MASTER'S THESIS

The conservation of the harbour porpoise (Phocoena phocoena) in the Dutch North Sea: an assessment of the social-ecological fit of relevant institutions

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Thesis MSc Environmental Sciences

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The conservation of the harbour porpoise (*Phocoena phocoena*) in the Dutch North Sea: an assessment of the social-ecological fit of relevant institutions

De bescherming van de bruinvis (Phocoena phocoena) in de Nederlandse Noordzee: een beoordeling van de sociaal-ecologische fit van de relevante instituties

Thesis MSc Environmental Sciences

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Acknowledgement

Hereby I present you my thesis 'The conservation of the harbour porpoise (*Phocoena phocoena*) in the Dutch North Sea: an assessment of the social-ecological fit of relevant institutions'. This thesis has been written as part of the master's degree Environmental Sciences at the Open University. The research process, from proposal to thesis took place between August 2020 and September 2021.

Together with biologist Mardik Leopold from Wageningen Marine Research, the first idea for the research subject was to focus on the conservation of the harbour porpoise in Dutch waters by analysing the anthropogenic effects. With the help of my supervisor Raoul Beunen, we eventually defined the final research question with a focus on environmental governance. I enjoyed studying an animal species I am passionate about, in the context of governance challenges.

This master's thesis almost marks the end of my master's studies at Open University. First of all, I would like to thank my supervisor Raoul Beunen for his guidance and support during the whole thesis process and supervisor Jean Hugé for the useful advices during the classes.
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A large part of this thesis would not have been realised without the contribution of the stakeholders who were willing to cooperate with the interviews. They generously shared their knowledge and information about the subject, which was a valuable contribution to this study. I hope that the results of this thesis can help them to reach an ideal set of institutions for the governance of the harbour porpoise in our coastal waters.

Liliane Solé
Vlissingen, September 2021

Abstract

The increasing amount of anthropogenic activities results in an increasing amount of pressures on the harbour porpoise (*Phocoena phocoena*) in the social-ecological system of the Dutch North Sea. In order to maintain a favourable population status under the EU Habitats Directive, a large number of institutions is implemented to govern the conservation of the harbour porpoise in this area. The objective of this research is to assess if the harbour porpoise and its social-ecological system, the Dutch North Sea, are protected in such a way that a future favourable conservation status for the harbour porpoise can be ensured in this area. The main question of this thesis is: Are the institutions governing the social-ecological system of the Dutch North Sea fit to ensure a future favourable conservation status of the harbour porpoise (*Phocoena phocoena*)?

The involved institutions are assessed by looking at the different dimensions of social-ecological fit. The assessed aspects of this fit are about the correspondence of the institutions with the geographical habitat boundaries, the fit between institutions and environmental developments, the approached challenges, participation levels, values and beliefs and the correspondence of the responsibilities and the accountable authorities. By creating a complete overview of the social-ecological system by investigating the different institutions and conducting interviews, it was possible to assess the social-ecological fit of the relevant institutions that govern the Dutch North Sea and the activities taking place there.

The results of this research show that the harbour porpoise is facing an increasing amount of threats in the area and that the future brings uncertainties, especially because of climate change and economic developments. Current institutions need improvements to ensure a future favourable conservation status for the harbour porpoise. Especially the ecological fit needs attention. The institutions perform better on social fit dimensions.

Reaching a perfect social-ecological fit is difficult and often even impossible. The different aspects of fit interact with each other. A good institutional fit on one level can therefore influence the level of fit of another aspect. This is also seen back in the results of this thesis. They made clear that a good social fit, does not automatically means that there is also a good ecological fit. Since it is difficult to reach a perfect institutional fit, it should not be a goal by itself, but the concept can be applied to identify possible improvements on institutional arrangements and reach a fit that is as good as possible in the context of the complex social-ecological system.

Samenvatting

De toenemende druk van antropogene activiteiten leiden tot een toenemende druk op de bruinvis (*Phocoena phocoena*) in het sociaal-ecologische systeem van de Nederlandse Noordzee. Om een gunstige staat van instandhouding onder de EU Habitats Directive te behouden zijn een groot aantal instituties betrokken bij het managen van de bruinvis in dit gebied. Tijdens dit onderzoek is onderzocht of de bruinvis in het sociaal-ecologische systeem van de Noordzee op zo'n manier wordt beschermd dat een toekomstige gunstige staat van instandhouding kan worden gegarandeerd. De hoofdvraag van dit onderzoek luidt als volgt: Zijn de instituties die betrokken zijn bij het managen van het sociaal-ecologisch systeem van de Noordzee passend genoeg om een gunstige staat van instandhouding van de bruinvis (*Phocoena phocoena*) te behouden?
De betrokken instituties zijn beoordeeld aan de hand van dimensies binnen de sociaal-ecologische fit. De aspecten van fit gaan erover of de toegepaste instituties passen bij de geografische habitatgrenzen, de fit tussen instituties en de omgevingsveranderingen, de uitdagingen die aangepakt worden, de wijze van participatie, de normen en waarden en of de verantwoordelijkheid van de toegepaste instituties bij de juiste autoriteiten ligt. Door het maken van een zo compleet mogelijk overzicht van het sociaal-ecologisch systeem, door het bestuderen van beleidsdocumenten en het houden van interviews, was het mogelijk dit systeem te beoordelen aan de hand van de eerdergenoemde dimensies.

De resultaten van dit onderzoek laten zien dat de bruinvis een toenemend aantal bedreigingen ervaart in het gebied en dat er grote toekomstige onzekerheden zijn, met name door de onzekerheden rondom klimaatverandering en economische ontwikkelingen. De huidige instituties dienen verbeterd te worden om een gunstige staat van instandhouding te garanderen. Er is met name aandacht nodig voor de aspecten binnen de ecologische fit. De instituties scoren beter op de dimensies binnen de sociale fit.
Het behalen van een perfecte sociaal-ecologische fit is moeilijk en vaak zelfs onmogelijk. De verschillende aspecten van fit hebben invloed op elkaar. Een goede fit op een bepaald aspect, kan daarom de fit op een ander aspect beïnvloeden. Dit is ook terug te zien in de resultaten van deze thesis. Het werd duidelijk dat een goede sociale fit, niet automatisch betekent dat de ecologische fit ook goed is. Omdat het moeilijk is om een perfecte sociaal-ecologische fit te behalen moet dit geen doel op zich zijn. Het concept van sociaal-ecologische fit kan echter goed gebruikt worden om verbeteringen van institutionele toepassingen te identificeren om een zo goed mogelijke fit te bereiken in de context van het complexe sociaal-ecologische systeem.

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1. Introduction

1.1 The harbour porpoise

Harbour porpoises *Phocoena phocoena*, are among the smallest cetaceans. Harbour porpoises are toothed whales, Odontocetes. Females reach a length of about 1.60m and have a maximum weight of circa 60kg, while males reach a length of about 1.50m and a weight of 50kg (Camphuysen & Siemensma, 2011). They are the most abundant cetaceans in the North Sea, with an estimate of 63.514 individuals (CI = 34.276 – 119.7342) on the Dutch Continental Shelf (Geelhoed, Janinhoff, Lagerveld, & Verdaat, 2018). The only known predator of the harbour porpoise in the Dutch North Sea is the Grey Seal (*Halichoerus grypus*) (Leopold, et al., 2015). Other predators are the Killer Whale (*Orcinus orca*) and the Great White Shark (*Carcharodon carcharias*), but these are not present in the Dutch North Sea (Bouveroux, Kiszka, Heithaus, Jauniaux, & Pezeril, 2014). In Scotland, bottlenose dolphins (*Tursiops truncates*) are responsible for fatal injuries in harbour porpoises, but they do not consume them (Ross & Wilson, 1996).

In the early 20th century the harbour porpoise was an abundant marine mammal in the Dutch North Sea, however from the 1960s the animal has rarely been observed. In the period between 1970-1985 about 15 to 30 harbour porpoise strandings were recorded annually, which indicates that the animal was still present in the area, but in very low numbers. Since the 1990s the animal made a comeback in the Dutch coastal waters with an increase in both stranding numbers and observations, as shown in figure 1 (Camphuysen & Siemensma, 2011).

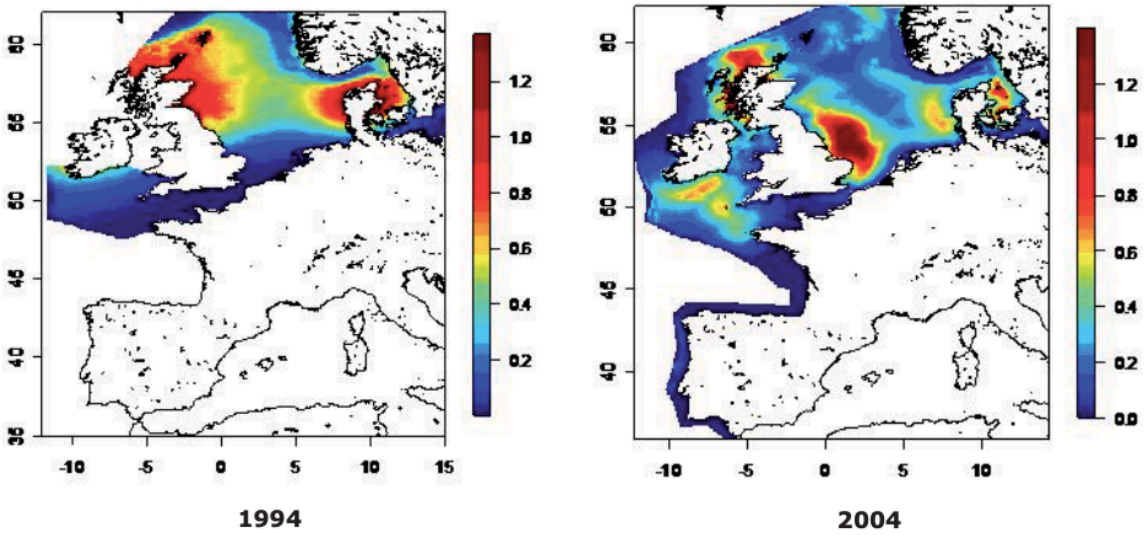

Figure 1 Areas of higher (yellow and red) observations and areas with lower observation numbers (blue) of the harbour porpoise, based on synoptic surveys in summer 1994 and 2004 (Camphuysen & Siemensma, 2011)

The abundance of the harbour porpoise is marked with a peak in stranding numbers in 2011 with 899 dead harbour porpoises found along the Dutch coastline (Walvisstrandingen.nl, 2020) and a peak in aerial observations in 2014 with 154.265 estimated individuals on the Dutch Continental Shelf (Geelhoed, et al., 2018).

Although the number of anthropogenic activities continues to increase (IJsseldijk, et al., 2020), the number of harbour porpoises observed during aerial surveys has remained stable (Geelhoed, et al., 2018). The number of dead harbour porpoises washed ashore the Dutch coast varies between 318 and 701 in 2015 and 2018 respectively (Walvisstrandingen.nl, 2020). There are several theories about the increasing abundance of harbour porpoises in the Dutch North Sea. One of them is the shift of prey availability from the Northern North Sea towards the Southern North Sea, but the cause of disappearance in the 1960s and their comeback since the 1990s is never studied and therefore currently unknown (Camphuysen & Siemensma, 2011; Hammond, et al., 2013).

1.2 Anthropogenic pressures

Anthropogenic activities such as vessel movements (Roberts, Collier, Law, & Gaion, 2019), offshore wind farm developments (Teilmann & Carstensen, 2012), commercial fisheries (van Beest et al., 2017; IJsseldijk et al., 2020) and naval sonar activities (Wright, et al., 2013) affect the behaviour of harbour porpoises and the characteristics of its habitat. The anthropogenic pressures that are considered the most important threats are marine fish and shellfish harvesting and habitat and ecological changes due to climate change. Extraction of gas and oil, wind, wave and tidal power, leisure activities and mixed source marine water pollution are considered of medium importance (European Commission, 2020).

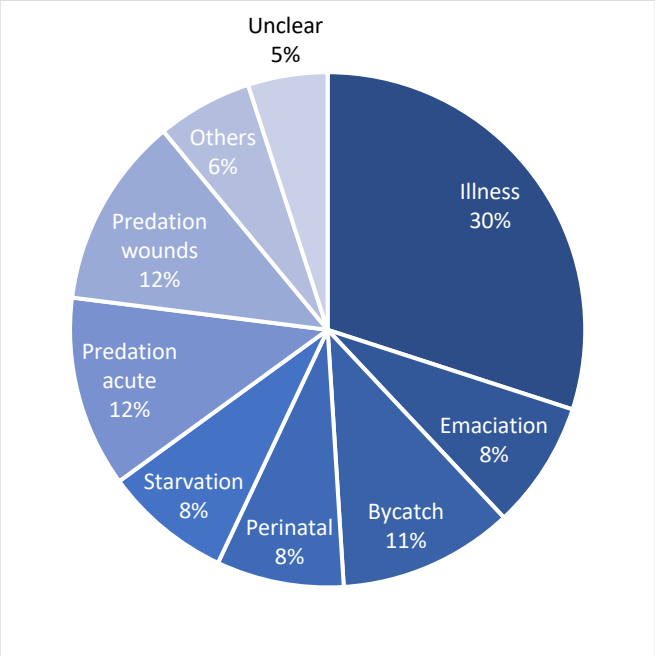

Figure 2 Results post-mortem research harbour porpoises in the Netherlands in the period 2016-2019 (IJsseldijk, et al., 2020)

Dähne, et al. (2013) observed that during the construction period of an offshore wind farm off the coast of Germany, a strong avoidance response within 20 km of the area occurred among harbour porpoises. A same kind of event is observed in highly trafficked coastal waters, where harbour porpoises interrupt their foraging activities when encountering high-noise levels. In the long-term, this may result in fitness problems because of the inability to catch enough prey to meet their energetic needs (Wisniewska, et al., 2018). Another anthropogenic threat for harbour porpoises is fishing activities. In the Netherlands, stranded harbour porpoises are collected for scientific research. This collection is limited to harbour porpoises that are not yet decomposed. The results of this research program show that during the period 2016-2019, 11% of the collected death harbour porpoises were the victim of bycatch (figure 2) (IJsseldijk, et al., 2020).

1.3 Conservation measures

The harbour porpoise is protected under several national and international laws. The most important international legal instruments are the International Convention for the Regulation of Whaling, the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR-Convention), the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS). The most important legal instruments under the European Union are the Habitats Directive, the Marine Strategy Framework Directive and the Common Fisheries Policy. On a national level, the harbour porpoise is protected under the Nature Conservation Act (the transposition of the European Habitats Directive into national law) and indirectly under the Offshore Wind Energy Act (a policy that ensures that during the development of offshore wind farms, nature conservation frameworks are taken into account and ensures species protection by the implementation of conservation measures during and after the realisation phase) (Dotinga, 2020). Of all these (inter)national legal frameworks, the Habitats Directive is a key legal instrument for the conservation of the harbour porpoise. The harbour porpoise is included in the Habitats Directive under Annex II (‘Animal and plant species of Community interest whose conservation requires the designation of

special areas of conservation') and Annex IV ('Animal and plant species of Community interest which need to be strictly protected'). Member States, among which the Netherlands, are required to take the necessary measures to ensure that the harbour porpoise reaches or maintains a favourable conservation status. These measures consist of generic species protection measures and the designation of Natura2000 sites to create special areas of conservation for the harbour porpoise (Dotinga, 2020). The conservation measures under the Habitats Directive are described in the 'Conservation plan for the Harbour Porpoise *Phocoena phocoena* in the Netherlands: towards a favourable conservation status' (Camphuysen & Siemensma, 2011). In December 2020, an update of the conservation plan is published, which has a focus on maintaining a favourite conservation status, since this status is obtained during the policy period of the first Harbour Porpoise Conservation Plan in 2011.

