Cumulative impact assessment of offshore windmill farms

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STUDENT REPORT

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Synopsis:

In Denmark, an expansion of the energy production from offshore windmill farms (OWFs) is planned. When several OWFs are under construction or in operation, the impacts from each might not be significant, but the cumulative impact of all these might. OWF projects have to undergo an environmental impact assessment, and as part hereof a cumulative impact assessment (CIA). These assessments should ensure the protection of the marine environment, but the practice of conducting CIAs is inadequate. This thesis evolves around the following research question: *How can the Danish practice of assessing cumulative impacts in environmental impact assessments for offshore windmill farms be improved?* Some of the influential problem areas are the conceptual understanding of CIA, and the identification of the relevant geographical and temporal scope. These are investigated through a literature review of international CIA practice and a case study of the current practice in Denmark and the United Kingdom (UK). The literature review presents specific problems and recommendations for *best practice*, these form a conceptual framework that is applied in the case study. It is investigated which of these are embedded in Danish and UK practice, and how they are influencing the current practice. Based on this, it is highlighted that to support and improve the Danish practice of conducting CIAs, it is relevant to develop standardised definitions of key concepts, and a step-wise practice-near guide for how to identify the relevant scope.

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Preface

This master thesis has been written between February 1^{st} and June 2^{nd} 2023, by students from the master's program Environmental Management and Sustainability Science at Aalborg University. An interest in promoting sustainability by protecting biodiversity and transitioning to renewable energy has formed the base of this thesis. The focus of the thesis is, how the Danish practice of assessing cumulative impacts from offshore windmill farms can be supported and improved, to protect the marine environment and ecosystems. The thesis is thereby intended as a contribution to the Danish society of environmental impact assessment, where the proposed recommendations and guidelines will hopefully support the future practice of conducting cumulative impacts assessments, and constitute a piece in the puzzle of protecting the offshore biodiversity and the marine environment.

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Style of reference

The Harvard reference system is used for referencing literature throughout this thesis. References will be presented in staples: [Surname(s) of the author(s), year]. In cases where there are more than two authors, only the surname of the first author will be written and then followed by *et. al.* When two or more publications written by the same author(s) and published in the same year are referenced, the references will be denoted *a, b, c*, etc. In cases where the year of publication is unknown, the year will be denoted *n.d.* (no date).

Abbreviations and prior clarification of terminology

Abbreviation	Definition
OWF	Offshore Windmill Farm
CIA	Cumulative Impact Assessment
CEA	Cumulative Effect Assessment
CI	Cumulative Impact
ZOI	Zone of Influence
DEA	Danish Energy Agency
EPA	Danish Environmental Protection Agency
EU	The European Union
UK	The United Kingdom
US	The United States
AyM	Awel y Môr
EA1N	East Anglia ONE north
KF	Kriegers Flak
VhS	Vesterhav Syd

The terms 'project', 'plan', and 'activity', are used when describing which aspects to include in a CIA. To simplify, the term 'actions' is used as an umbrella term that contains all three. The thesis will touch upon different concepts of CIA, where 'effect' and 'impact' are two of these. The terms can have the same or different meanings, and the terms are in some cases used interchangeably. The authors have decided to unify the use of the terms throughout this thesis, based on the following definitions:

- Effect: The pressure causing an impact
- Impact: The final change on a receptor

This means that in each text referenced, it is assessed how the terms are understood and used, and then aligned with the definitions used in this thesis. In this way, it is ensured that the meaning of the texts is not manipulated or misunderstood. This is however not done in the literature review and the case study related to the conceptual understanding, and the terms used will instead depend on the definitions provided by the respondents or found in the texts.

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Summary 1

Der er et øget fokus på klimaforandringer som medfører et skifte i temperatur og vejrforhold. For at modvirke klimaforandringerne, er der fokus på vedvarende energi, og i den forbindelse er der i Danmark planlagt en udvidelse af havvindmølleparker. Ved etablering af mange havvindmøller vil der opstå påvirkninger, som potentielt kan kumulere til at blive væsentlige. Der udarbejdes miljøkonsekvensvurderinger, og som en del heraf, foretages der en vurdering af kumulative påvirkninger hvor påvirkninger fra flere projekter, planer eller aktiviteter inkluderes i vurderingen. Udarbejdelse af en kumulativ vurdering er med til at sikre beskyttelse af det marine miljø og offshore biodiversitet. Den nuværende internationale praksis er beskrevet som utilstrækkelig og det påpeges at der er usikkerheder om hvordan praktikere skal tilgå og udarbejde den kumulative vurdering. Disse usikkerheder og udfordringer leder til en uens praksis. Nogle af de problematikker der er fundet på internationalt niveau, er usikkerheder i forhold til konceptforståelsen af kumulative vurderinger, hvilken tilgang der skal anvendes til at identificere den relevante tidsmæssige- og geografiske afgrænsning, samt manglende data til at udføre vurderingerne. Dette leder frem til følgende forskningsspørgsmål:

Hvordan kan den danske praksis for vurdering af kumulative påvirkninger, i miljøkonsekvensvurderinger for havvindmølleparker forbedres?

