance.

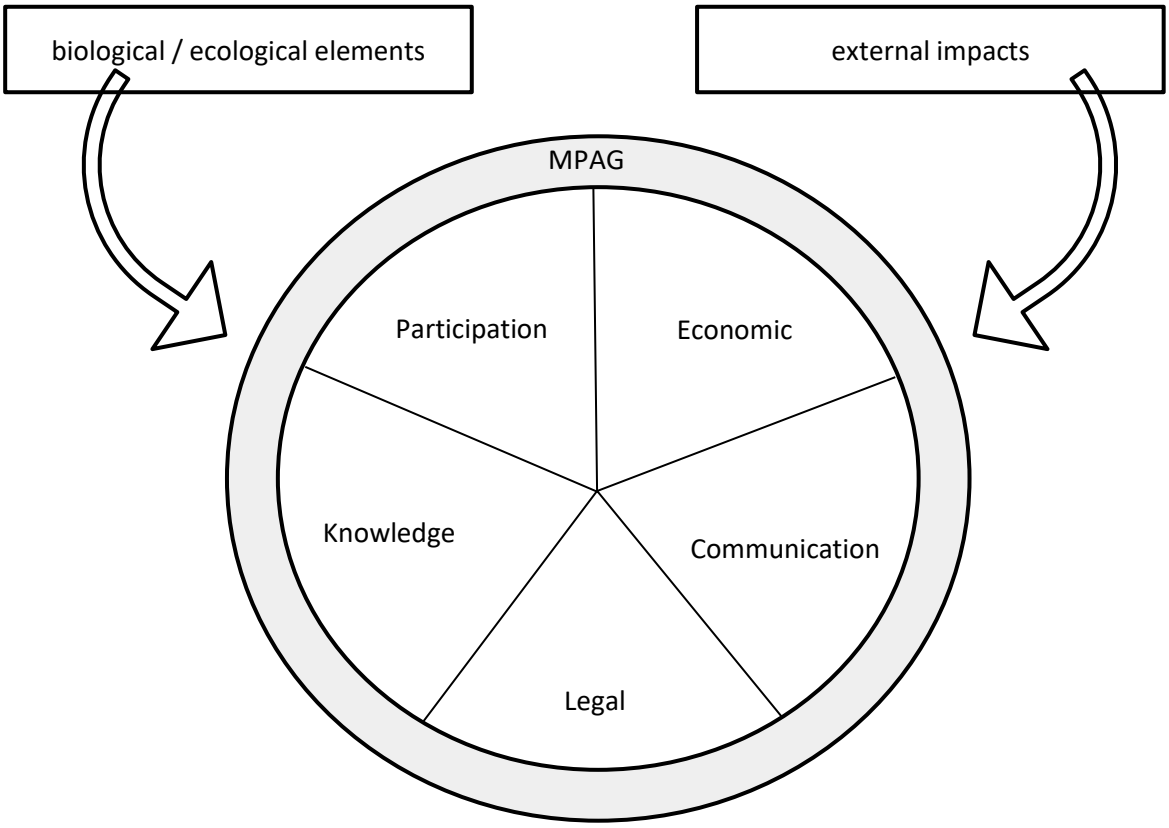
2. Integrated advancement: A holistic framework

Together, the two suggested advancements - (1) the integration of ecological indicators and (2) the incorporation of external pressures - would significantly improve the practical and analytical applicability of the MPAG. They would enable the framework to better capture feedback loops between institutional action and ecological, or in the WS case, species dynamics. Our suggestions widen the potentials of MPAG beyond those of a governance assessment tool to those of a transdisciplinary instrument for adaptive conservation planning. A future version of the MPAG could include a dual-track assessment:

- One track for evaluating the presence and functionality of governance incentives.
- A second track for mapping how these incentives interact with conservation outcomes and external threats, based on a combination of empirical ecological data and stakeholder perception.

The suggested extension, pictured in Figure 3, allows for a more systems-oriented diagnosis of MPA performance, bridging the divides between governance quality and ecological success and between internal and external drivers of MPA outcomes. In highly formalized institutional multi-use contexts like the German North Sea, where marine mammal conservation intersects with global energy policy, shipping, and fisheries, this evolution of the framework is not only desirable but essential.

Figure 3: An extended MPAG framework that includes biological and ecological elements as well as external impacts.