All Member States assess the conservation status of species under the Habitats Directive Article 17 and classify it either as favourable, unknown, unfavourable-inadequate, or in the worst case unfavourable-bad. Despite the scientific facts that show that the harbour porpoise is facing negative consequences of several anthropogenic activities, the Netherlands changed the conservation status of the Harbour Porpoise under Article 17 of the Habitats Directive from unfavourable-inadequate to favourable in 2019. The assessment results do not make clear if this favourable status will be maintained in the future (European Commission, 2020). The assessment for the conservation status is based on aerial surveys, which are considered as a necessary research method to monitor the density and distribution of the population and to evaluate the potential impacts of anthropogenic activities (Geelhoed, et al., 2018). Another parameter used to assess the population is the quality of the habitat. This parameter is assessed more favourably compared to previous population assessment, but the underlying arguments to support this conclusion are unknown (European Commission, 2020). The IUCN (International Union for Conservation of Nature and Natural Resources) classifies the harbour porpoise as 'vulnerable' with a decreasing population trend in Europe on their Red List of Threatened Species (IUCN, 2007). The Dutch IUCN Red List was updated in 2020 and resulted in a positive assessment for the harbour porpoise. The harbour porpoise was placed on the Dutch IUCN Red List, but the latest 2020 assessment made clear that this is no longer necessary, and the species is removed from the list, together with other (marine) mammals like the common seal (*Phoca vitulina*). Compared with other European countries, the Dutch IUCN assessment is positive. Belgium considers the species as 'vulnerable' and Denmark even as 'endangered' (Zoogdier Vereniging, 2020). The UK, where the largest population of harbour porpoises in the North Sea is living according to figure 1, has translated the IUCN Red List to the 'JNCC spreadsheet of species conservation designation' and has classified the harbour porpoise as a Priority Species under the UK Post-2010 Biodiversity Framework. This means that the species is seen as 'most threatened and requiring conservation action under the UK Biodiversity Action Plan', the precursor of the Post-2010 Biodiversity Framework (JNCC, 2019).

2. Problem statement and research objective

Harbour porpoises live in an environment where social, political, cultural, economic and ecological developments are shaping the condition of its habitat. These habitats with complex social-ecological interactions are called social-ecological systems (SESs) (Pollnac, et al., 2010). Social-ecological systems can be approached through three different perspectives. The first perspective is about the services the ecosystem provides for humans. The second perspective identifies to what extent the demand for the ecosystem services defines the system. The last perspective identifies how both the ecological and social systems respond to changes within and outside the social-ecological system (Berrouet, Machado, & Villegas-Palacio, 2018). In these environments, complex problems are often experienced because of the many activities taking place and the influence of natural events. Consequently, these problems ask for collective action from stakeholders to adapt to changing circumstances (Marshall, 2013). Bigagli (2016) argues that this collective action is insufficiently accounted for the international

framework of global oceans governance. The framework is not broad enough to include the wide variety of challenges in global ocean management, where 'our' harbour porpoise and the Dutch North Sea are part of. More local and/or regional approaches are therefore necessary.

The above paragraph made clear that the governance of social-ecological systems is challenging. The governance of any social-ecological system is controlled by the use and application of institutions. Epstein et al. (2015) explained the concept of institutions as 'the formal and informal rules, norms and conventions that societies use to structure interactions and increase predictability in situations of interdependent choice'. Formal institutions as are applied in this case, 'are normally established and constituted by binding laws, regulations and legal orders which prescribe what may or may not be done' (Hodgson, 2006). Informal institutions are included in our culture, beliefs, religions, traditions and all other behaviour (Kaufmann, Hooghiemstra, & Feeney, 2018). The term institutional fit can be used to analyse to what extent institutional arrangements correspond with the social and ecological aspects (Lebel, Nikitina, Pahl-Wostl, & Knieper, 2013). In other words, are the norms and rules of the institutions governing the social-ecological system of which the harbour porpoise is part corresponding the characteristics of this system? And are they complementing each other when interacting? Or are they counteracting one another? Each social-ecological system has its own characteristics, which need specific approaches. The North Sea needs other governance tools than the Mediterranean Sea, because of the difference in ecology, biology, users and resources. The concept institutional fit can thus be used to assess to what extent a social-ecological system is governed in a sustainable way and to identify possible improvements. Because of the large number of applied institutions involved in harbour porpoise conservation management, the concept of institutional fit helps to create an overview of the institutions and their fit. It helps to identify possible improvements to increase the fit between the applied institutions and the social-ecological system the harbour porpoise is living in.

The objective of this research is to assess if the harbour porpoise and its social-ecological system, the Dutch North Sea, are protected in such a way that a future favourable conservation status for the harbour porpoise can be ensured in this area. The research is approached by assessing the governance of the species and the social-ecological system of which it is part. An analysis of the institutional fit of the institutions governing the species and the social-ecological system will be used to answer the main question. The analysis of the institutional fit will give the opportunity to assess if conservation measures are corresponding with the conditions of the social-ecological system and the harbour porpoise, and to identify possible improvements.

Main question:
Are the institutions governing the social-ecological system of the Dutch North Sea fit to ensure a future favourable conservation status of the harbour porpoise (*Phocoena phocoena*)?

Sub questions:

1. What aspects of the social-ecological system of the Dutch North Sea are relevant for the harbour porpoise?
2. Which institutions govern the social-ecological system of the Dutch North Sea and the harbour porpoise in this area?
3. Are the specific institutions applying norms and rules that are corresponding with the characteristics of this social-ecological system?
4. How are the different institutions governing the Dutch North Sea interacting with each other?
5. How is the harbour porpoise population influenced by the institutional fit of the institutions governing the species and the SES of the Dutch North Sea?

3. Theoretical framework

3.1 Institutional fit

Epstein et al. (2015) explained the concept of institutions as 'the formal and informal rules, norms and conventions that societies use to structure interactions and increase predictability in situations of interdependent choice'. Measuring institutional fit is one of the methods to assess the institutional response to conservation issues (Guerrero, Sporne, McKenna, & Wilson, 2021). The concept institutional fit is related to the analysis of institutions. It refers to the diagnostic approach where institutions are analysed in the context of their approach towards the problem they are meant to address (Cox, 2012). Are the applied management approaches corresponding the realities they address? (Fabritius, Jokinen, & Cabeza, 2017) A low institutional fit may lead to ineffective governance of the social-ecological system, which can reduce the chance of meeting the long-term ecological goals. This institutional fit is not only necessary on ecological aspects, but also requires a good fit on social environmental aspects to meet the characteristics of complex social-ecological systems (Tremi, Fidelman, Kininmonth, Ekstrom, & Bodin, 2015). This broader view developed since the start of the use of the concept institutional fit, when it was mainly focussed on ecological fit. It is argued that ecological fit cannot be assessed without the involvement of social aspects, because the ecological fit is partly determined by social aspects. Institutional fit is not only about the fit between the institutions and the ecology of the system, but also about the fit of the values, beliefs and relations of the environment. Studying institutional fit is currently still an important research field within the science of social-ecological systems (Ishihara, Tokunaga, & Uchida, 2021). Cox (2012) emphasizes that an overall fit does not exist. It is not automatically true that if there is a fit on one aspect of the system, there is also a fit on other aspects. The concept of institutional fit however helps to investigate the complex and dynamic relationships between the different institutions involved in the governance of complex social-ecological systems.

By approaching conservation studies with an assessment of the institutional fit, it is possible to involve a variety of dimensions of the institutional performance, including ecology, society and politics (Guerrero, et al., 2021).
Several factors are essential to acquire a suitable institutional fit. These factors are:

- Effective collaboration between the involved stakeholders in both the planning and execution phases of the institutions contributing to conservation efforts (Guerrero, Mcallister, & Wilson, 2014);
- Involving a broad variety of factors defining the actual conservation status, such as political and economic drivers (Clement, Moore, Lockwood, & Mitchell, 2016);
- Set up institutions that correspond to the responsibility and authority of the lead organization(s) (Clement et al., 2016).

A key factor in the assessment of the institutional fit of conservation challenges is that not only formal rules and norms should be assessed, but that also informal rules and norms as well as the interplay between formal and informal institutions (Guerrero et al., 2021).

The assessment dimensions of Epstein et al. (2015) will be applied in this study. Epstein et al. (2015) assesses the institutional fit with the use of three types of fit, with corresponding dimensions:

1. Ecological fit: examines if the institutions match the ecological and/or biological problems they are meant to address.
    a. Spatial fit: refers to the coherence between the geographical boundaries of the environmental challenge and institutions;
    b. Temporal fit: refers to the rate of environmental changes and the ability to apply institutional response in the same pace;
    c. Functional fit: is about the alignment between the different functions within the social-ecological system.

2. Social fit: examines the coherence between the institutions and needs and wishes of human actors.
    a. Values, interests and beliefs: fit between operational rules and the social context in which they operate;
    b. Participation and psychological needs: the appropriateness of rulemaking processes given the expectations and psychological needs of stakeholders;
    c. Spatial fit: fit between institutions and the scales or levels of social organizations.
3. Social-ecological system fit: examines interactions between institutions and factors that contribute to its success or failure based on the results of the ecological and social fit.
    a. The fit of an institution is more measurable if it is associated with a measurable level of success;
    b. Contextual attributes that lead to its success must be identified.

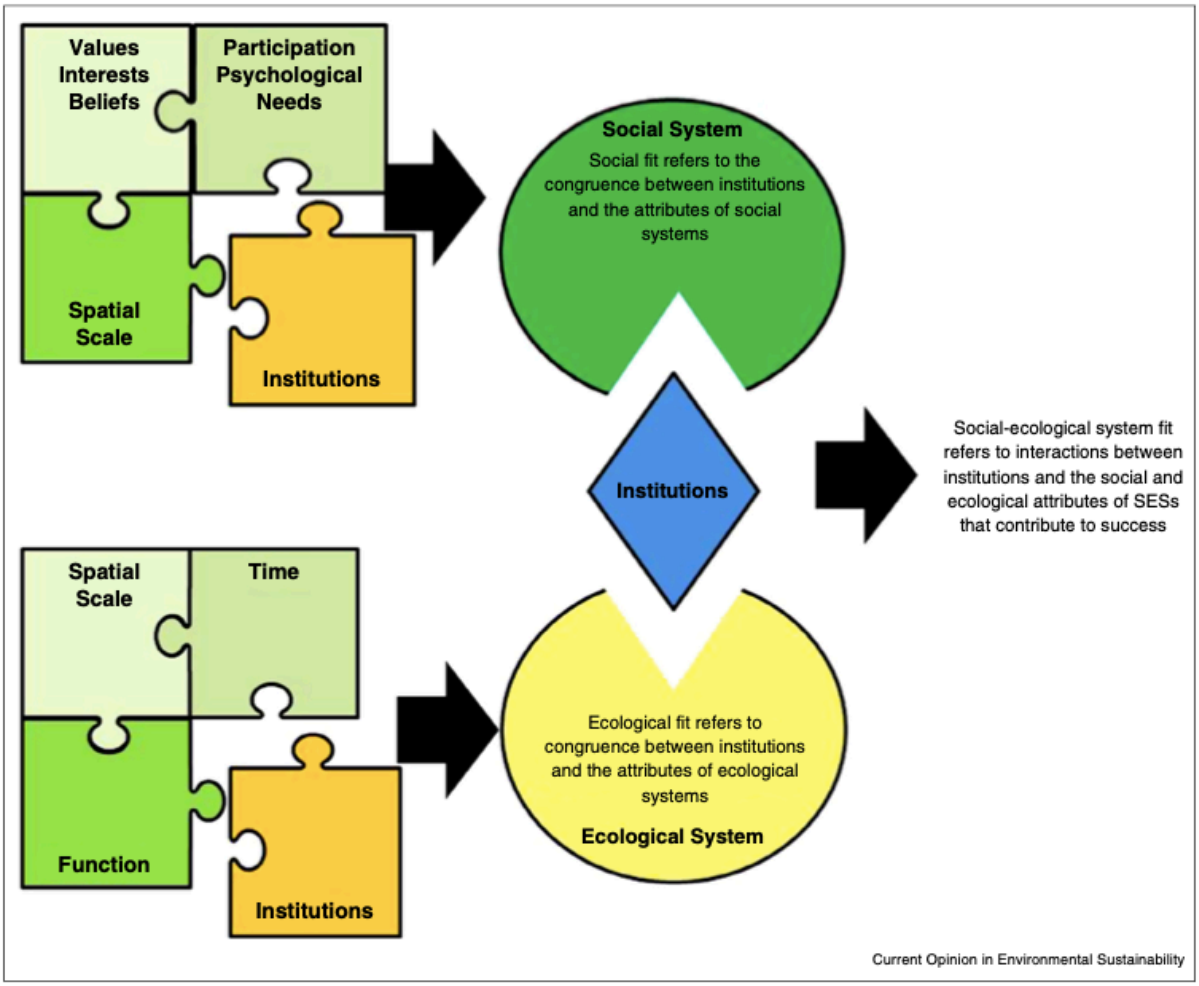

Table 1 The institutional fit typology developed by Epstein et al. (2015)

3.2 Social-ecological system framework

Cox (2012) studied how the diagnosis of institutional fit could be improved. He concluded that the institutional fit could best be studied by developing knowledge of the social-ecological system as a starting point of studying institutional fit. To meet these conclusions, the framework of Ostrom (2009) is applied in this study. Ostrom (2009) developed the Social-ecological system framework (figure 3) to analyse social-ecological systems. In the social-ecological system of the harbour porpoise, where several ecological, political, economic and cultural factors are influencing the status of this system, this

framework is helpful to identify interactions between these factors and their outcomes on SES level. These results are necessary to identify the institutional fit.

The framework consists of several variables that together define the SES. The variables of the framework are resource units (RU), resource systems (RS), governance systems (GS) and users (U). Each variable contains second-level variables. Ostrom (2009) developed a set of second-level variables for the assessment of social-ecological systems. To meet the goals of this research, the set of subvariables is adjusted for the purpose of this study. As an example of adjusted variables, the harbour porpoise is assessed under resource unit (RU), even if we do not consume or use this species.
Nevertheless, this species is one of the generated natural resources generated by the resource system (RS), they are countable, and their numbers cannot be measured precisely and are based on estimations, by which they meet the requirements to be assessed under the variable resource system (RS) (del Mar Delgado-Serrano & Ramos, 2015).

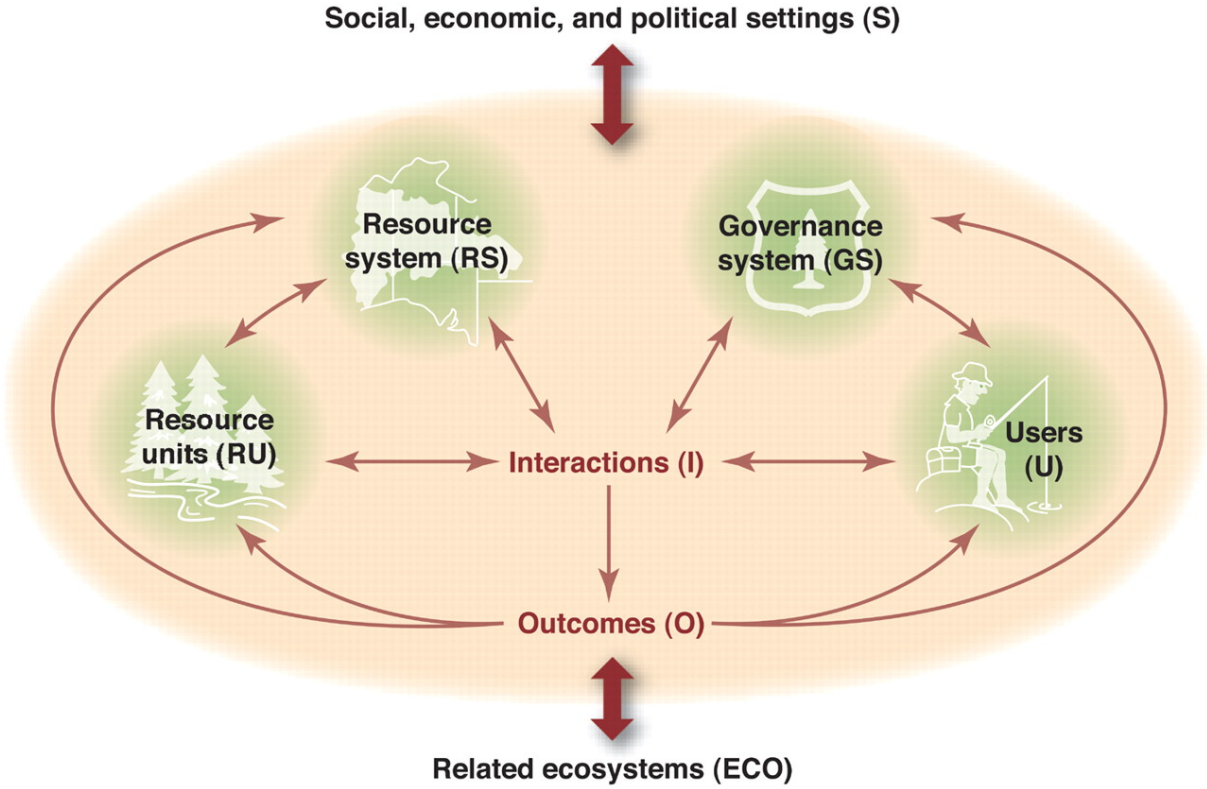

Figure 3 The social-ecological systems framework developed by Ostrom (2009)

The Interactions (I) and Outcomes (O) will give an overview of the results of the applied variables (RU, RS, GS, U) and their interplay. Other important variables are Social, economic and political settings (S) and Related ecosystems (ECO).
In the context of this research, the Outcomes (O) and Interactions (I) are relevant. These variables give necessary information to assess if the institutions are fit to ensure a future favourable conservation status for the harbour porpoise, or if adjustments are necessary. Nevertheless, the Outcomes (O) and Interactions (I) can't be assessed without visualizing the whole social-ecological system with the help of the variables and second-level variables.