For at besvare dette forskningsspørgsmål er der udarbejdet to undersøgelsesspørgsmål. Det første fokuserer på hvordan den danske konceptforståelse af kumulative vurderinger kan forbedres og dermed understøtte den danske praksis. Det andet undersøgelsesspørgsmål omhandler forbedring af den danske praksis i forhold til at identificere den relevante tidsmæssige- og geografiske afgrænsning. Disse spørgsmål besvares med udgangspunkt i den videnskabsteoretiske retning kritisk realisme. En kritisk realist fokuserer på at identificere de underliggende og ikke-observerbare strukturer, som påvirker den virkelighed den enkelte ser. Det søges derfor, i denne rapport, at opnå en forståelse for de strukturer der influerer den nuværende praksis for kumulative vurdering. Spørgsmålene vil blive besvaret ved at anvende en induktiv og abduktiv tilgang. En induktiv tilgang anvendes til at fremhæve specifikke tendenser, der er fundet gennem observationer af litteraturens fund, udvalgte kumulative vurderinger og praktikeres forklaringer. Den abduktive tilgang er anvendt til at opnå en forståelse for de underliggende strukturer, som påvirker den nuværende praksis. De teorier der anvendes i denne opgave, omhandler hvordan praksis bliver skabt, og har fokus på, at der både er behov for strukturer og praktikere/agencies for at skabe praksis. Det påpeges, at strukturer er et vigtigt element af at skabe praksis, da det er disse strukturer som praktikere kan anvende og følge.

For at opnå viden om praksis for kumulative vurderinger, er der udarbejdet et litteraturstudie med fokus på den internationale praksis, hvor det undersøges hvilke problematikker litteraturen præsenterer og hvilke bud på *best practice* der kan medvirke til at forbedre praksis. Derudover er der udarbejdet et komparativt casestudie, hvor den danske og engelske praksis sammenlignes. Det undersøges om de problematikker og anbefalinger der er fundet gennem litteraturen, er gældende i disse praksisser. Som en del af casestudiet er der anvendt interview og dokumentanalyse for at opnå viden om den danske og engelske praksis. Der er udvalgt to kumulative vurderinger af havvindmølleparker i henholdsvis Danmark og England, hvor disse er analyseret for at opnå viden om de anvendte tilgange til at udarbejde en kumulativ vurdering. Derudover er der foretaget interviews med praktikere bag vurderingerne, samt foretaget yderligere fem interviews med eksperter og myndigheder. Det udarbejdede litteraturstudie danner en analyseramme for hvad der undersøges i casestudiet. Fokus er på om fundene fra litteraturen er gældende og stemmer overens med det der observeres i casestudiet. Derudover undersøges det hvad forskellen er på den danske og engelske praksis, og hvordan den enkelte praksis er påvirket af de strukturer der er til stede i den specifikke kontekst. Ved at sammenholde de forskellige fund, kan det udledes hvilke elementer og strukturer der mangler i Danmark, for at forbedre praksis.

I forhold til konceptforståelse, er det fundet i litteraturstudiet af den internationale praksis, at der er en del forskellige og ufyldestgørende definitioner, hvor der mangler definitioner af nøglebegreber, hvilket skaber rum for usikkerhed og fortolkning. Gennem casestudiet er det fundet, at disse problemstillinger er gældende i den danske praksis, men ikke i samme grad i den engelske, hvor praktikerne udtrykker en fælles og ensartet forståelse af hvad en kumulativ vurdering er og hvad den bør omfatte. Denne forskel kan forklares ved, at de anbefalinger der er fundet i litteraturstudiet, i høj grad allerede er implementeret i den engelske praksis, hvorimod de ikke er til stede i den danske. I England har de offentlige instanser publiceret vejledninger der indeholder definitioner af nøglekoncepter. Der er dog ikke umiddelbart en sammenfattende definition, der er mere detaljeret end de der er tilgængelige i en dansk kontekst. Det konkluderes derfor, at en omfattende standardiseret definition ikke er nødvendig for at understøtte praksis, men at det er tilstrækkeligt at der udvikles definitioner af nøglekoncepter, og at det defineres i hver vurdering hvilke termer der anvendes hvordan. I undersøgelsen af praksis for at identificere den relevante tidsmæssige og geografiske afgrænsning er det fundet, at praksis er uens grundet manglende afklaring af forventninger til omfang og indhold, samt at der ikke forelægger nogen ensrettet tilgang. Igen er det i casestudiet observeret at problemstillinger i højere grad er gældende i den danske- end den engelske praksis, og at dette skyldes at der i England er publiceret vejledning der indtænker størstedelen af de anbefalinger der er fundet i litteraturstudiet. I England er der eksempelvis en del sektor- og receptorspecifik vejledning, hvorimod der i Danmark ikke på nuværende tidspunkt er en praksisnær vejledning for hvordan den relevante afgrænsning findes. Baseret på fundene i litteraturstudiet og i casestudiet fremføres der bud på definitioner af nøglekoncepter, samt en trinvis tilgang til at identificere den relevante afgrænsning, og der præsenteres slutteligt et bud på en sammenfattende definition af hvad en kumulativ vurdering er og bør indbefatte.