4. Conclusion

This study advances the conceptualization and thus the application potentials of the Marine Protected Area Governance (MPAG) framework (Jones, 2014; Jones & Long, 2021) to a species-focused conservation case in a high-income country: harbour porpoise conservation in the Whale Sanctuary (WS) in the German North Sea. By applying the MPAG to this context, the analysis reveals key institutional arrangements and governance dynamics that impact the conservation of harbour porpoises - an ecologically and nationally important species whose reproductive activity in the WS underscores the area's conservation significance.

Despite existing conservation measures, the conservation status of harbour porpoises remains inadequate (Gilles et al., 2023). The documented population shift from the northwest to the southern German North Sea underscores the importance of the WS, which serves as a vital calving and nursing ground for a slightly declining population facing growing anthropogenic pressures, highlighting the urgent need for effective governance. The importance of this region as important nursing and calving site for the North Sea is underscored by a documented population shift from the northwest to the southern German North Sea, which, together with increasing anthropogenic pressures, intensifies the need for effective governance. Many of these pressures such as offshore wind farm production, international fisheries originate beyond the direct jurisdictional control of the National Park Authority (NPA), making governance coordination and enforcement more complex.

The governance of the WS can be characterized as decentralized and multi-actor (see figure 2). While the NPA holds formal authority and the Water Police of Schleswig-Holstein is responsible for monitoring and enforcement, local NGOs - particularly Schutzstation Wattenmeer - play a vital role in area-based stewardship, public education, scientific communication, and civil society engagement. This collaborative structure promotes participatory governance and strengthens institutional diversity, thereby enhancing system resilience.

Of the 36 MPAG incentives assessed, 12 are fully in use, 14 are used but in need of strengthening, and one is not used but identified as needed. Nine incentives were found to be not applicable in the current governance context. This distribution indicates a governance system that is operational but still offers substantial room for improvement. The WS employs incentives from all five MPAG categories - economic, communication, knowledge, legal and participatory - illustrating the importance of functional integration and co-evolution across top-down, market-based, and bottom-up approaches.

Strong performance is evident in the categories of participation and communication, where bottom-up approaches like public education trails, nature tourism, and NGO-led initiatives contribute to awareness, stewardship, and social support for conservation. Conversely, legal incentives remain the weakest category, particularly in addressing transboundary issues such as fishing practices by vessels from neighboring countries and vessel traffic through sensitive areas.

Our analysis highlights the need for cross-jurisdictional coordination and the integration of sectoral policies that currently undermine conservation objectives. In particular, reforms of the European CFP and national shipping regulations are essential to reduce external threats to harbour porpoises. The development of a Harbour Porpoise Management Plan, grounded in an ecosystem-based approach, is recommended to harmonize conservation measures across jurisdictions, explicitly address ecological uncertainties, and align nature conservation with other marine policy goals.

To strengthen the effectiveness of the Whale Sanctuary in fulfilling its conservation objectives, targeted policy recommendations are essential. In particular, addressing governance gaps - such as the protection gap within the first 150 meters off the coastline known as the "Schutzlücke" - should be prioritized.

Enhanced cross-jurisdictional coordination between federal and state agencies is necessary, especially given the spatial overlap of different MPAs and overlapping mandates for environmental protection, fisheries, and offshore energy development. Harmonized regulatory frameworks and integrated monitoring would reduce fragmentation and improve enforcement capacity. Moreover, implementing vessel speed restrictions in ecologically sensitive zones, particularly during calving seasons, can significantly reduce acoustic and collision-related stressors on harbour porpoises. These policies, if adequately funded and enforced, could mitigate key anthropogenic threats and support the recovery of the declining population.

Beyond our recommendations relating to the specific case of the North German Whale Sanctuary (WS) this study identifies critical pathways for advancing the MPAG framework as a generic tool for increasing the effectiveness of MPAs. While the MPAG has proven valuable in identifying governance incentives across socio-political contexts, its current structure insufficiently captures the ecological dynamics and external drivers that are central to effective conservation in marine social-ecological systems. The case of the WS reveals that governance performance cannot be decoupled from ecological/biological realities such as species-specific habitat uses, seasonal variability, and cumulative pressures from adjacent maritime sectors. Our above outlined suggestions to extend the MPAG framework through two innovations: (1) the integration of ecological indicators that link governance mechanisms to species and habitat outcomes, and (2) the inclusion of a category addressing external pressures and cross-scale threats. The proposed dual-track framework links institutional incentives with conservation effectiveness. This supports a more systemic and adaptive approach to marine governance. In highly formalized institutional multi-use settings like the German North Sea, this evolution of the framework is not only desirable but essential for achieving resilient and ecologically meaningful protection. In doing so, this report contributes both applied policy guidance and theoretical advancements toward more robust MPA governance.

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