This framework was originally developed to give insight in a social-ecological system which specifically includes a resource (resource unit RU) (Ostrom E. , 2009). In the study on the institutional fit of harbour porpoise conservation management, no specific resource is present. As humans, we do not consume or use harbour porpoises. Nevertheless, the harbour porpoise is considered the resource unit in this

study, because the resource unit (RU) is considered to be the managed resource, like is the case with the harbour porpoise in this study (Ostrom, 2009). Literature shows that the application of this framework is diverse but dominated by marine related studies e.g. in studies related to aquaculture and specific fisheries. The use of the framework lately expanded beyond resource-use sectors and more specifically food production systems and is also seen in marine conservation and marine ecosystem management studies (Partelow, 2018). E.g. Ban, et al. (2015) used the social-ecological framework to get insight in the governance structure around the Great Barrier Reef and Cinner et al. (2012) applied the framework to evaluate the co-management of different coral reefs. These last two examples are comparable with the application of the framework in this study.
This framework is particularly applicable for this study because the aim is, like Cinner et al. (2012) and Ban et al. (2015), to get insight in a whole social-ecological system. The harbour porpoise is influenced by various elements of the total ecosystem. Therefore, conservation efforts from the whole SES are important. The interactions (I) and outcomes (O) of the framework will help to give insight in how governance systems (institutions) interact with each other, users (e.g. fisheries, shipping activities), the resource system (Dutch North Sea), and the resource unit (harbour porpoise).

Ostrom (2009) developed a set of sub-variables to use for the application of the social-ecological systems framework. These sub-variables are adjusted to fit the purpose of this research, which is encouraged by the author of this framework. Not all the proposed sub-variables are applicable and necessary for this study. The used sub-variables are shown in table 1. These variables are used as a guideline for the interpretation of the social-ecological system of the North Sea with as most important aspects the harbour porpoise, the institutions that should maintain the favourable conservation status and their outcomes and interactions.

Social, economic, and political settings (S)	
S1 Economic development, S2 Demographic trend, S3 Political stabilization, S4 Government resource policies, S5 Market incentives, S6 Media organisation	
Resource Systems (RS)	**Governance Systems (GS)**
RS1 Sector (e.g. water, forests, pasture, fish) RS2 Clarity of system boundaries RS3 Size of resource system RS4 Human-constructed facilities RS5 Productivity of the system	GS1 Government organisations GS2 Nongovernment organisations GS3 Network structure GS4 Operational rules GS5 Collective-choice rules GS6 Constitutional rules GS7 Monitoring
Resource Units (RU)	**Users (U)**
RU1 Resource unit mobility RU2 Growth or replacement rate RU3 Interaction among resource units RU4 Economic value RU5 Number of units RU6 Spatial and temporal distribution	U1 Number of users U2 Socioeconomic attributes of users U3 History of use U4 Location U5 Leadership/entrepreneurship U6 Norms/social capital U7 Knowledge of SES/mental models U8 Importance of resource U9 Technology used
Interactions (I) → outcomes (O)	
I1 Harvesting levels of diverse users I2 Information sharing among users I3 Deliberation processes I4 Conflicts among users I5 Investment activities I6 Lobbying activities I7 Self-organizing activities I8 Networking activities	O1 Social performance measures O2 Ecological performance measures O3 Externalities to other SESs
Related ecosystems (ECO)	
ECO1 Climate patterns, ECO2 Pollution patterns, ECO3 Flows into and out of local SES	

Table 2 The used variables of Ostrom's social-ecological framework

4. Methods

A diversity of information is necessary to answer the main and sub questions of this study. To measure the institutional fit of the applied institutions, information about the formal and informal institutions are necessary. Formal institutions were researched by the use of literature, as explained in chapter 4.1. The informal rules were identified by the use of interviews, as explained in chapter 4.2.

4.1 Literature

The information about formal institutions necessary to use the SES-framework came from policy documents and scientific papers. A lot of studies about harbour porpoises in the North Sea have been conducted. These studies are used to assess the social-ecological fit of the applied institutions. Scientific literature is used to identify the variables resource unit, resource system and users. Scientific literature with a focus on institutional fit of marine social-ecological systems, harbour porpoise conservation, anthropogenic pressures on harbour porpoises, harbour porpoise conservation, the social-ecological system of the North Sea area and North Sea governance were relevant for this study. Scientific literature is consulted via the Open University library. The used scientific papers were selected by the use of search terms based on the above-mentioned aspects. The papers were assessed by scanning the abstract, introduction and conclusions of the paper to determine the relevance for this thesis and the papers were assessed on relevant references.

Policy documents and studies concerning the governance of the Dutch North Sea were of particular importance for the variable governance, because information from policy documents, laws and (international) agreements was necessary to get a complete overview of this variable. Grey literature formed an addition for the other variables and on the other side, scientific literature formed an addition for the variable governance.
Literature was scanned using the variables of Ostrom (2009). The information needed to identify the variables was used from the literature to complete the social-ecological system framework. After completing the framework, this framework and the grey literature were used to assess the institutional fit according to the dimensions of Epstein (2015). Nevertheless, the use of literature alone did not lead to a complete overview of the SES of the Dutch North Sea. Literature was therefore complemented with interviews.

4.2 Interviews

In addition to the literature research explained in paragraph 4.1, six interviews were conducted. The interviews were conducted with two policy makers responsible for the development of the newest Harbour Porpoise Conservation Plan, two scientists involved in harbour porpoise research in the Netherlands and two NGO representatives involved in harbour porpoise conservation. The interviews were necessary to find out what people feel, know and think about a subject in order to contribute to the information needed to identify the informal institutions. The expert knowledge of the interviewees was necessary to obtain information which is not available in literature. In this case the fit of the institutions contributing to the governance of the Dutch part of the North Sea and the harbour porpoise population living in this area (Baarda, 2014). The combination of literature (grey literature and scientific literature) and experiences from the field gave a complete overview of the researched area's SES and species. Interviews were of specific importance for the variables Resource System, Outcomes and Interactions from the SES framework.

This study applied multiperspective interviews. Multiperspective interviews are a tool to define multiple and possibly diverse viewpoints, appearances and roles (Park, Kapoor, & Leigh, 2000). Multiperspective interviews are useful because they help to understand relationships between different actors within the same sector, they help to explore similarities and differences, they help to understand the individual needs of actors or stakeholders and finally they can help to know suggestions for improvement (Kendall, et al., 2009). The different perspectives are needed to

complement the information about the social-ecological system learned by conducting literature research. The application of multiperspective interviews means that several stakeholders involved in the governance of the SES of the Dutch North Sea and/or the conservation of the harbour porpoise were interviewed. They are all involved or working in the same sector, in this case the (governance of the) SES of the North Sea and/or the conservation of the harbour porpoise.

The form of the interviews was unstructured (open), with the help of a topic list. The topic list consisted of (some of) the variables from the SES framework, which led to a broad conversation where all the aspects of the SES framework were discussed. The respondents were interviewed individually. To respect the privacy and encourage freedom of speech, the names of the interviewees are not named in this thesis. Registered information was limited to solely the profession of the respondent. For this thesis, a total of six respondents was interviewed. Among them were two policy makers involved in the harbour porpoise conservation plan, two scientists involved in EU as well as Dutch cetacean research and two NGO representatives involved in harbour porpoise conservation in the Dutch North Sea.

The interviews were transcribed and subsequently analysed by the use of the program ATLAS TI. Three steps were taken to complete the coding process: (1) open coding (2) axial coding (3) selective coding. These three steps gave a structured approach for the analysis of interviews. After transcribing the interviews, the process of open coding started. The irrelevant information was removed from the interview transcription. The relevant information was coded for a first time using an open coding approach. Each relevant text fragment was labelled with a code which summarizes the information in this fragment. In the following step, the codes were compared with each other and equivalent codes were merged in one code. This step is named axial coding. Finally, selective coding filtered the most relevant codes to answer the sub-questions and main question of this study (Baarda, 2014). The open coding process contained a wide variety of specific codes which were merged into a set of codes used for the analysis of the interviews. The applied codes of stage 2 and 3 for this study were:

- Population assessment (3)
- Involvement EU policies (3)
- EU policies (2)
    - Habitats Directive (3)
- Monitoring (2-3)
- Responsibilities of authorities (3)
- Governance networks (2)
    - OSPAR (3)
    - ASCOBANS (3)
- Dutch policies (2-3)
- Execution of policies (2-3)
- Threats harbour porpoise (2)
    - Threats in Dutch coastal waters (3)

COVID-19 was a limiting factor for conducting interviews. Luckily, there are several digital meeting opportunities available. Because of the restrictions due to COVID-19, the program Microsoft Teams was used to facilitate the video conference and record the interviews. These recordings were done with permission of the interviewees.

5. Results

5.1 The social-ecological system of the Dutch North Sea

5.1.1 The harbour porpoise

Harbour porpoises are small cetaceans that reach a length of approximately 150cm. Neonates are animals <90cm, juveniles are 90-130cm and harbour porpoises reach adult age when they reach a length of >130cm (IJsseldijk, Kik, van Schalkwijk, & Gröne, 2020). Females attain a larger body size than males. Males reach a length between 141.1-148.8cm and females reach a length between 153.4-163cm. Exceptions on these averages are recorded, with as example a female that reached almost 200cm in Scottish waters (Lockyer, 2003).

Harbour Porpoises are considered a slowly reproducing species since they give birth only once a year. Females reach maturity age around five years old. The mating season occurs between June and September and birth period is from June to August (Kesselring, Viquerat, Brehm, & Siebert, 2017). Young cetaceans must swim and maintain body temperature directly from birth, which requires a relatively high body weight at birth reaching 10-15% of the bodyweight of the mother. This almost always results in uniparity (IJsseldijk, Gröne, Hiemstra, Hoekendijk, & Begeman, 2014). Male harbour porpoises reach adult age at approximately 4 years (Ólafsdóttir, Víkingsson, Halldórsson, & Sigurjónsson, 2003).

Harbour porpoises are mostly observed alone or in pairs (Siebert, et al., 2006). The general assumption was that harbour porpoises have limited social interactions. Field research conducted by Sørensen et al. (2018) made clear that harbour porpoises use narrow-band high-frequency (NBHF) clicks to communicate with each other. This phenomenon was not only observed at mother-calf interactions but also at individual animals. This suggests that social interactions among harbour porpoises are more important than previously observerd. Another proof of interaction among individual harbour porpoises is their contamination with whale lice (Lehnert, Fonfara, Wohlsein, & Siebert, 2007). Whale lice are little crustacean amphipods occasionally found on porpoises. They have no life stage where they are free-swimming, so transmission can only occur during contact between porpoises (Iwasa-Arai, et al., 2018).

As stated earlier in this chapter, harbour porpoises are mostly observed alone or in pairs (Siebert, et al., 2006). The most recent observation numbers of aerial surveys in 2019 indicate that 38,911 (CI=20,791-76,822) individual harbour porpoises were present on the Dutch Continental Shelf (Geelhoed S. C., Janinhoff, Lagerveld, & Verdaat, 2020). With a total estimation of 345,000-361,000 individuals in the North Sea, this means that 20% of the animals has been present on the Dutch Continental Shelf (Ministry of Agriculture, Nature and Food Quality, 2020).

This number of harbour porpoises has not always been observed in Dutch waters. Sightings of harbour porpoises in ports or river mouths are documented in historical literature, which indicates their presence in the past. From the 1950s-1970s an overall decline of the species occurred. Since the 1990s the number of harbour porpoises in Dutch waters increased (Ministry of Agriculture, Nature and Food Quality, 2020). Aerial surveys executed in 1994, 2005 and 2016 indicate a peak in observations in 2005 (see figure 4), however statistically this

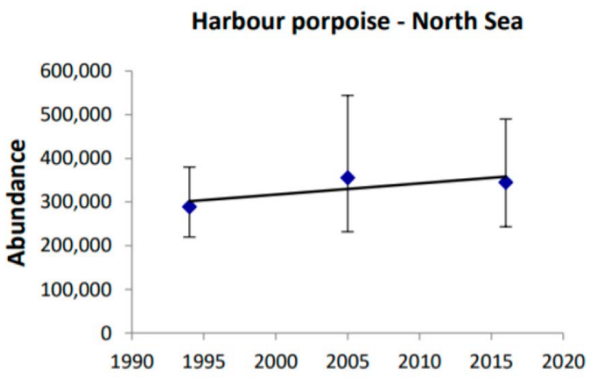

Figure 4 Abundance estimations after aerial surveys 1994-2016 (Hammond et al., 2017)

peak does not support a change in abundance looking at the survey period 1994-2016 (Hammond, et al., 2017).

The last decades, strandings of harbour porpoises along the Dutch coast are not rare. The stranding numbers of harbour porpoises started to concentrate along the Dutch coastline especially from 2009. As figure 5 shows, between 1990 and 1999 the peak stranding numbers were found along the Danish coast. This concentration shifted gradually towards the south with a stranding concentration along the Dutch coast from 2000 until 2017.

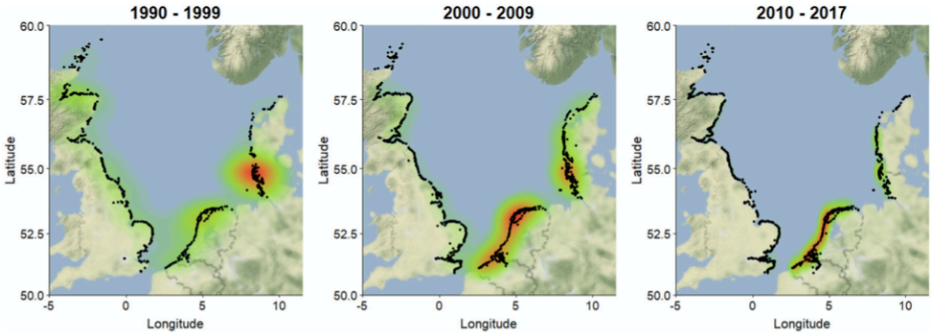

Figure 5 Spatial distribution of stranding numbers of Harbour Porpoises (IJsseldijk, et al., 2020)

Strandings are occurring year-round, with a peak between the months March and September. Most of the stranded harbour porpoises along the Dutch coast were juveniles that did not yet reach maturity age (IJsseldijk, et al., 2020). The number of strandings and the age distribution of stranded animals is an indication of the number of animals and their age living along the Dutch coast.
Aerial surveys confirm the seasonal variability in spatial distribution of harbour porpoises in the North Sea. During spring (March-May) and summer (June-August) more animals are observed along the Dutch coast than during autumn (September-November), see figure 6. These aerial observations were not performed during winter, so no winter estimations are available (Gilles, et al., 2016).