Det kan derfor konkluderes, at for at understøtte og forbedre den danske praksis for at vurdere kumulative påvirkninger fra havvindmølleparker, er det relevant at udarbejde og implementere specifik praksisnær vejledning med eksempler, samt udarbejde standardiserede definitioner af nøglekoncepter der kan vejlede i forhold til hvilke elementer der skal indtænkes i vurderingen.

A Danish focus on offshore wind 2

There is an increasing focus on the climate crisis across nations because climate changes are occurring which implies long-term shifts in temperatures and weather patterns. Human activities have been the main driver of climate change since the 1800s, and the activity found to be the primary contributor is the burning of fuels, which generates greenhouse gas emissions and leads to rising temperatures [United Nations, 2022; IPCC, 2023]. It is relevant to prevent this rise in temperature since it can lead to e.g. droughts, hurricanes, and declining biodiversity [IPCC, 2023]. Focus has therefore shifted to providing energy through more sustainable measures [Nielsen, 2021], and there is an increasing focus on renewable energy and phasing out the use of fossil fuels. The Danish government enacted a law on the Promotion of Renewable Energy in 2008. A partial purpose of the law is to exploit energy from water and wind at sea [The Ministry of Climate, Energy and Utilities of Denmark, 2008]. In 2022 it was assessed that the Danish part of the North Sea has the potential to produce at least 35 GW offshore wind, which is 15 times as much as what was already installed in Denmark in 2022. By fulfilling the potential of offshore wind, Denmark will move towards achieving a green transition in the energy sector [The Ministry of Climate, Energy and Utilities of Denmark, 2022].

The planned rise of activities at sea entails a necessity for improved planning. Therefore Denmark and the rest of the countries within the European Union (EU) are developing maritime spatial plans [The Danish Maritime Authority, 2021]. The Danish Climate Act presents a goal to reduce the Danish CO_2 emissions by 70% before 2030 [The Danish Energy Agency, n.d.c]. The Danish maritime spatial plan seeks to support the fulfillment of this goal and presents that a way to achieve this reduction is to be among the most ambitious countries in Europe regarding offshore wind. This is underlined in the Danish Maritime Spatial Plan by the significant allocation of sea area to offshore windmill farms (OWF) [The Danish Maritime Authority, 2021]. Figure 2.1 illustrates which areas at sea are designated for renewable energy.