The harbour porpoise is a highly mobile species, which means that conservation through the use of marine protected areas is challenging, because their presence in these protected areas in unsure (Embling, et al., 2010). There are only a few groups that are residential, like the harbour porpoises living in the semi-enclosed tidal bay Eastern Scheldt (Jansen, Aarts, & Reijnders, 2013).

Harbour porpoises do not deliver a direct economic value. They are not caught for consumption, education or leisure. They are sometimes accidentally a victim of bycatch in the commercial fishing industry (Bjørge, Skern-Mauritzen, & Rossman, 2013). Nevertheless, harbour porpoises can potentially be economically valuable for the tourism industry. Marine mammals are known for their touristic attraction, e.g. in New Zealand (Meissner, et al., 2015), Tonga (Fiori, Martinez, Orams, & Bollard, 2019) and Gibraltar (Tenan, et al., 2020) where whale or dolphin watching is one of the common local leisure activities. In the Netherlands, the touristic attraction of the harbour porpoise is mainly concentrated in the Eastern Scheldt, where they are residential. Marine mammal tours in the Netherlands are mainly focussed on seals. Harbour porpoises are seen as an important indicator species as it is a top predator in European coastal waters (Gilles, et al., 2016). Because of this characteristic they are valuable to measure fish stock estimations for the commercial fishing industry (Bisack & Magnusson, 2014).

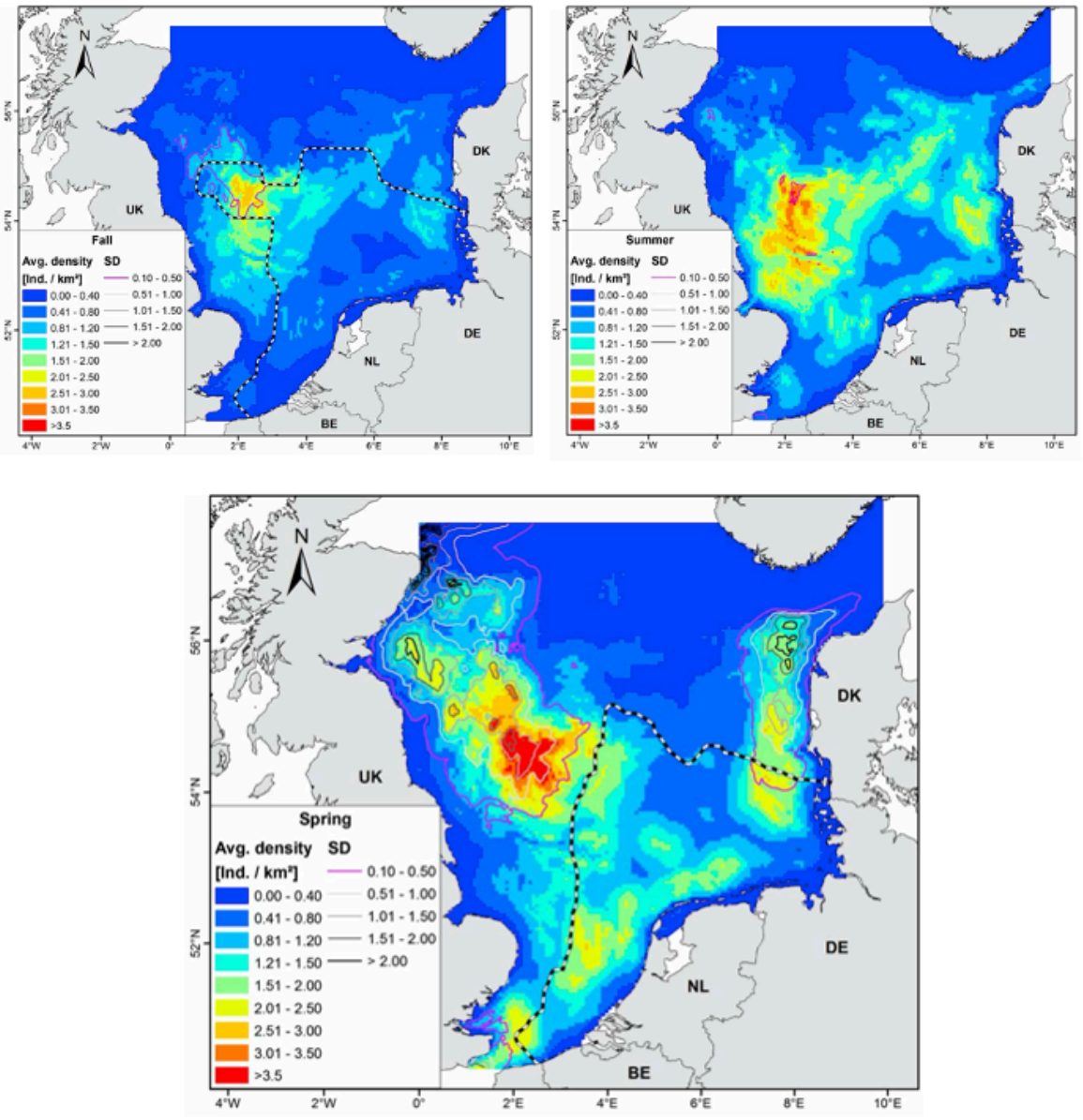

Figure 6 Seasonal distribution of harbour porpoises in the North Sea (Gilles, et al., 2016)

5.1.2 The Dutch North Sea

The Dutch North Sea has a size of approximately 58.000m^2. The average depth is 35 meters and has a depth of 60 meters in the Northern part of the area. It is one of the busiest maritime areas on earth. It has busy fairways, wind farms, fishing activities and a busy underground infrastructure. An impression of the use of the Dutch North Sea is shown in figure 7. This figure also indicates the boundaries of the Dutch North Sea (Noordzeeloket, 2016).

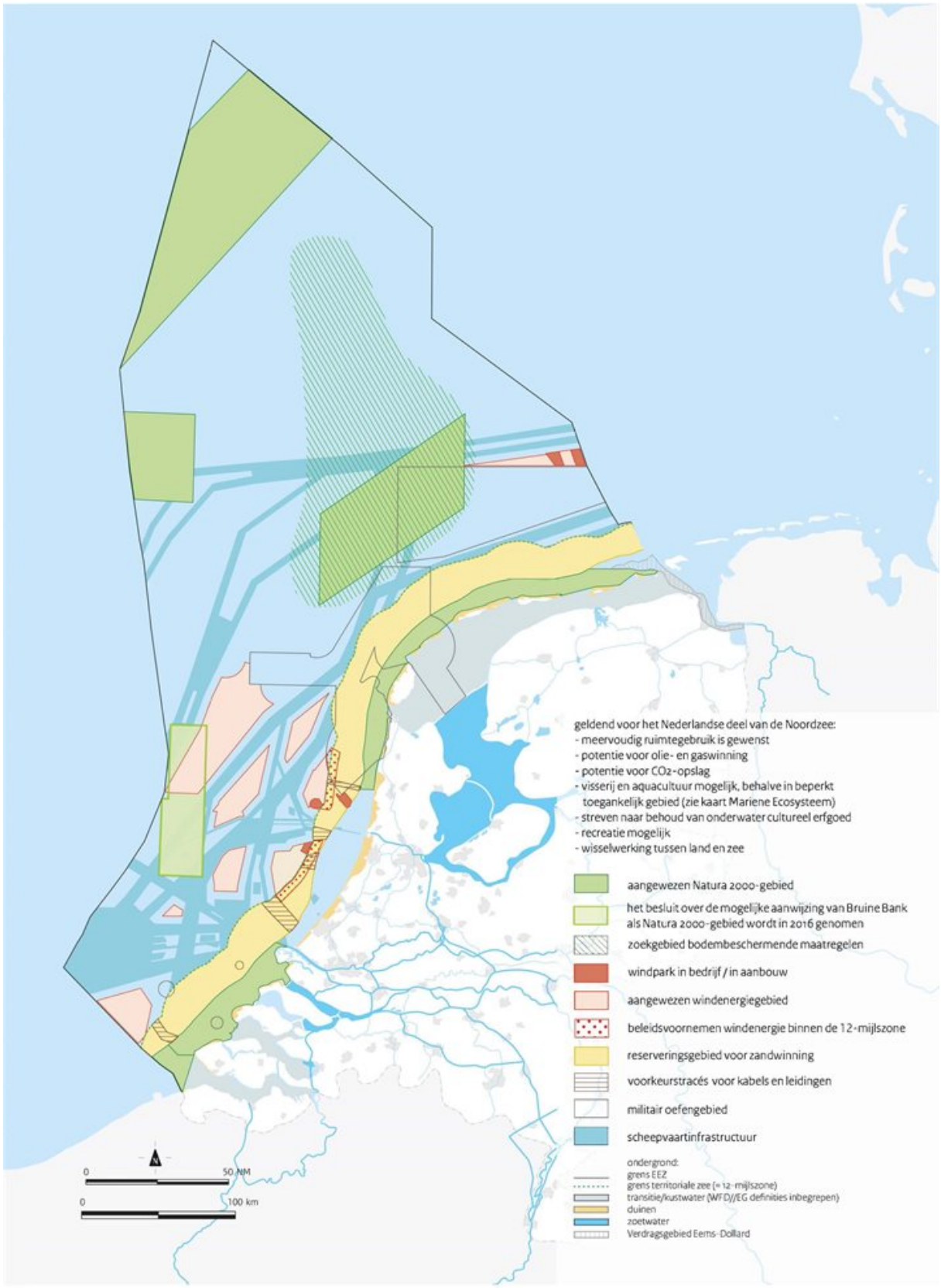

Figure 7 Spatial planning policy for the Dutch North Sea (Noordzeeloket, 2016).

The North Sea is an ecologically productive area (Skogen & Moll, 2000). The basis for the marine food web is the primary production of phytoplankton. Research of Capuzzo et al. (2017) shows that primary production in the North Sea suffered a 25% decline between 1988 and 2013. Possible causes are climate change, which results in warmer water temperatures, and a reduced supply of river nutrients. A reduced primary production has direct and indirect consequences for the higher trophic levels of the food web.

Porpoises need 10% of their body weight as daily food intake. This is much more than similar sized terrestrial mammals. Because of their relatively large need for food, living in a productive area is necessary for their survival (Leopold M. , 2015). Diet composition research by Leopold and Meesters (2015) showed that gobies, gadoids and sandeels are the most important prey species of harbour porpoises along the Dutch coast. Clupeids, estuarine roundfish, pelagic roundfish and squid are also important prey species (Leopold & Meesters, 2015).
The European Environment Agency (2019) concluded that the reproductive capacity of commercially exploited fish is slowly increasing since 2009. This is good news for the harbour porpoise and means that some of their target prey species, like herring and mackerel, will be more abundant in the (near) future.

Here above we are talking about ecological production. The North Sea also has non-ecological production capacities. The area has multiple extraction areas for the oil and gas industry (Voldsund, Ertesvag, He, & Kjelstrup, 2013) and is home to various offshore wind farms for the production of energy (Jongbloed, van der Wal, & Lindeboom, 2014).

5.1.3 Users of the Dutch North Sea

The North Sea forms an important source of resources for the Netherlands. The area is essential for the availability of natural gas and the generation of wind energy. The North Sea has also an important economic importance for the Netherlands. The Port of Rotterdam is one of the most important economic drivers of the North Sea and has an equal economic importance than all Dutch main ports combined including the coastal area.
A total of 53% of the Gross Domestic Product is generated in the Dutch maritime region. In 2014, the North Sea represented 3,8% of the Dutch economy. Oil and gas extraction contributed to 3% of the total government revenue (CBS, 2016).

The North Sea Policy Document (2015) identifies ten different users of the Dutch North Sea. Rijkswaterstaat (2021) visualized these users in a map (appendix I). The term ‘users’ is a broad term that identifies the occupants of the area. The marine ecosystem (1) is the first ‘user’, referring to the characteristics of the North Sea as an ecosystem. The North Sea is strongly influenced by oceanic as well as atmospheric circulations from the Atlantic Ocean. This circulation provides freshwater inputs which is rich of land runoff and input from adjacent rivers. The area is influenced by tides and contains mudflats, estuaries and sandbanks. The seabed almost has no rocky surfaces and mostly consists of sand and mud. There is a large animal biodiversity with over 230 species of fish, more than 10 million seabirds and several marine mammal species. The most important spawning ground of the North Sea is the Wadden Sea (Vogel, Ripken, & Klenke, 2018). Relatively new is the user renewable energy (2). There are currently five operational wind farms in the Dutch North Sea. Six other wind farms are under construction or planned before 2030. Together, those eleven wind farms will produce 6.100 MW of energy which equivalents the energy use of approximately 8 million households (Rijksoverheid, 2021). Concerns were raised whether harbour porpoises would avoid wind farms with as a consequence that the rapid increase of wind farms in the Dutch North Sea would reduce their living environment. During a study examining the acoustic activity of harbour porpoises in Dutch windfarms and two reference areas, the acoustic activity of harbour porpoises within wind farms was significally higher than observed in the reference areas. This could indicate the abundant presence of harbour porpoises

within the wind farm. A possible explanation could be the increased food availability inside wind farms or the restrictions for shipping activities which makes wind farms a shelter area in an otherwise busy environment (Scheidat, et al., 2011). This is an opposite finding with respect to the study of Dähne et al. (2013), who observed an avoidance of wind parc areas by harbour porpoises, as mentioned in the introduction of this thesis.
The extraction of surface minerals (3), like sand, is of national importance for the Netherlands. The sand is used for coastline defence and prevents the Dutch coastline from shifting landwards. The extraction of surface minerals can cause interaction with other users such as marine mammals, birds and infrastructure. E.g. the extraction of surface minerals isn't possible on locations where underwater pipelines are installed or planned and in Natura2000 areas (Rijksoverheid, 2021). Also, the extraction of oil and gas (4) is of national importance for the Netherlands, mainly economically. Oil activities are mainly concentrated in the Northern and Central part of the North Sea. Gas extractions are primarily found in the Southern part. Approximately 160 production platforms are located in the Dutch North Sea. Several restrictions are effective around the platforms. It is forbidden to access the area within 500 meters around the platform and perform any form of activity which consists of activities for shipping, fishing and recreation (Rijksoverheid, 2021).

The Dutch North Sea is an important area for the transport of energy, gas and telecom cables (5). A total of 4.500 kilometres of pipeline and 6.000 kilometres of cables is currently present in the Dutch North Sea. Approximately 50% of the cables present is no longer in use. It is expected that more cables will be necessary mainly for the transportation of electricity because of the increasing number of wind farms in the area (Rijksoverheid, 2021). The cables and pipelines are installed under the seabed and are therefore only threatening harbour porpoises during the installation period where underwater noise can be expected. Another busy infrastructure network in the Dutch North Sea is the infrastructure put in place to organize a safe and smooth shipping traffic (6). Ships use prescribed shipping routes with the use of the Traffic Separation Scheme which encompass approximately 6% of the total sea surface. The Southern North Sea is home to the busiest fairways in the world with fairways leading to the ports of Rotterdam, Amsterdam, IJmuiden, Antwerp, Ghent, Vlissingen, Terneuzen and Eemshaven. The busy characteristic of the Dutch North Sea is not always favourable for shipping. E.g. fairways and anchorages are not allowed to interact with pipelines and cables, windfarms and the extraction of oil and gas which indicates the importance of a strategic spatial planning of the compact and busy area (Rijksoverheid, 2021).

Another user of the area is the use for military activities (7). More than 7% of the Dutch North Sea is available for military activities. This varies between shooting, flying and mine clean-up exercises. Military activities can cause harm for marine animals in the surrounding of the activities, especially because of underwater noise. Areas appointed for military activities are chosen respecting the Natura2000 areas (Rijksoverheid, 2021).

Around 600 Dutch ships are registered to perform fishing activities (8) in the Dutch North Sea. Economically important fish species in the North Sea are sole, plaice, langoustines, shrimps, mussels and oysters. Fishermen have to deal with several restrictions to perform fishing activities in the area. Fishing is not allowed in wind farms, around oil and gas installations, in fairways, in areas known for the presence of ammunition and in several Natura2000 areas. Mariculture activities, on the other hand, are more suitable to apply in multiple land/sea use cases, like the use of wind farms as a location for the growth of mussel seed (Rijksoverheid, 2021). Because of the increasing pressure on the available space in the area, the government is searching for methods to apply multiple land/sea use. As an example, the Dutch government is currently exploring the possibilities to make the reserved space for military exercises available for sand mining during times where no military activities are taking place (Rijksoverheid, 2021).

Last but not least is tourist and recreation (9) as user of the Dutch North Sea. Tourism activities vary between sailing, surfing, flying a kite, going to the beach and many more. Recreation can have a negative impact on nature, because many recreational activities are related to nature or performed in the surrounding of nature areas. To prevent negative effects of recreation on Nature2000 areas, they can (temporarily or seasonally) be closed for recreational activities (Rijksoverheid, 2021).

One user that is not yet present in the Dutch North Sea but has the potential to be an important user within the next few years is Carbon Capture and Storage (CCS). The use of CCS helps the Dutch government to reach the climate goals and realise a CO_2 reduction of 80-95% in 2050. Empty gas fields of the Dutch North Sea will be filled with CO_2. New pipelines are needed to transport CO_2 from shore to the offshore empty gas fields. No pilots for CCS have been started yet (Rijksoverheid, 2021).

The Dutch government developed a framework to assess whether all licensed required activities are still permissible in the future, taking into account the wishes and needs to improve the ecological status. The framework is an important tool to reach and maintain a good environmental condition of the North Sea. The framework includes policy considerations about marine ecosystems, renewable energy, (oil and gas) mining, CO_2 storage and underground infrastructure (Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken, 2015).

Compared to 150 years ago, the North Sea is severely depleted looking at species richness and habitat diversity. One of the main causes of this depletion is the disappearance of hard substrate like stones and reefs, especially oyster reefs. The European Flat Oyster (*Ostrea edulis*) used to be a widespread key species in the North Sea but is currently considered extinct. Continuous ground disturbance seems to be the most important cause of the extinction of natural reefs and is also considered the largest bottleneck for recovery. The cause of this extinction is overfishing in second half of the 20th century. The quick infrastructure developments in the North Sea over the past years lead to worries about the recovery of the ecosystem. New infrastructure structures in the North Sea or on its grounds (bottom) can create habitats for exotic species that do not occur naturally in the North Sea. These species can proliferate, with sometimes severe consequences for the existing ecosystem (Duimel, IJlstra, & Siemensma, 2019).

Since the beginning of the 1970s, Rijkswaterstaat Zee & Delta is the executive agency for the management of the Dutch North Sea. This marked the beginning of the management of the Dutch North Sea. Four main tasks were defined: coastal water defence, management of mining, prevention of outflow of nutrients and chemical substance from land and shipping management. The United Nations Convention of the Law of the Sea in 1982 made it possible to execute policies for the management of the Dutch North Sea. Until today, Rijkswaterstaat is the responsible authority of the management of the Dutch North Sea. The policies describing the management procedures are set up by the different ministries, e.g. the Ministry of Economic Affairs (offshore wind energy) and the Ministry of Agriculture, Nature and Food (fisheries and nature management) (Rijkswaterstaat, 2021).

The North Sea is extensively studied by a wide variety of scientists operating in a wide variety of knowledge fields. Knowledge of the social ecological system focussed on the harbour porpoise is shared among North Sea countries in the several existing governance organizations that are hosting working groups. These governance systems are extensively explained in chapter 5.2. De Jong (2016) studied how scientific knowledge is used in decision making processes of North Sea policies. His conclusion was that the increase in knowledge increased uncertainty, instead of decreasing it, because of the increasing amount of information that is available to indicate causes of a problem and identify possible solutions. Another interesting conclusion was that scientific information is simplified in order to make it negotiable in the political arena and adjust it to the political climate. This simplification can exclude important information or facts, necessary to make policy decisions. Additionally, not all new relevant scientific information is included in new policies. Furthermore, most of the scientists involved

in scientific research included in North Sea policies are scientists that are hired by the government on a regularly basis. This can cause bias in research results, because their independence can possibly be doubted after working for a governmental organization for a longer period of time (de Jong, 2016).

5.2 Governance systems managing harbour porpoise conservation

This chapter gives an overview of the institutions involved in the governance of the harbour porpoise population in the Dutch North Sea. Their level of governance and their mutual relationships are explained. This chapter contains an outlined explanation of the institutions. The institutions will be further elaborated in chapter 5.3 and 5.4.

5.2.1 Government organisations and network structures

A large variety of government organisations are involved in the conservation of harbour porpoises in the Dutch North Sea. The conservation of the harbour porpoise in this area falls under the responsibility of the Dutch Ministry of Agriculture, Nature and Food Quality (Ministry of Agriculture, Nature and Food Quality, 2020). This ministry implements several international policies and agreements, which are briefly explained here below.

Several international network structures are the foundation of the Dutch management strategy for the conservation of harbour porpoises in Dutch waters. First of all, the International Whaling Commission (IWC) plays a role in studies and advices on small cetacean conservation issues. More attention is payed to the harbour porpoise in the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention). The harbour porpoise is included in the OSPAR List of Threatened and/or Declining Species and Habitats for which the Contracting Parties have to take the necessary protection measures. A third, more harbour porpoise specific convention that monitors the conservation of the harbour porpoise in the Netherlands is the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Sea (ASCOBANS). It contains legally binding agreements for the conservation of the harbour porpoise in the Netherlands. Some of the important resolutions that are adopted during the ASCOBANS Meeting of Parties (MOP) include dealing with incidental bycatch, adverse effects of underwater noise during the construction of offshore installations for renewable energy and the management of the accumulation of anthropogenic activities on marine mammals (Dotinga, 2020).

The European Union has an important role in the governance of the harbour porpoise through the Habitats Directive and the Marine Strategy Framework Directive. The Habitats Directive is the main legal instrument for harbour porpoises in the North Sea (Dotinga, 2020). More about this policy will be explained in chapter 5.2.3.

Besides these network structures that are all directly influencing the conservation approach for the harbour porpoise in the North Sea, there is a large variety of international agreements and organisations that indirectly influence the conservation of the harbour porpoise. Examples of this are:

- International Maritime Organisation (IMO) that include the MARPOL convention for the reduction of pollution caused by shipping and the Ballast Water Convention that prevents the introduction of foreign species;
- The London Convention that restricts the duping and incinerating of waste matter at sea;

These international agreements are not further discussed in this thesis, because they do not directly influence harbour porpoise conservation governance.

5.2.2 Nongovernment organisations

Various nongovernment organisations are involved in the conservation of the harbour porpoise in the Dutch North Sea. Most of them have nature and/or species conservation in general as main goal, but some NGO's have the conservation of harbour porpoises in the Dutch North Sea as main goal. Some organizations that have harbour porpoise conservation as one of their goals are:

- World Wildlife Fund (WWF)
- International Fund for Animal Welfare (IFAW)
- Stichting de Noordzee

Besides these more general NGO's defending the conservation of harbour porpoises, several foundations are specifically focussed on harbour porpoise conservation in the North Sea. SOS Dolfijn is a Dutch NGO taking care of stranded cetaceans. They are specialised in the care of small stranded cetaceans like harbour porpoises. This NGO is building a rehabilitation facility for the rehabilitation of harbour porpoises and small toothed whales (<3m) (SOS Dolfijn, 2021). Next to their expertise in the stranding of small cetaceans, the Ministry of Agriculture, Nature and Food Quality appointed them as one of the advisors in case of a stranding of a large cetacean (baleen whales or toothed whales larger than 3m in length) (Ministry of Agriculture, Nature and Food Quality, 2020).
Another NGO defending the conservation of harbour porpoises is Stichting Rugvin. This foundation specifically focusses on the conservation of harbour porpoises in the semi-enclosed sea arm Eastern Scheldt, next to their research on harbour porpoises in the North Sea. Their main activity is monitoring the population numbers by a yearly monitoring of harbour porpoise numbers in the Eastern Scheldt and regular monitoring activities from the ferry from Hoek van Holland (the Nether-lands) to Harwich (Great Britain) (Stichting Rugvin, 2021).

5.2.3 Constitutional rules

Constitutional rules are institutions defined in the highest levels of governance (Ostrom, et al., 1994). The most important constitutional rule for the protection of the harbour porpoise in the Dutch North Sea is the EU Habitats Directive. The harbour porpoise is protected under the Habitats Directive Annex II and Annex IV of the Habitats Directive. This means that that they are 'in need of strict protection' and that the harbour porpoise benefits from protection measures under both Annex II and IV. (European Commission, 2007) Article 12 under the Habitats Directive ensures that Member States form and execute strict protection measures for Annex IV species, among which the harbour porpoise. Besides this, Member States are required to provide monitoring documents of the conservation status of the Annex IV species every six years. (European Commission, 2021) To ensure a long-term survival of species listed under the Bird and Habitats Directive, Natura2000 areas are set in place. Natura2000 offers a network of protected breeding and resting sites across whole Europe. Member States must 'ensure that the sites are managed in a sustainable manner, both ecologically and economically' (European Commission, 2021).
Since the harbour porpoise is listed under Annex II and IV, the Netherlands have to take measures to protect the species. The European Commission (2007) provides the 'Guidance document on the strict protection of animal species of Community interest under the Habitats Directive 92/43/EEC'. The intended goal is to reach a favourable conservation status for the species listed under the Habitats Directive. This conservation status needs to be obtained through the execution of various conservation measures, like the designation of protected sites (Natura2000) to protect their habitat and protection measures to prevent influences on the species themselves. The mandatory protection measures that Member States need to take in order to protect species falling under the Habitats Directive (Annex II) are limited to the prohibition to deliberately disturb the species or its habitat, destroy or damage their sites of reproduction and deliberately kill or capture wild live animals in their natural habitat.

The 'Wet Natuurbescherming', the nature protection law is the Dutch legislative framework that ensures protection of species described in the EU Habitats Directive. The legislation includes the following prescriptions: (Ministry of Economic Affairs and Climate, 2021)

1. It is forbidden to deliberately kill or capture wild live animals in their natural habitat, described under the Habitats Directive Annex II, Treaty of Bern Annex 1, excluding species included in article I of the Bird Directive;
2. It is forbidden to deliberately disturb animals as mentioned under enumeration 1;
3. It is forbidden to deliberately take or destroy eggs of animals mentioned under enumeration 1;
4. It is forbidden to destroy, or damage sites of reproduction or rest of animals mentioned under enumeration 1.

Looking at the prescriptions here above, it is clear that the Dutch Wet Natuurbescherming is a copy of the prescriptions described in the Habitats Directive. The harbour porpoise falls under Annex II of the Habitats Directive and is therefore also protected under the Wet Natuurbescherming.

Another legally binding framework set up by the EU is the Marine Strategy Framework Directive (MSFD). It forms a legal framework for the protection, conservation, prevention of deterioration and, where possible, restoration of the marine environment (Rijkswaterstaat, 2021). The Dutch Marine Strategy Framework Directive (MSFD) is a translation of the EU MSFD. The MSFD describes, among other things, how the Netherlands want to deal with the (cumulative) anthropogenic effects on harbour porpoises. The MSFD is the first step in the realization of policies for the execution of the strategic plans described in the MSFD. Their intention is to explore a methodology to describe the cumulative effects of anthropogenic activities in the Dutch North Sea on the basis of several scenarios (Ministry of Infrastructure and Water & Ministry of Agriculture, Nature and Food Quality, 2012).

The Dutch part of the North Sea is not only the habitat of harbour porpoises and other animals, but as stated earlier, it is also an important economic driver for the Netherlands and other European countries. The Dutch Offshore Energy Law ensures that Natura2000 areas will not be damaged because of the development of offshore wind energy in the Dutch part of the North Sea. If there is a chance that a nearby Natura2000 area will suffer from the development of an offshore windfarm, compensation measures are mandatory (Ministry of Economic Affairs and Climate, 2020).

5.2.4 Operational rules

Operational rules are institutions that are involved in the implementation and operationalisation of institutions defined on a constitutional level (Ostrom, et al., 1994). International institutions governing the harbour porpoise population are translated to national guidelines in the Harbour Porpoise Conservation Plan. The Dutch government presented their first Harbour Porpoise Conservation Plan in 2011. In the meantime, an update of this plan is available since the end of 2020. This plan gives recommendations for conservation measures to maintain the favourable conservation status and reach positive future prospects. The following conservation aspects are included:

- Population ecology, abundance and distribution:
  Focus on long- and short-term diet studies and abundance and distribution monitoring. This will help the understanding of the position of the harbour porpoise within complex food webs;
- Stranding of porpoises:
  Necropsies of stranded harbour porpoises give valuable indication on the cause of death, diet, life history and chemical contaminants. Nevertheless, they are not fully representative for the whole population. Therefore, more transboundary and offshore research is necessary;
- Chemical pollution:
  Chemical pollutants remain a significant threat for this species and is possibly affecting their immune system and reproduction success. It is therefore recommended to continue and increase (international) research on this subject;

- Incidental bycatch:
  Despite many efforts to reduce incidental bycatch, it remains a significant problem. Mainly the involvement of the fisheries sector is challenging. The use of alternative gear to prevent incidental bycatch deserves more attention;
- Underwater noise:
  Underwater noise is a problem caused by diverse anthropogenic activities in the North Sea. It is recommended to increase knowledge on the effects of continuous noise, like shipping and to tackle the problem on a national as well as international level;

The concerns expressed by stakeholders during the consultation phase of the conservation plan are included in the plan, in a separate chapter. It is explained why certain concerns were not included in the plan and it is emphasized that 'the recommendations in this plan focus on what is needed to fulfil the (legal) requirements from the perspective of policy and management, with the overall aim to maintain a Favourable Conservation Status of the species in Dutch waters'.
The conservation plan is supported by the Harbour Porpoise Action Plan 2020-2026. The action plan includes a list of monitoring, research, management, mitigation and policy recommendations to implement in order to increase the success of conservation management of the harbour porpoise in Dutch waters. The actions will be included in existing policies, like the Netherlands Marine Strategy (Ministry of Agriculture, Nature and Food Quality, 2020).

The Dutch North Sea has an overarching policy 'The North Sea Policy' (2015) which aims at dynamic management of the dynamic and busy Dutch North Sea through the integrated management method 'ecosystem approach'. The Dutch government made the decision to appoint areas for the purpose of developing functions. The choices in this policy are based on other existing policies, like the Integrated Management Plan for the North Sea. This framework is integrated and expanded for the purpose of the North Sea Policy.

Other policies that include measures that support the conservation of harbour porpoises in the Dutch North Sea are the EU Common Fisheries Policy that include the mandatory use of specific gear to prevent incidental and unwanted bycatch and measures to prevent damage on the marine environment (European Commission, 2021).

5.2.5 Monitoring

Member States are obliged to periodically monitor the habitats and species listed under Annex I, II, IV and V to meet the requirements of Article 11. Additionally, Member States are obliged to send the European Commission an assessment of the conservation status and trends of the species and habitats falling under the Habitats Directive every six years. The conservation status is assessed separately for each species or habitat, following a standard methodology (European Commission, 2021). According to the latest assessment report, the Netherlands indicate that the required measures for conservation were taken and that the current population status can be classified as 'favourable'. Nevertheless, there are doubts about the continuation of this positive population trend, because of upcoming climate change and the increasing numbers of offshore wind farms. The future prospects of the harbour porpoise population are therefore classified as 'unknown' (European Commission, 2020).

To meet the requirements of the OSPAR MSFD indicator on abundance and distribution of marine mammals, aerial surveys are conducted to monitor the harbour porpoise population in the Dutch North Sea. A total of 189 individual harbour porpoises were observed during the survey in summer 2019. This resulted in a population estimation of 38.911 individuals (CI= 20.791-76.822) living in the Dutch part of the North Sea (Geelhoed S. C., Janinhoff, Lagerveld, & Verdaat, 2020).