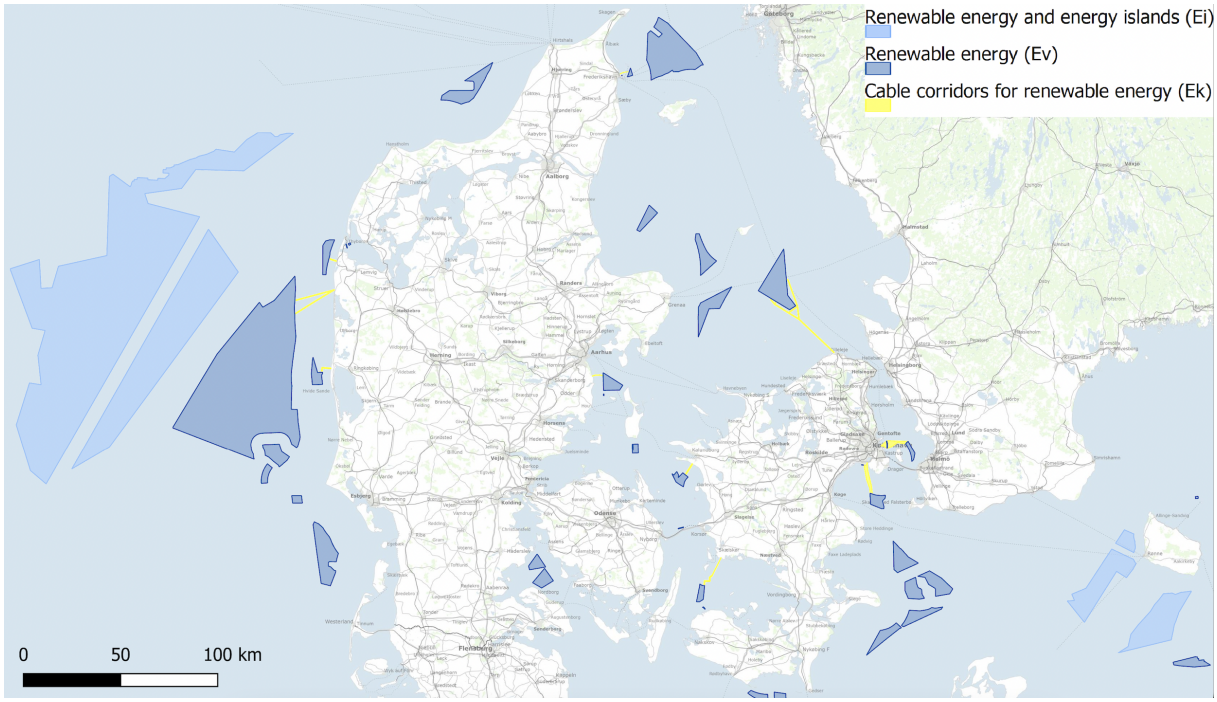

Figure 2.1. *Map of the areas designated for renewable energy. The map is created in QGIS by using data from The Danish Maritime Authority [2021].*

The Danish politicians are focusing on wind power and plan to use it to cover a larger amount of the Danish energy consumption [The Danish Maritime Authority, 2021]. At the moment Denmark has established 15 OWFs which equals a capacity of 2.9 GW. Additional 33 farms are in the pipeline, which can be argued to be a significant expansion compared to the existing quantity of OWFs [The Danish Energy Agency, n.d.b]. It is not only the Danish politicians who have a focus on expanding offshore wind. Other countries in Europe are also planning to establish more OWFs, to increase the production of renewable energy as a response to climate change [Busch et al., 2012].

The expansion of OWFs and other renewable energy developments, are human activities that can have an impact on the marine environment [Korpinen and Andersen, 2016] and therefore it is important not to disregard the emerging biodiversity crisis. It is stated by the The European Commission [2020a] that the: *"Biodiversity loss and ecosystem collapse are one of the biggest threats facing humanity in the next decade"*, therefore it is also necessary to focus on and mitigate the biodiversity crisis. OWFs can have an impact on biodiversity by causing collision risks, habitat loss, and barrier and displacement effects [Bennun et al., 2021]. There is a fundamental lack of knowledge regarding the negative and positive impacts of OWFs. As a result of the planned large-scale expansion, unforeseen cumulative impacts (CI) can occur and lead to changes in ocean currents, waves, and wind [The Ocean Institute, 2022]. The Ocean Institute [2022] states that knowledge about assessing CIs is missing and underlines it is a risk that a *"permanent construction phase will occur, where an impact that is normally temporary, such as underwater noise, can become permanent over a long period of years"* [The Ocean Institute, 2022]. It is therefore a necessity that CIs are considered when it comes to the planning and development of OWFs [Bennun et al., 2021; The Ocean Institute, 2022].

When project developers apply for establishing OWFs, the Danish Energy Agency is the authority responsible for the approval process [The Danish Energy Agency, n.d.a]. When the decision-making is related to long-term societal considerations and a weighing of different interests, it is necessary to base it on analyses and assessments. A tool that can be used for analyses and assessments of impacts on people and environment, is environmental impact assessment (EIA) [Kørnøv et al., 2017]. EIA can therefore be used to assess the impacts of OWFs on the marine environment. EIA as a tool for decision-making will be further presented in the following chapter.

EIA as a tool to ensure environmental protection 3

This chapter will shortly outline what an EIA is and how it is a tool that supports decision-making. An assessment of CIs is a required part of the EIA process [The Ministry of Environment of Denmark, 2023; The Ministry of Environment and Food of Denmark, 2018], and by some perceived as the assessment that unravels the *true extent* of the impacts [Nelson and Shirley, 2022; Caine, 2019; Masden et al., 2010]. Given the planned expansion of OWFs in Denmark and the fact that more stressors will appear in the marine environment in the future, the assessment of a project's cumulative impacts is becoming more relevant in relation to ensuring that negative impacts are not overlooked in the approval process [Caine, 2019; Kørnøv et al., 2017]. It will therefore be outlined how an assessment of CI can qualify the approval process of OWF projects and thereby contribute to protecting the environment. Furthermore, problem areas related to the current practice of assessing CI will be investigated, in order to map improvement potentials.