5.3 EU policies

The EU has several legal frameworks for the conservation of the harbour porpoise in the North Sea. The most important and dominant framework is the Habitats Directive. This directive is twofold; Member States need to know the population status of the species listed under the directive, and Member States need to take the necessary protection measures. This subchapter will explain the institutions applied on an EU level.

5.3.1 Population status assessment

Every six years, Member States have to perform a population assessment for the species listed under the Habitats Directive. The population status is assessed according to a standard tool provided by the EU. Each Member State assess the population status of harbour porpoises in their waters. This tool provides a set of indicators that needs to be assessed, with the most important indicators being habitat quality and population numbers. Several interviewees explained that the information and data used to assess the population status are free of choice, providing that they are scientifically supported. The EU does not prescribe which data is mandatory to support the population assessment. The scores of the different indicators are assessed by the Member States itself, which can potentially result in a difference in interpretation of indicator results and scores. According to the interviewees this results in conflicting differences between (sometimes adjacent) Member States. All interviewees were therefore questioning the population assessment approach. A common argument was the fact that the harbour porpoise as a highly migratory species cannot be assessed on population level by only one Member State, since the whole Southern North Sea is considered as their habitat and the individuals living in the Southern North Sea are seen as one population. As one of the interviewees stated: '*As an example, you can see that the population slightly declined in Germany, and somewhat grew in the Netherlands. So, it is likely that the population moved a little towards the Netherlands, instead that the population grew, even if that is what it looks like if you look at the population assessment of the Netherlands*'.

The Netherlands concluded that the population can be assessed as being favourable, but with unsure future prospects. Mainly the indicator 'habitat' had a higher score than during previous population assessments, which resulted in a higher overall score and a favourable population assessment. Several researchers, NGO's and research institutes refuted this with research results that are indicating a deterioration of the common health status of harbour porpoises and an increase in anthropogenic pressures within their habitat, suggesting that a positive population assessment is questionable.

All interviewees therefore suggested a habitat wide population assessment, covering the whole Southern North Sea. This would prevent differences in assessment results between Member States since the assessment will be performed on habitat level (Southern North Sea) instead of Member State level. Shifts in habitat use, as is now seen shifting from the northern part of the Southern North Sea, towards the southern part, will be remarked earlier and knowledge exchange will be encouraged.

5.3.2 Implementation of the Habitats Directive

Next to monitoring, Member States need to take the necessary protection measures to prevent deterioration of habitat and population density of species listed under the Habitats Directive. Besides the mandatory protection measures, focused on the prevention of deliberate disturbance of the harbour porpoise, the European Commission does not describe other (strict) protection measures. Several interviewees stated that the lack of a framework for the application of measures is a threat to the conservation of the harbour porpoise in the Southern North Sea. According to the interviewees, the harbour porpoise needs an unambiguous conservation policy in the whole Southern North Sea since it is a highly migratory species that does not respect country boundaries. Since each country applies different conservation measures for this specific species, the harbour porpoise also faces different conservation levels within its habitat. As an example, one of the interviewees stated '*in*

Denmark and Germany you are allowed to install a wind farm in a Natura2000 area, while wind farms are banned in these areas in other Member States'. Another example is the noise standard for piling wind farms. The noise standard depends per Member State, which has consequences for the harbour porpoise migrating between Member States. One of the interviewees stated: '*Apply an equal noise standard for all Member States within the habitat of the harbour porpoise. Harbour porpoises don't see the difference between Belgium, Germany or the Netherlands. But there certainly is a difference*'.

5.3.3 Governance networks

Within the EU, two governance networks are working on cetacean conservation, among which the harbour porpoise. On ASCOBANS level, a Conservation Plan for Harbour Porpoises in the North Sea (2009) is set up, which also formed the basis of the first Dutch harbour porpoise conservation plan in 2011. The ASCOBANS plan, on the other hand, has never been updated since and is therefore outdated. Under the supervision of ASCOBANS, collaborating parties are required to take several monitoring measures. Two of these measures are the post-mortem research that is performed by the University of Utrecht and the research on diet composition performed by Wageningen Marine Research. The interviewees, who almost all take part in one of the working groups of ASCOBANS, experience the collaboration between countries in this governance network as positive, but they emphasize that the network is missing executing power, mainly because of the lack of funding. Because of the broad variety of attendees from different countries and work fields, the decision-making process is slow within the network structure. This has as a consequence that the implementation of conservation measures lags behind on the actual developments in the North Sea.

A part of the monitoring obligation of the Habitats Directive is secured by the OSPAR convention. The international survey program of OSPAR ensures a regular population monitoring, called SCANS. Besides this monitoring obligation, OSPAR also proposed a list of indicators that can give an indication of the population's health. By monitoring contaminants in stranded cetaceans or harbour porpoises over several years and in all North Sea adjacent Member States, a trend can be observed if the harbour porpoise's health is sufficient to ensure a positive future population development. OSPAR has the aim to include the monitoring of contaminants in the Habitats Directive population assessment. Most of the interviewees named the above monitoring initiatives as an example of a positive development towards European collaboration and equal monitoring. On the other hand, a governance network like OSPAR also has its downsides: '*it takes a lot of time and it is always unsure if an OSPAR plan will be accepted. That can easily take six years. Nevertheless, with these developments we contribute to a more coordinated monitoring method'*.

The wide variety of governance networks puts pressure on the scientists, policy makers and NGO's collaborating in the working groups facilitated by the networks. Every network has working groups working on specific challenges corresponding the challenges found in the social-ecological system of the Dutch North Sea. Scientists remark that every governance network has working groups with the same subjects, often including the same scientists and NGO's collaborating in these working groups. It also happens that the working groups don't include the same NGO's and scientists and that they subsequently don't exchange knowledge. For example, there is a working group bycatch within OSPAR and within ASCOBANS. Both including partly the same scientists. They fear that this wide variety of working groups within the different governance networks leads to overlap in work and research focus. As one of the scientists mentioned: '*I sometimes ask myself if we are not duplicating our work'*.

5.4 National policies

The Netherlands implemented European laws and guidelines to Dutch policies. This chapter explains how this European law is translated to the Dutch situation and how it fits the situation the harbour porpoise is currently living in the social-ecological system of the Dutch part of the North Sea.

5.4.1 Threats within the social-ecological system of the Dutch North Sea

As explained in chapter 5.1.4, the Dutch part of the North Sea has many users. These users, with their economic and leisure activities have the potential to change the social-ecological system. All interviewees confirmed that the Dutch North Sea is a busy area with several threats for the harbour porpoise. None of the interviewees could say which activity is most threatening the harbour porpoise. All indicated that it is a cumulation of pressures and that every new pressure is the figurative 'straw that breaks the camel's back'. Bycatch is among the biggest threat for cetaceans. Dutch policy makers indicated that the research project 'Remote Electronic Monitoring' with Dutch fishermen showed that bycatch of harbour porpoises in the Dutch North Sea is estimated on 0.3% of the population. This is well below the ASCOBANS directive that prescribes a maximum of 1% bycatch. Despite these favourable results, NGO's still expressed their concerns, especially regarding the bycatch numbers in gillnet fisheries, since the research project 'Remote Electronic Monitoring' was only performed on a small part of the Dutch fleet, which can result in unrepresentative research results. NGO's are of opinion that more research is needed to be sure that bycatch is no big threat for harbour porpoises in Dutch waters.

All interviewees referred to underwater noise as a silent killer for harbour porpoises. As humans, we are unable to hear these noises, which makes it more difficult to understand the consequences and create awareness, according to the interviewed NGO's. Policy makers and scientists also named underwater noise as one of the threats that seems most difficult to tackle. Underwater noise comes from a large variety of activities in the Dutch North Sea, with the most important being wind park constructions, clearing explosives and shipping activities. Much research has been done on the reduction of underwater noise during wind park construction. This resulted in noise limitations for constructors of these offshore wind parks. The noise is reduced, but still not disappeared. Policy makers and scientists both emphasized that these noise limitations are only applied during the construction period. It is still unknown which are the consequences of operational noise of offshore wind parks on harbour porpoises. Especially the long-term effects of this noise pressure on the ability to catch prey and on their reproduction is currently unknown.

Two other threats that NGO's and scientists appoint are chemical pollution and food availability. Chemical pollution is a problem for harbour porpoises, but it is currently unclear what the long-term consequences of the pollutants are for the species. Interviewed NGO representatives and scientists emphasize that contaminants have been found back in female harbour porpoises. As a scientist told: '*contaminants are probably an important limiting factor in the reproduction of harbour porpoises. We find high levels of PCB's in female porpoises, above the accepted levels. That should lead to consequences on their reproductive capacities'*. Besides, the interviewees indicate that the cumulation of contaminants in organs and blubber layer has the potential to influence the overall health condition of the species.

The availability of food is a more complex question that can have several origins. All interviewees named several potential causes of shifts in prey availability, like noise levels disturbing fish populations, climate change and fisheries.

5.4.2 Laws and policies

Policy makers of the Dutch government explained that the Habitats Directive is entirely copied into the Wet Natuurbescherming. Every Member State is obligated to implement the policy, but there is room to do this in such a way that it meets the regional circumstances. The Netherlands choose to stick to the Habitats Directive and implement the policy as is stated in the EU guideline as is explained in chapter 5.2.3. One of the interviewees referred to it as follow: '*Every country is free to implement*

the guideline following their wishes and needs and we, as Netherlands, implemented the guideline without any adaptations. Some people say we made it more complicated, where the other rejects that argument. I think we did make it more complicated than it should be, especially regarding implementations from the past, that could be adapted to current situations'. Despite these complications, policy makers are convinced that the current policies for the protection of the harbour porpoise offer enough support to implement corresponding conservation measures to ensure a future favourable conservation status. As explained in chapter 5.2, the Harbour Porpoise Conservation Plan is the most important policy for the protection of the harbour porpoise in Dutch waters. Besides, the protection is included in several specific policy papers, like fishery and offshore wind energy policies. No economic or leisure activities are ruled out in order to protect the harbour porpoise. Policy makers emphasized: '*We want to ensure that the risk of disturbance of the harbour porpoise is as little as possible. If you can prove that the risk is minimalized to a maximum, you are allowed to perform the activity in the Dutch part of the North Sea. That is what happened with the development of wind farms, but it is also the case with fisheries'*. Moreover, Dutch policies have to deal with a large variety of ambitions, wishes and obligations. Next to the obligation to protect the harbour porpoise, the Netherlands also have the obligation to meet the climate mitigation goals of the Paris Agreement. This causes conflicting interests. With on the one hand, the wish and obligation to minimize to a maximum the activities in the habitat of the harbour porpoise, but on the other hand, build wind farms to meet the climate goals of the Paris Agreement. These conflicting interests can also be found back between different Ministry departments. Policy makers involved in fishery policies have other priorities than the policy makers writing the harbour porpoise conservation plan. The same can be said of policy makers involved in offshore wind energy.

Policy makers are aware of these conflicting interests regarding harbour porpoise conservation. In order to prevent implementation issues, they organized an extended stakeholder consultation process. NGO's and scientists indicated that they are pleased that they were involved in the policy process. Especially NGO's indicated that their involvement in policy processes and projects much improved over the past years. On the other hand, NGO's, as well as scientists emphasized that their input was not sufficiently implemented in the harbour porpoise conservation plan. Nevertheless, especially NGO's mentioned that they are glad that they were able to contribute in the policy process and that they are confident that their input will be of increasing importance in the coming years.

Drawing up a policy is not evident, according to the policy makers involved in the harbour porpoise protection plan. All interests have to be taken into account. The harbour porpoise conservation plan includes a list of research priorities. Policy makers indicated that it is difficult to prioritize research projects: '*We often talk with the same scientists if it's about cetacean research, because there are not that many researchers involved in cetacean research. Some scientists promote their own research and it is sometimes difficult for policy makers to prioritize which research projects really are necessary in the interest of the policy goals and which projects are a personal preference of the scientist*.' Scientists recognize this dilemma. From their position it is more difficult to be critical during stakeholder consultations, like the stakeholders consultation of the harbour porpoise conservation plan. Scientists are asked to critically review the conservation plan, while the Ministry of Agriculture, Nature and Food, the makers of the plan, is also one of their clients.

5.4.3 Policy implementation

The Netherlands has a harbour porpoise conservation plan since 2011. The Harbour Porpoise Conservation Plan was updated in 2020 and includes a number of priorities for action to maintain a favourable conservation status for the species. The 2020 plan includes many of the research, management and monitoring projects that were already part of the 2011 action plan. Policy makers emphasize that the inclusion of partly the same projects as in 2011, is not because a lack of implementation of the 2011 plan. Some of the projects are still in the execution phase and others are

not yet executed but are still considered as a priority by the Ministry of Agriculture, Nature and Food. The projects included in the action plan are categorized by priority. This priority is defined regarding the availability of funding, feasibility, the availability of data, how it fits current policies, and whether it is addressing a major threat (Ministry of Agriculture, Nature and Food Quality, 2020).
Policy makers named several projects that were executed for the protection of the harbour porpoise. The implemented noise limitation for wind park constructions and a pilot study with the Ministry of Defence to minimize the hearing damage of harbour porpoises during the clearing of underwater explosives were named as two successful policy implementations. Scientists and NGO's are more critical on the execution of the harbour porpoise conservation plan. The starting point of monitoring is the first comment that is appointed by scientists. The first SCANS survey is considered as the starting point, but the status that is derived from this SCANS survey is a status that is influenced by human activities for years. Scientists emphasize that it is important to realize that current status changes are derived from a starting point that already was influenced by anthropogenic pressures. Population numbers and health status from the period before anthropogenic pressures were severely influencing the social-ecological system of the Dutch North Sea are currently unknown.

NGO's and scientists are critical about the implementation of the harbour porpoise conservation plan and other policies that are contributing to the conservation of the harbour porpoise. They are aware of the implemented noise restrictions named here above, but have their doubts about the implementation of other, in their eyes essential, conservation measures, like more measures to prevent bycatch. Looking at underwater noise, which is named as one of the most important threats for harbour porpoises, the pressure on the social-ecological system is increasing. The noise limitation for wind park developments is taking some of the pressure away, but the construction of wind parks is a relatively new addition to the already busy and noisy area. The noise restriction doesn't take the pressure away. Other anthropogenic activities that are increasing noise pressure still exist and are often even increasing because of economic developments.
NGO's also commented on the implementation of measures in fisheries. Policy makers suggested that no measures were necessary to prevent bycatch, since research showed that bycatch levels in Dutch waters are well below the ASCOBANS limit of 1%. NGO's agree with these results but emphasize that the research was done on only a few vessels, which does not represent the whole Dutch fleet. According to NGO's, the research results does not justify the decision to renounce the implementation of further measurements to prevent harbour porpoise bycatch in commercial fisheries. On the other hand, they encourage the initiative of the Dutch Ministry to initiate a European bycatch monitoring project.

What NGO's and scientists emphasized most, is that they are missing executive power. The existence of the harbour porpoise conservation plan shows the ambition of the Dutch government to contribute to the conservation of the species. NGO's and scientists on the other hand do not see clear implementation of measures that are helping the harbour porpoise or contribute to the overall improvement of the social-ecological system. As some scientists and NGO's said: '*We talk too much and act too little!*'. This lack of executive power is considered mainly caused by the lack of funding and the continuation of projects without implementing any modifications that would suit the environmental changes and changes in knowledge gaps. They also indicate the lack of enforcement of the policy rules. This enforcement is well arranged at e.g. wind park development but is less common in commercial fisheries.