OWF projects have to undergo an EIA because they are covered by Appendix 2 section 3J in the Danish law of EIA. The object clause of the law, states that: *"The purpose of the law is to ensure a high level of environmental protection and contribute to the integration of environmental considerations (...) when projects are given a permit (...)."* [The Ministry of Environment of Denmark, 2023]. EIA is a systematic process that is used to predict and assess the environmental consequences of suggested projects. The EIA will thereby ensure that the environment is protected by including environmental considerations in the decision-making process. By providing knowledge of a given project's impacts on the environment, the EIA contributes to increased transparency in regard to consequences and thereby ensures a higher level of environmental protection [Kørnøv et al., 2017].

The report of the EIA must contain a description and an assessment of the project's expected significant impacts. The assessment should cover the project's direct impacts, and if required, the indirect, cumulative, secondary, transboundary, short-, medium-, and long-term, temporary or continuous, and negative or positive impacts [The Ministry of Environment and Food of Denmark, 2018]. In a broad study of EIA practice, Morgan [2012] states that when comparing the different aspects of an EIA, the practice of assessing CIs is not as developed as other aspects. According to Bailey et al. [2010], the need to assess CIs increases as the size and number of OWF projects increase. This is because an increased amount of implemented and proposed projects lead to increased pressure on the environment, and the CIs thereby become a more prominent issue [Masden et al., 2010; Caine, 2019]. The assessments in the EIAs are based on guidance documents, legislation, declarations, or directives related to the specific subjects - examples of such are the Habitat directive, the Water framework directive, and Denmark's maritime spatial plan [The Ministry of Environment and Food of Denmark, 2018]. Some of these set up specific

limits which the impacts are assessed against, while others do not and the assessments become more qualitative and subjective. Few provide definitions of CI or guidance in terms of methods that can be applied when conducting a cumulative impact assessment (CIA). This makes it difficult to know whether the assessments are conducted properly because the regulatory frame is uncertain [Masden et al., 2010]. In the Danish law of EIA, the content requirements are specified in Appendix 7, 5e, where it is stated that *"the cumulation of the project's effects with other existing and/or approved projects (...)"* must be included in the EIA [The Ministry of Environment of Denmark, 2023]. When the EIA Directive was adopted, EU published a guide for the preparation of an EIA report. This guidance focuses on the importance of assessing CIs and states that: *"Cumulative effects can occur at different temporal and spatial scales. The spatial scale can be local, regional, or global, while the frequency or temporal scale includes past, present, and future impacts on a specific environment or region"* [European Union, 2017]. There is no explanation or further guidance on how to work with these elements in practice, it is simply stated that they must be included in the CIA. In Denmark, no final guidelines have been adopted for the assessment of projects nor for plans, and programs. Drafts have been prepared, and in the draft for EIA, it is mentioned that CIs must be assessed, where it is stated that *"both the project developer's and the municipality's/other authorities' information about other activities in the area, that can describe the total impact on the environment in the area and on the project, must be included. This means that there can be one or more cumulative impacts with other projects which must be described"*, but it contains no further guidance or examples on how the CIA should be conducted [The Ministry of Environment and Food of Denmark, 2018]. The Danish guide is more a guide on how to understand the law, than a practice-oriented guide that can support the conduction of assessments.

Besides being described as underdeveloped, the practice of assessing CIs is described as complex, challenging, inconsistent, uncertain, unfulfilling, and insufficient [Willsteed et al., 2017; Duinker and Greig, 2006; Morgan, 2012; Durning and Broderick, 2015; Masden et al., 2010; Durning and Broderick, 2019; Caine, 2019]. This indicates that it is relevant to investigate how the practice of assessing CIs can be supported to ensure complete assessments, a fulfilling knowledge foundation for qualified decision-making, and that environmental protection is ensured. In the following, it will be investigated why the current practice is insufficient and thereby which potentials for improvement exist.

3.1 Supporting decision-making and ensuring environmental protection

Each project has an impact on the environment, but the CIs of multiple projects can be greater than those of the individual project [Masden et al., 2010; Durning and Broderick, 2019]. It is highlighted in an assessment of the general CIA practice, that the assessment of the direct impacts is the common approach in EIAs, where isolated impacts are assessed from a single source - e.g. the impact on birds from a specific OWF project. This approach is criticised because the project and its impacts are not isolated in the real world. It is therefore argued that the common approach can lead to a misguiding knowledge foundation, and thereby compromise the validity of EIA as a tool that supports decision-making since the actual impacts are not being assessed [Nelson and Shirley, 2022; Willsteed et al., 2018]. CIs are impacts resulting from the

project and reasonably foreseeable, present, or past actions [Hyder, 1999]. The CIA is perceived as essential for sensitive species which have limited capacity to change, and if a permit is given based on an inaccurate assessment of the cumulative impacts, it can lead to fatal consequences [Caine, 2019].

The purpose of assessing a project's CIs is *"to provide decision-makers with sufficient information to support consenting decisions which ensure the sustainable development of marine spaces in parallel with conservation of the receptors considered"* [Hague et al., 2022]. The output of such an assessment is therefore knowledge that informs the decision-makers and ensures that impacts are not overlooked and that the accumulation of impacts is thereby not causing irreversible negative effects [Hague et al., 2022; Masden et al., 2010; Caine, 2019; Busch et al., 2012]. King et al. [2009] present that a review of EIAs for OWFs has shown that the approach chosen to conduct the CIAs differs from assessment to assessment, and that the assessments are more often qualitative than quantitative. According to Masden et al. [2010] the assessments of receptors are oftentimes qualitative when threshold limits are not defined.

The assessment of CIs is not easy, and it is described as a complex task [Durning and Broderick, 2019]. If the assessments of the potential CIs are inadequately conducted, it is a risk that impacts are significantly underestimated. Decisions based on incomplete knowledge of CIs can thereby lead to unforeseen significant cumulative impact levels and irreversible consequences for species [Hague et al., 2022; Caine, 2019]. According to Masden et al. [2010] the unsatisfying practice of assessing CIs is common across Europe and in Northern America. This is not a new discovery because the general practice of assessing CIs was already given attention in the 1990s, where Canter and Kamath [1995] highlighted that only a few assessments were conducted due to confusion of geographical and temporal scope, lack of methodologies, and absence of a sufficient definition. These problem areas are still present and are identified as issues that are influential for the quality of the assessments [Ryan et al., 2019].

3.2 Conceptual challenges

It is indicated in literature that there are many different definitions of what CIs are and what should be taken into consideration in the assessments [Kirkfeldt et al., 2016; Blakley and Russell, 2022; Foley et al., 2017; Wärnbäck and Hilding-Rydevik, 2008; Durning and Broderick, 2015]. The concept of CI covers a wide spectrum of understandings and definitions, and definitions contain different interpretations and approaches to working with CIs [Willsteed et al., 2017]. Furthermore, there is no definition of CIs that is accepted across countries and sectors, and their practices [Wärnbäck and Hilding-Rydevik, 2008].

A reason why problems and misunderstandings can arise when conducting CIAs is that it is a problem that uncertainty and ambiguity are created by the definitions due to different meanings of words and sentences when they are translated into different languages. The words can also take on a new meaning over time or have different meanings within the concerned subject areas. If a standardised definition that applies across countries is formulated, it can support practice and reduce uncertainty and ambiguity [Masden et al., 2010].

3.3 Methodological challenges

An aspect influencing the quality of the assessments is the varying practice of conducting CIAs. It is highlighted by Hague et al. [2022] that the current practice is fragmented and non-uniform, and that the marine environment can not be sustainably managed as long as assessments do not meet the same standard. It is questioned whether CIAs have resulted in a homogeneous sustainable development across industries and waters when the approaches applied are inhomogeneous [Hague et al., 2022]. CIAs are increasingly conducted as part of the EIA process for OWFs but the quality of these has been presented as inadequate [Masden et al., 2010].

One of the key challenges to conducting a sufficient CIA is to choose the appropriate scope both temporally and geographically [Hague et al., 2022; Therivel and Ross, 2007; Canter and Kamath, 1995]. The outcome of a CIA is dependent on the chosen scope, and the clarification of geographical- and temporal scope is a fundamental part of the CIA [Brignon et al., 2022]. According to Ryan et al. [2019] EIAs are criticised for not being able to adequately consider the scope of impacts. It is a difficult but important task to define the proper scope of a CIA since an improper delimitation can set limits for an analysis and affect the conclusions. According to Masden et al. [2010] the CIAs are ineffective and unfulfilling because guidance is currently missing. There is a lack of knowledge about how to conduct CIAs amongst practitioners, and specific instructions and guidance in relation to conceptual understanding, best practice, and methods are needed [Kirkfeldt et al., 2016; Blakley and Russell, 2022]. Furthermore, it is highlighted that it is necessary that requirements are clarified by statutory authorities [Masden et al., 2010; Blakley and Russell, 2022]. These findings indicate a need for guidance on how to define the proper scope of a CIA, in order to ensure that the conducted assessments are adequate and able to ensure environmental protection.