Scientists involved in cetacean conservation are often involved in many different working groups on national, European and sometimes even global scale. As one of the scientists mentions: '*I see many indications that the overall health condition of the harbour porpoise is not that good. Also, in conversations with colleagues when we compare data for a congress poster or a paper, I see that it's not going too well in the Southern North Sea. That we have many emaciated animals, only few animals that have offspring… I think that the problem that we have is that science is going too slow. It takes so*

long before you finally have a paper and that's it is peer reviewed. While status adjustments or environmental changes in the North Sea are going in a much higher pace. So, I think that there is much more information and data available in the minds of scientists, than that is written on paper and peer reviewed. If I look at myself and everything I have in mind, I'm convinced that it's not going that well with the harbour porpoise. A lot of animals in the North Sea does not mean that they're all healthy and feeling well'. Scientists realize that the Netherlands invest a lot in harbour porpoise funding, especially compared to the conservation of other wildlife species. They do remark that most of the funded research is focused on the consequences of certain threats, while a lot is still unknown about the species. Where do they find their favourite prey? Which habitat do they prefer? Those are questions that are mostly unanswered, while they are important data to be able to make deliberate policy choices in a busy social-ecological system as the Dutch North Sea. NGO's support this: '*It is good to see that the Netherlands invest in specific research for the harbour porpoise. It is sad to see that the link towards policy implementation is currently missing*'. This missing link becomes clear when looking at the knowledge gaps about the species. The past years, a lot of diet research is done to know what their favourite prey is. On the other hand, we still do not know where this prey is available in the North Sea. This link in knowledge could be expanded more to decrease the knowledge gap and be able to apply suitable conservation management tools.

5.4.4 Future proof policy

The Netherlands is the only Member State with a harbour porpoise conservation plan. Policy makers stated that the Netherlands can be proud of their conservation plan, because it shows that the government set their priorities on the protection of the species. One of the interviewees referred to other Member States who have a 'small cetacean conservation plan' instead of a plan exclusively focused on harbour porpoises, as is the case in e.g. the United Kingdom. Countries with a small cetacean conservation plan have a larger diversity of cetaceans in their waters than the Netherlands, which mainly has harbour porpoises and sometimes receives guests like common dolphins (*Delphinus delphis)*, bottlenose dolphins (*Tursiops truncatus)*, minke whales (*Balaenoptera acutorostrata*), white beaked dolphins (*Lagenorhynchus albirostris*) and humpback whales (*Megaptera novaeangliae*) (waarneming.nl, 2021). A study performed by Williamson, et al. (2021) in UK waters showed indications of an increase in stranding numbers of warm water adapted cetacean species (in this case short-beaked common dolphin and striped dolphin) between 1990 and 2018. A suggested cause of this increase in stranding numbers of warm water adapted species is climate change and its consequences on the marine ecosystem. Dutch scientists, NGO's and policy makers are aware of the chance that the occurrence of non-native cetaceans will increase in the Southern North Sea. An independent advisory board already concluded that the translation of the Habitats Directive to the Dutch situation is not flexible enough to adapt to changes occurring in the social-ecological system of the North Sea. Policy cycles are too long to adjust policies after short periods of time and there are still a lot of uncertainties about the consequences of climate change. Nevertheless, research funds are available to collect tissue samples of stranded non-native individuals along the Dutch coast. This tissue bank forms a starting point for the situation in the Dutch part of the North Sea and helps to identify changes in an early stage. Policy makers noticed that the Netherlands disposes of a well-trained stranding network that contributes to the monitoring of the stranding of cetaceans. This monitoring and registration of stranded animals helps to identify changes in stranding patterns of species. However, they do agree that the Dutch policy as it is implemented today, does not allow quick adaptations to changing circumstances.

5.5 Institutional fit

The institutional fit of the above mentioned constitutional and operational rules is assessed on the basis of the dimensions of fit defined by Epstein et al. (2015). The assessment is done from the perspective of the harbour porpoise in the context of the social-ecological system of the Southern North Sea. As explained in chapter 3.2, the institutional fit assessment framework of Epstein et al. (2015) consists of three types of fit: ecological fit, social fit and social-ecological systems fit. All three types of fit are assessed using the dimensions defined under each of the fits. Each dimension is used as indicator for fit. The scores on each of the dimension are divided in good (+), average (+/-) and bad (-). The following grading criteria are applied:

- Good score: Theoretically the concerning institution has a good fit. The institution meets the requirements of the dimensions. This is also the case for the operationalisation of the institution. There is a good fit between the institution and the concerning social and/or ecological system;
- Average score: Theoretically the concerning institution has a good fit. The institution meets the requirements of the dimensions. The operationalisation of the institution does not meet the requirements of the dimensions and does not result in a good social and/or ecological fit;
- Bad score: Both theoretically and operationally the concerning institution does not fit the dimensions and subsequently results in a bad social and/or ecological system fit.

5.5.1 Ecological fit

Looking at the ecological fit, three dimensions are identified: spatial fit, temporal fit and functional fit. The spatial fit is about the coherence between the geographical boundaries of the environmental challenge and the institutions.

	Ecological fit		
	Spatial fit	Temporal fit	Functional fit
Habitats Directive	+/-	-	+/-
OSPAR	+	-	+/-
ASCOBANS	+	-	+/-
Harbour Porpoise Conservation Plan	-	-	+/-
The North Sea Policy	-	-	+/-
Marine Strategy Framework Directive (NL) (MSFD)	-	-	+/-
Fisheries Policy	-	-	-
Offshore Wind Energy Policy	-	-	-

Table 3 Assessment of the ecological fit dimensions by Epstein et al. (2015) on harbour porpoise conservation policies in the Netherlands

The first dimension within ecological fit is spatial fit. This fit refers to the coherence between the geographical boundaries of the environmental challenge and institutions. The spatial misfit is mainly visible in the match between spatial policy coverage and the presence of the harbour porpoise population. The policies do not cover the whole habitat of the species. This results in the application of different policies addressing one problem within one habitat. An example is the application of Offshore Wind Energy Policy. The Netherlands made the choice that wind parks are not allowed in Natura2000 areas, while the installation of wind parks is allowed in Natura2000 areas in Denmark and Germany.

Not all applied institutions have a bad score on spatial fit. The Habitats Directive has the intention to create an overview of the population by applying a mandatory population assessment for each Member State and the obligation to apply necessary protection measures. Despite the good intentions of this Directive, the operationalisation is less successful. Each country uses other indicators to perform the population assessment and also the level of protection varies per Member State. For a highly

migratory species like the harbour porpoise, these differences in operationalisation of an international directive may decrease the chance of favourable future prospects. The Habitats Directive scores an average fit for this dimension, because of their good intentions to apply the directive on habitat level, but the implementations of conservation measures under the Habitats Directive does not correspond the geographical boundaries of this environmental challenge.
The governance networks OSPAR and ASCOBANS both function as a flywheel to encourage international collaboration on habitat level. Their governance structure fits the requirements of a good spatial fit, because these institutions cover the whole habitat of the harbour porpoise and the implementation of measures is applied on habitat level.

The second dimension, temporal fit, is about the ability to apply institutional response in the same pace as environmental changes. Interviews made clear that the policies involved in harbour porpoise conservation lack the ability to quickly respond to environmental changes, because of the long decision-making process within governments and international governance organisations. The duration period of the different policy documents is mostly for a period of 5 to 10 years. A lot can change within this period, especially under human influences. Another important aspect of the dimension of temporal fit is the gap between research and adaptation to environmental changes. Often, scientific research is needed to define the best reaction to environmental changes. Research takes time. This contributes to the ability to quickly respond to environmental changes. Because of these policy characteristics, every assessed policy has a bad score on this dimension.
Even if current policies do not score well on temporal fit, a change is noticeable in new policy documents. The new North Sea Policy, the North Sea Program that is currently available in draft version and will be effective as of 2022, included the intention to implement an adaptive management approach to be able to respond to environmental changes. (Rijksoverheid, 2021) Looking at the currently applied institutions, there is a temporal misfit between the harbour porpoise living in the social-ecological system of the Dutch North Sea and the applied institutions.

The third and last dimension of ecological fit is the functional fit. This dimension is about the alignment between the different functions within the social-ecological system. The social-ecological system of the North Sea includes conflicting interests. On the one hand, the development of economic activities is important for the Netherlands, and on the other hand it is preferred that ecological deterioration is prevented. For some of the economic activities, preservation of a good ecological status is even essential to continue the economic activities, like aquaculture, fisheries and some leisure activities like diving. The different aspects of the system are connected with each other. Implementing a measure to address one challenge, can influence other challenges or aspects in the social-ecological system. The implementation of integrated institutions like the Harbour Porpoise Conservation Plan works as an overview of the economic, social and ecological factors influencing the harbour porpoise population. The execution of the policy is implemented on sectoral levels, which prevents maintenance of the overview and the ability to monitor the consequences of the implementation of conservation measures, since monitoring is limited to that one sector.
NGO's mentioned the lack of implementation of general, or no-regret measures in harbour porpoise conservation. These measures are not sector dependent and can be implemented in integrated institutions, like on Habitats Directive or Harbour Porpoise Conservation Plan level of governance, which involves a large variety of stakeholders and governance levels. Nowadays, the implementation of general conservation measures is missing.
The current applied institutions have an average functional fit. Sectoral institutions have a low score on the dimension of functional fit.

5.5.2 Social fit

	Social fit		
	Values, interests and beliefs	Participation and psychology	Spatial fit
Habitats Directive	+/-	-	+/-
OSPAR	+/-	+	+
ASCOBANS	+/-	+	+
Harbour Porpoise Conservation Plan	+	+/-	+/-
The North Sea Policy	+	+/-	+
Marine Strategy Framework Directive (NL) (MSFD)	+	+/-	+
Fisheries Policy	-	-	+
Offshore Wind Energy Policy	-	+/-	+

Table 4 Assessment of the social fit dimensions by Epstein et al. (2015) on harbour porpoise conservation policies in the Netherlands

The second type of fit is the social fit. The three dimensions identified under the social fit are: values, interests and beliefs, participation and psychology, and spatial fit.
The first dimension, values, interests and beliefs is about the fit between operational rules and the social context in which they operate. The Habitats Directive theoretically has a good fit for this dimension. It gives the obligation to implement necessary conservation measures, but every Member State is free to implement the measures they deem appropriate. This freedom of measure implementation is the same for every Member State. On an operational level, the fit is less good. Because of the differences in the implementation of conservation measures for the harbour porpoise, the consequences for sectors in different Member States can vary. For example, energy companies are allowed to build wind parks in Natura2000 areas in Germany and Denmark, while the Netherlands forbids the building of wind parks in these protected areas. This results in less room for the development of this economic activity in the Netherlands.
Governance networks like OSPAR and ASCOBANS also have a good theoretical fit on this dimension. All governments involved together decide about the policy and project implementations in favour of the conservation of the harbour porpoise. The operationalisation of these policies and projects can be more difficult because of regional differences in governance styles, economic or policy priorities, or environmental conditions.
The Harbour Porpoise Conservation Plan, The North Sea Policy and the MSFD deal with a large majority of the interests that are at stake within the habitat of the harbour porpoise. Within these documents, it is well explained who has the authority for conservation measures in different sectors. Handing over tasks to the corresponding authorities is an aspect of a good fit in this dimension. For the Fisheries and Offshore Wind Energy policies the interests and values are not prioritized on harbour porpoise conservation. Despite the measures that are taken to decline nuisance for the species, policy makers have to take many different interests into account, among which the interest of the harbour porpoise. The interviewed policy makers indicated that it is almost impossible to include all interests equally. Next to harbour porpoise conservation, other nature conservation interests have to be taken into account, all while preserving economic profit for the targeted policy activity. The variable scores on this dimension lead to an average fit for this dimension.

The second dimension within the concept social fit is participation and psychology. This is about the appropriateness of rulemaking processes given the expectations and psychological needs of stakeholders. The Habitats Directive is one of the most important directives for harbour porpoise conservation. The set-up of the population assessment is most questioned among interviewed NGO's

and scientists. They do not support all included assessment criteria. They also remarked that objections on the population assessment were not taken into account by the EU officials. The support for this directive, especially for the population assessment, is therefore not always good among scientists and NGO's occupied with harbour porpoise conservation. This results in a bad fit for this dimension of social fit. The sectoral Fisheries Policy still lead to a lot of objections among stakeholders involved in harbour porpoise conservation. According to this group, the policy does not include the necessary measures to prevent bycatch among harbour porpoises. This results in a bad fit on the dimension of participation and psychology. The Offshore Wind Energy Policy is also not always preferred among these stakeholders, but their objections resulted in the successful implementation of measures to prevent severe nuisance.
The Harbour Porpoise Conservation Plan executed an extensive participation process. Stakeholders were pleased that the revision of the 2011 conservation plan included an extensive participation plan. Despite the good intentions, based on the conducted interviews with NGO representatives and scientists it became clear that the stakeholders were disappointed with the results of this participation process and feel that little has been done with the feedback delivered during the participation process.
The North Sea Policy and the MSFD both include all involved policies and laws in their documents. The MSFD had a similar participation process as the Harbour Porpoise Conservation Plan, but also focussed on international stakeholders like OSPAR. The participation process of the North Sea Policy was organized the way that stakeholders had the opportunity to hand in their view on the policy beforehand and after publication of the concept version of the policy.
Both OSPAR and ASCOBANS function well on participation and psychology as governance organizations. Stakeholders are actively participating in the planning and writing process. Decision making processes are done with the agreement of the participating parties. This results in a good score on this dimension of social fit.

The last dimension within social fit is the spatial fit. This addresses the fit between the institutions and the scales or levels of social organizations. OSPAR and ASCOBANS perform well on this dimension by governing on habitat scale with the use of regional governments and organizations. Every country is responsible to implement the necessary conservation measures and by organising these measures on an international (habitat) scale, differences in conservation levels can be prevented. The Habitats Directive also strives for equal like conservation levels among Member States. The idea to delegate responsibilities to local authorities is good, but the execution is more difficult because of differences in policy interests and governance styles. As is seen today, this delegation of responsibilities does not lead to an adequate implementation of general conservation measures on regional levels.
Both the North Sea Policy and the Marine Strategy Framework Directive are more successful on the dimension of spatial fit. Both policy documents function more as an overview of all projects, policies and laws leading to a more sustainable North Sea. The obligations from both policy documents is translated into sectoral policies and thus delegated to the corresponding authorities. The Harbour Porpoise Conservation Plan has a similar function, but interviews made clear that collaboration with sectoral policy officers can be challenging because of the striking interests. This can be seen back in the sectoral policies. It leads to a good spatial fit that measures for harbour porpoise conservation are implemented in these policies, but the strong field of interests makes implementation of these measures difficult which often leads to a golden mean.

5.5.3 Social-ecological systems fit

	Social-ecological system fit		
	Measurability	Identification of successful contextual attributes	Interactions between institutions and the SES
Habitats Directive	+	+	+/-
OSPAR	+/-	+	+
ASCOBANS	+/-	+/-	+
Harbour Porpoise Conservation Plan	+	+/-	+/-
The North Sea Policy	+	+/-	+/-
Marine Strategy Framework Directive (NL) (MSFD)	+	+/-	+/-
Fisheries Policy	+/-	+	-
Offshore Wind Energy Policy	-	+	+/-

Table 5 Assessment of the social-ecological fit dimensions by Epstein et al. (2015) on harbour porpoise conservation policies in the Netherlands

As a last type of fit, Epstein et al. (2015) defined the social-ecological systems fit. Two dimensions are linked to this type of fit: measurability and the identification of successful contextual attributes. Therewith the interaction between institutions and the social-ecological system is an important factor for the institution's success and therefore included in table 5 as a dimension of social-ecological fit.
The first dimension, measurability, means that the fit of an institution is more measurable if it is associated with a measurable level of success. All above named institutions include measurable policy goals to rate the level of success. The most often mentioned goal is to 'reach and maintain a favourable conservation status for the harbour porpoise'. The Habitats Directive, MSFD, Harbour Porpoise Conservation Plan and North Sea Policy all included this goal in their policy. And they were successful, the goal to reach a favourable conservation status under the Habitats Directive is obtained in the Netherlands. As mentioned earlier in this thesis, the value of this assessment is doubtful because of the set of indicators used to perform the assessment is not supported by all involved stakeholders. Nevertheless, the Habitats Directive has a good score on this dimension because of the inclusion of a measurable policy goal and the fact that the goal is reached in the Netherlands. The same is the case for the Harbour Porpoise Conservation Plan, the MSFD and the North Sea Policy.
OSPAR and ASCOBANS have the goal to encourage international cooperation and reach and maintain a favourable conservation status. OSPAR has more focus on international monitoring of cetacean distribution, where ASCOBANS is focused on specific projects, like bycatch reduction and pollution. The OSPAR goals are difficult to measure. International cooperation is increasing, but it can always be improved. The ASCOBANS goals are well explained, but not all reached or consequently monitored. This gives an average score for both governance networks.
The Fisheries Policy has to respect the goals set up by ASCOBANS. This goal is well known, but the compliance with this policy is rarely monitored among the whole fishery fleet. It is therefore impossible to precisely indicate the bycatch number of harbour porpoises in the Dutch North Sea. After implementation of the Offshore Wind Energy Policy, several measures have been implemented to prevent nuisance of wind parc constructions for harbour porpoises. Despite these good intentions, measuring the success of these implementations is nearly impossible. For both of these policies, this results in an average score for this dimension. Because of this lack of measurability of the set goals, this policy has a bad score for this dimension.