3.4 Unstandardised practice of identifying the baseline

Another aspect influencing the outcome of a CIA is the baseline [Masden et al., 2010; Willsteed et al., 2018; Foley et al., 2017; Canter and Kamath, 1995]. When there is no standard baseline measure for a receptor, historical data is sometimes left out of the assessment and the baseline is defined as the time of the assessment instead. Masden et al. [2010] call this the 'shifting baselines syndrome' and states that it can lead to degradation of the specific receptor over time. It is stated that it should be questioned whether the current state forms a proper baseline [Masden et al., 2010]. When baselines are based on current conditions, the baseline continuously becomes a more impacted state because the impacts of prior activities are disregarded and perceived as part of the baseline state [Duinker and Greig, 2006; Foley et al., 2017]. According to Foley et al. [2017] this means that CIAs are not able to prevent a gradual ecological loss, because a standard for how to define a baseline does not exist. According to Foley et al. [2017], historical data should constitute the baseline. A historical baseline can both be defined as the *"time when resources were most abundant or unaffected by human activities, or to a time when ecosystem conditions were consistent with management goals"*. Masden et al. [2010] refer to the baseline as a representation of the unaffected environment. These findings indicate that more guidance on how to determine the baseline is needed, and defining a common approach is crucial according to Willsteed et al. [2018].

Even though the literature states that the baseline should be historical, most of the CIAs assessed by Foley et al. [2017] present the current state as the baseline. This can partly be a explained by the fact that adequate time-series data is rarely available for determining a historical baseline [Masden et al., 2010]. These data limitations make the task of identifying the baseline an even more challenging and complex task for the practitioners to solve [Foley et al., 2017]. Furthermore, the data that is available can originate from different sources and thereby be inconsistent and difficult to compare [Canter and Kamath, 1995; King et al., 2009].

3.5 Lack of data and knowledge

It is a shared opinion amongst practitioners that there is a lack of data that can be used to conduct CIAs [Foley et al., 2017; Masden et al., 2010; Blakley and Russell, 2022]. In the end, low data availability can ultimately have an influence on the quality of assessments [Ryan et al., 2019], and the CIAs can become uncertain [Foley et al., 2017]. The availability of essential data is pivotal, but practitioners state that they find it difficult to obtain data and knowledge that can form the basis for an adequate assessment. Masden et al. [2010] state that *"there is a discrepancy between the data required for a comprehensive CIA, and that which is available"*. It is a widespread problem, and due to the lack of data, it can be difficult to ensure the best conditions for the environment [Masden et al., 2010]. Human activities such as OWFs affect multiple species and environmental conditions. It is a risk that potential sources of disturbance are scoped out of the CIA because there is no knowledge about the specific area and there is no knowledge or data indicating whether OWFs might have an impact on various elements in the marine environment. In addition, it is a risk that an impact is assessed as insignificant due to missing data, which will have consequences for the environment [Hague et al., 2022].

3.6 Summarising the problems

Figure 3.1 summarises the found problems influencing the quality of CIAs. The problems are illustrated as individual aspects but in reality, some are related and overlapping. As an example the problems related to determining the proper scope are influenced by a lack of data, guidance, and statutory clarification of requirements.