The second dimension under the social-ecological fit is the identification of contextual attributes that lead to the success of the institution. The Habitats Directive identified a set of indicators for the population assessment. A good score on these indicators lead to a favourable population assessment. The Habitats Directive therefore fit the goals of this dimension. OSPAR has as one of the goals to identify indicators to measure harbour porpoise well-being and habitat health and implement them in existing policies, which also results in a good score on this dimension. In the other institutions, several indicators for success are identified, such as noise reduction or the exclusion of specific fishing gear that increases the chances of bycatch. Other institutions mention the ambition to identify attributes by the identification of research gaps. Because of the implementation of these proven successful attributes in both the Offshore Energy Policy and Fisheries Policy, they both have a good score on this dimension. A sidenote is that exclusion of these activities would be most successful for harbour porpoise well-being. The other mentioned institutions all have an average score, because of the intentions to identify attributes that lead to institutional success.

A last and key aspect of the social-ecological system fit is the interaction between institutions and the social-ecological system. The Habitats Directive offers a measurable tool to identify if the habitat is corresponding the needs of a species by the application of the population assessment. By assessing the different criteria of the population assessment, Member States gain insight in the good aspects and aspects that needs attention and eventual response by the implementation of additional conservation measures. NGO's and scientists indicated that the interpretation of the population assessment criteria can vary per Member State which leads to different outcomes between Member States, even if the circumstances appear to be equal. According to these interviewees this can lead to the possible unjustified assumption that the species has a good population status, even if a lot of uncertainties prevent the assurance that favourable future population developments are to be expected. These good intentions, but uncertain assessment outcomes lead to an average score for the Habitats Directive on this dimension.
The Harbour Porpoise Conservation Plan describes the desired conservation and research projects for the preservation of a favourable conservation status for the harbour porpoise. These intentions are good, but NGO's and scientists experience that only little of the desired projects are executed because of a lack of funding. The North Sea Policy focusses on all activities taking place in the habitat of the harbour porpoise. Even if the spatial planning is executed in order to prevent severe nuisance for the natural environment, no activity is ruled out and all activities contribute to the level of disturbance of the harbour porpoise. This is also the case for the MSFD, who tries to increase the sustainability of the habitat, but is not executing any anthropogenic activities.
The Fisheries Policy is the only institution that scores bad on this dimension, because of the limited amount of measures that are taken to prevent bycatch. An exception here are pilot projects, like 'pinger' projects, that are meant to prevent bycatch by the spread of noise that should keep away harbour porpoises.
Altogether, the applied institutions have an average score on this dimension. It is clear the intentions of all institutions are to prevent nuisance for the species, but the operationalisation of the different policies and laws and their interaction is not as effective as expected.

6. Conclusion

This research has as a main question: 'Are the institutions governing the social-ecological system of the Dutch North Sea fit to ensure a future favourable conservation status of the harbour porpoise (*Phocoena phocoena*)?'
A variety of institutions operating on different governance levels are involved in the management of the harbour porpoise in the Dutch North Sea. The concept of institutional fit is applied to measure if the institutions involved in harbour porpoise conservation management are corresponding the situation in the social-ecological system they are living in.

Harbour porpoises are living in the whole Southern North Sea. This area is therefore considered being their habitat. Being a high migratory species, the harbour porpoise tents to migrate within the habitat, not respecting any Member State borders. The habitat of the species is one of the busiest marine areas, with a large variety of economic activities. All these activities put pressure on the harbour porpoise population by the emission of noise and chemical pollutants and possible effects on the availability of prey species. The uncertain developments regarding climate change increase the concerns for the future habitat quality of the harbour porpoise. The match between this ecological system and the institutions involved in its governance is assessed by the application of the concept of ecological fit. The institutions involved in harbour porpoise conservation governance are not corresponding the geographical boundaries of the social-ecological system the species is living in. This leads to differences in the application and implementation of international institutions and variations in conservation levels within one social-ecological system. The implementation of conservation measures in the Netherlands is not enough to ensure the maintenance of a favourable population status for the whole habitat.
The social-ecological system is subject to a large variety of anthropogenic and natural influences which leads to sometimes quickly changing environmental circumstances. The applied institutions do not include enough adaptive capacity to respond to those quickly changing environmental circumstances. Decision making processes are too slow and policy cycles are too long to have the capacity to quickly implement responses to environmental changes. On a functional level, the institutions are applying a sectoral approach to govern the aspects within the system. This results in an incomplete overview of the cumulative effects of all activities within the social-ecological system, since all sectors are governed individually, and general conservation measures are missing. It can be concluded that the ecological fit is not matching the social-ecological system of the habitat of the harbour porpoise.

Different institutions are involved in harbour porpoise conservation governance, each operating on their own level of governance. The institutional performance on the social dimension is assessed by the application of the concept of social fit. International guidelines, especially on EU level, are suitable to be translated to regional situations. These results in implementations that suit regional characteristics and governance styles. A majority of the institutions is set up with the help of an intensive participation process, which gave stakeholders the opportunity to be involved in the writing process and contribute to the content of the different institutions. Especially institutions operating on a national level included well organized participation processes. Stakeholders had the opportunity to be involved during the whole writing process. Each institution includes different responsibilities corresponding a specific sector or a specific governance level. The responsibilities described in the different institutions involved in the management of harbour porpoise conservation management lie within the corresponding authorities. Taking the above conclusions into account, it can be concluded that there is a fairly good social fit.

As an overall conclusion it can be said that there are aspects with a good institutional fit, but that some aspects need extra attention to obtain a good fit, especially regarding the ecological fit. Fragmentation causes the spread of the different conservation measures among a large number of institutions. Little attention is paid to the cumulative effects of all anthropogenic activities in the social-ecological system

of the North Sea on the harbour porpoise population. Improvements are needed to ensure a favourable future conservation status for the harbour porpoise population in the Dutch North Sea.

7. Discussion

7.1 Interpretation of research results

The busy North Sea is a challenging environment for the harbour porpoise. The increasing number of activities increases the pressure on the species. Efforts are made to decrease the pressure of the individual activities on the species by mitigating their effects, but none of the activities is ruled out in favour of harbour porpoise conservation. A study among European marine mammal conservation experts revealed that the cumulative effects of stressors is considered a top research priority to ensure suitable future conservation management. (IJsseldijk, ten Doeschate, Davison, Gröne, & Brownlow, 2018)

A wide variety of institutions is involved in harbour porpoise conservation in the Netherlands, with the most important being the Habitats Directive. The results of this thesis made clear that the Habitats Directive offers room for interpretation, which leads to different implementation levels of conservation measures and differences in assessment methods for the population assessment. This results in an incomplete and unreliable overview of the population status and uncertainties in future favourable population prospects because of variable conservation levels within one habitat.
Duimel, IJlstra & Siemensma (2019) support this institutional misfit in their report about future North Sea policies. Petursson, Vedeld & Vatn (2013) also concluded that transboundary cooperation is only possible if management structures and cultures are equal between countries. Even if the European culture is a Western culture, each Member States has their own political and management culture and their own political priorities. With policy structure like the Habitats Directive, this results in differences between policy application and implementation between Member States. An example of these differences is the way EU Member States deal with the guidelines for the population assessment performed under the Habitats Directive. The results of the Dutch population assessment led to a change of the population assessment from unfavourable-adequate to favourable. Adjacent Member States, Belgium and Germany, were less positive about the population status and maintained a less favourable status. This is remarkable regarding the fact that the environmental circumstances are almost equal in the waters of the three Member States. A well specified EU guideline that assesses the whole habitat of the harbour porpoise would fit more the species and the social-ecological system it is living in.
On the other hand, a tool like the Habitats Directive is suitable to implement general conservation measures on habitat level. All Member States within the habitat are involved and obligated to follow the directive guidelines. Moreover, the implementation of general conservation measures can be seen as a no regret measure that can be applicable regardless the environmental and/or economic situation in the area.
A positive result of this research is the cooperation between EU Member States within the working groups under the different governance networks. Governance networks like OSPAR and ASCOBANS work as a flywheel for European cetacean research and policy implementation. Above all, the strength of these networks is that it stimulates (informal) knowledge exchange between Member States. A remark on these governance networks is the long decision-making process for the provision of (transboundary) research funds and policy implementations on EU level, which means that research and pilot projects are always behind the times.

This study conceptualized institutional fit by using the social ecological system framework from Ostrom (2009). This involves a large number of variables in order to reach a most complete overview of the studied social-ecological system. This makes the framework very suitable for the assessment of the institutional fit of social-ecological systems and in particular a complex system as the Dutch North Sea. Other applied methods for the assessment of the institutional fit in marine or river basin ecosystems are the assessment of the seven governance principles by Lockwood (2010) (Turner, et al., 2014), the drivers-pressure-state-impacts-response (DPSIR) model (Guerrero, et al., 2021) and the use of expert

judgements (Lebel, et al., 2013). All named studies used the concept of institutional fit to measure governance performance in the context of the social-ecological system. Guerrero et al. (2021) emphasized that the necessity to identify the interactions between social and ecological factors in order to assess the institutional fit of complex social-ecological problems. The use of the social-ecological system framework of Ostrom (2009) in order to create a complete overview to assess the institutional fit according to dimensions of fit defined by Epstein, et al. (2015) as applied in this study complies with this advice.

Reaching a perfect institutional fit is unlikely to be successful because of the complexity of the social-ecological systems (Epstein, et al., 2015). Reaching a perfect institutional fit should not necessarily be a goal by itself, because of the large number of future uncertainties and the role of political decisions. Measuring institutional fit can be a tool to identify possible improvements to increase institutional success.
The global consumption and production rates aren't decreasing, despite decades of environmental awareness raising to prevent further environmental deterioration (Bengtsson, Alfredsson, Cohen, Lorek, & Schroeder, 2018). Ecologists and biologists try to link marine ecology and economy in order to decrease the trade-off between ecology and economy in the marine environment. The complicated interrelated importance of ecology, economy and society within marine ecosystems make it difficult to link ecology and economy (Lin, 2020) and hampers the realization of a good ecological as well as social fit. Within this thesis, this trade-off is also noted between the application of general and specific conservation measures and the application of flexible institutions to deal with quick environmental changes and stability in institutions to meet the wishes and needs of stakeholders and follow the policy cycles. Obtaining a good social fit does not automatically leads to a good ecological fit and vice versa. It is expected that a good social fit results in a higher level of support because of the inclusion of stakeholder participation, but this is not automatically key to reach a good ecological fit, as is seen back in the results of this thesis.

The constantly changing environmental circumstances and uncertain future climate prospects for the Dutch North Sea are challenging for the application of institutions. The results of this research made clear that the current institutional fit is not corresponding changing environmental circumstances because of the lack of adaptive characteristics. Folke (2006) supports this conclusion by stating that social-ecological systems that are prone to perturbations and dynamic changes ask for an adaptive governance approach to obtain a good institutional fit. Applying adaptive management in conservation issues can be challenging when uncertainties are observed. The ignorance of uncertainties when implementing adaptive management tools can lead to the dramatic decline of populations and ecosystem health (Memarzadeh & Boettiger, 2018). Obtaining a good institutional fit by applying an adaptive management approach is only possible if the social-ecological system is completely understood (Fabritius, Jokinen, & Cabeza, 2017). This is not yet the case for the social-ecological system of the harbour porpoise in the Dutch North Sea and it is questionable if we will ever be able to completely understand the whole system. A lot is still unknown about the species itself and their habitat preferences. It is still unknown what their favourite foraging grounds are, if the availability of prey species is sufficient and which habitat circumstances are preferable for reproduction success. This comes together with the uncertainties of climate change. Filling this knowledge gap is necessary to be able to apply an adaptive management approach.

7.2 Implications

The results of this thesis can help policy makers to adjust current and new policies to reach a good institutional fit for the harbour porpoise in this social-ecological system. The results make clear that the institutional fit cannot be obtained with efforts on a national level only. International adjustments of applicable policies are necessary to reach a good institutional fit on the habitat level of the harbour porpoise. Governance networks like OSPAR and ASCOBANS are good examples of initiatives to

encourage international cooperation on habitat level. Generic conservation measures, especially with a no-regret character, can be applied in the whole habitat in favour of the harbour porpoise. These generic measures require international coordination and implementation. It is not to be forgotten that regional differences make it necessary to include the possibility to adjust institutions to regional situations. This is not only applicable for ecological or economic differences, but also differences in governance styles can make it necessary to adjust existing or new policies to create a good institutional fit.

The results of this research are not only useful for the development of harbour porpoise conservation. Other highly migratory species can benefit from this research's conclusions, especially when their habitat is covering multiple European countries under the Habitats Directive. The aspects of a good institutional fit discussed in this research are not specific for the discussed species. These aspects are general for nature conservation issues and can therefore be applied to assess the institutional fit of other species than the harbour porpoise.
Several researches have been conducted on marine mammal governance. When looking specifically at studies about institutional fit, mainly the social fit or specific governance challenges like bycatch or plastic pollution are discussed, but the concept of institutional fit for the evaluation of cetacean governance is not found back in literature. For marine mammals, Robards & Lovecraft (2010) evaluated the institutional fit of co-management implementations for the conservation of the pacific walrus.

7.3 Reflection and recommendations for further research

This discussion revealed that more research is necessary to be able to apply the norms and rules that are necessary to reach a better institutional fit. A first recommendation for further research is therefore to focus on research that fills the knowledge gaps. As a next step, the involved institutions can be reviewed with the help of the results of this research. Together with the necessary knowledge, policy improvement on a national level can be implemented. On an international level, it is recommended to discuss the concept of institutional fit in the corresponding working groups of the governance networks, in order to decide what is necessary to improve the institutional fit of EU and international institutions for harbour porpoise conservation in the North Sea and therewith also the Netherlands.
One of the most frequently mentioned knowledge gaps is the wish to know more about the cumulative effects of anthropogenic activities in the social-ecological system of the North Sea. Scientists and NGO's emphasized that every new activity can be the proverbial straw that breaks the camel's back. It would be recommended to study the cumulative effects of anthropogenic activities on harbour porpoises in order to be able to formulate appropriate policy tools to ensure a favourable future conservation status.
Another recommendation for further research is to include a larger population of interviewees with a broader variety of backgrounds. For this research, stakeholders who are actively involved in harbour porpoise conservation in the Netherlands were interviewed. For further research it can be useful to include interviews with stakeholders who are less involved in Dutch harbour porpoise conservation but are aware of the situation and applicable institutions. Here it can be advised to involve researchers and policy makers from other Member States involved in the governance networks OSPAR and ASCOBANS. Involving interviewees who are less involved in the subject can give information about harbour porpoise conservation in a broader context than is researched for the purpose of this thesis.

Evaluating the applied research approach, the research was limited by the limited number of interviewees involved in this thesis research. A larger number of interviewees could be given more (in depth) insights and create an even broader perspective. All researched policy documents were available through open-source access, which made it possible to implement all necessary policy documents in this research.

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Appendix I: Visualisation of the activities in the Dutch North Sea

(Rijkswaterstaat, 2021)