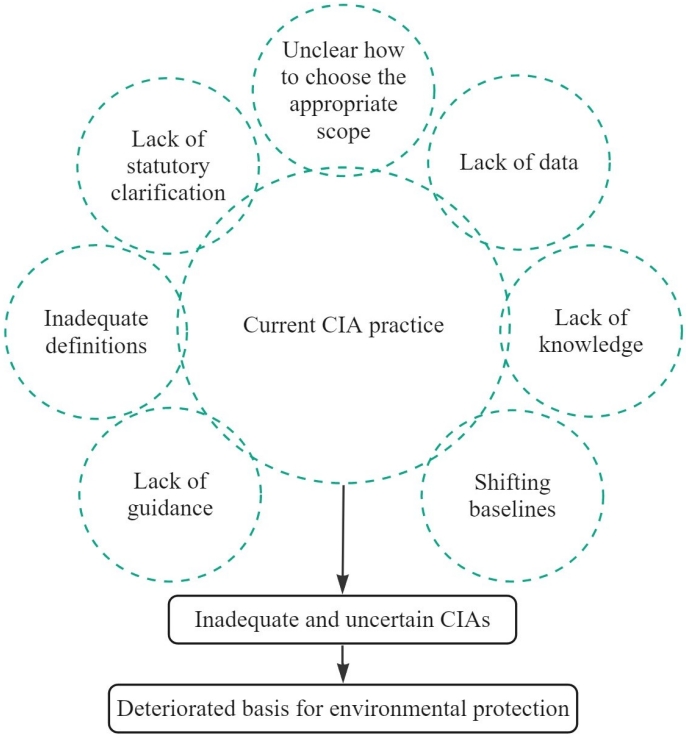

Figure 3.1. *The challenges influencing the current CIA practice.*

The current practice of CIA is not able to fully support decision-making and thereby ensure environmental protection [Hague et al., 2022; Masden et al., 2010; Nelson and Shirley, 2022; Busch et al., 2012; Caine, 2019; Ryan et al., 2019]. Several reasons for the currently inadequate and inconsistent practice are found. These are related to conceptual challenges, methodological challenges, and challenges with data availability. It is found that the needed data is not always available to the practitioners [Kirkfeldt et al., 2016; Korpinen and Andersen, 2016; Foley et al., 2017; Masden et al., 2010]. The determination of a proper baseline is also found to be inconsistent, both due to lack of guidance and clarification of statutory expectation, but also due to lack of appropriate data to define a historical baseline [Willsteed et al., 2017; Foley et al., 2017; Duinker and Greig, 2006; Masden et al., 2010]. It appears that there currently is no clear definition applied by all practitioners, this is highlighted as an aspect that makes the CIAs inconsistent [Foley et al., 2017; Masden et al., 2010; Blakley and Russell, 2022; Kirkfeldt et al., 2016]. Another aspect influencing the inconsistency of the CIAs, is the lack of guidance in terms of temporal and geographical scope [Hague et al., 2022; Blakley and Russell, 2022; Masden et al., 2010; Brignon et al., 2022; Ryan et al., 2019].

Without a clear definition, it is a challenge to make clear and sufficient assessments that contain all relevant aspects. Without a standardised, guided, and consistent CIA approach, it can be challenging for practitioners and developers to find the right approach and solution in the work of protecting the marine environment through CIA. Uncertainty in assessments makes it even more difficult to maintain a high level of protection, as it is a challenge for decision-makers to decide correctly without a fully informed knowledge base [Blakley and Russell, 2022; Willsteed et al., 2017].

Delimitation and research question 4

It is evident that there currently is no Danish guidance that can support and guide the practice of conducting CIAs. The guidance that is available does not provide any practice-oriented guidelines nor any examples of *best practice*. It is further found that several problems related to the assessment of cumulative impacts are present, where some can be argued to rise from the lack of guidance on how to conduct CIAs. Lack of data is acknowledged as an important barrier because it is needed to conduct assessments. But the data-related problems are perceived as rather technical to solve and would require specific biological knowledge and more resources than what is accessible in this master thesis. The data-related problems will therefore not be further investigated in this thesis. Current practice is also found to be influenced by uncertainty related to defining and understanding the concepts of CIA, and to identifying the relevant geographical and temporal scope. There are different definitions of the concept CI, and the definitions can be perceived in different ways due to language barriers, differing interpretations, and wording. Without a clear and distinct definition to guide practice, it can be difficult to navigate what should be included in the assessments of CI. This entails that it can be difficult to conduct adequate assessments where it is ensured that all relevant aspects are included. Another challenge is related to identifying the appropriate temporal and geographical scope. It is found that there is uncertainty amongst practitioners in terms of how to identify the appropriate temporal and geographical scope for the assessments. These two problem areas are perceived as important to overcome since the protection of the marine environment can be compromised if the CIAs for OWFs are not sufficient. Given the planned expansion of OWFs in Denmark it is also perceived as more important than ever, to support the Danish CIA practice. It is thereby relevant to investigate how practice can be improved. This thesis will therefore be investigating how the problems related to determining scope can be supported by developing generic guidelines, and what a definition should contain to guide practice. This leads to the following research question and appertaining sub-research questions:

How can the Danish practice of assessing cumulative impacts in environmental impact assessments for offshore windmill farms be improved?

- *How can the current Danish understanding of the concepts of CIA be improved in order to support the Danish CIA practice?*
- *How can the current Danish practice of identifying the relevant geographical and temporal scope for assessing CIs be enhanced?*

Research design and methods 5

In this chapter, the research design for this thesis and the underlying theory of science will be presented. Furthermore, relevant theories will be presented, along with the case design and the applied methods. The research design is illustrated on figure 5.1, where the approach to answering the sub-research questions and the research question is presented.

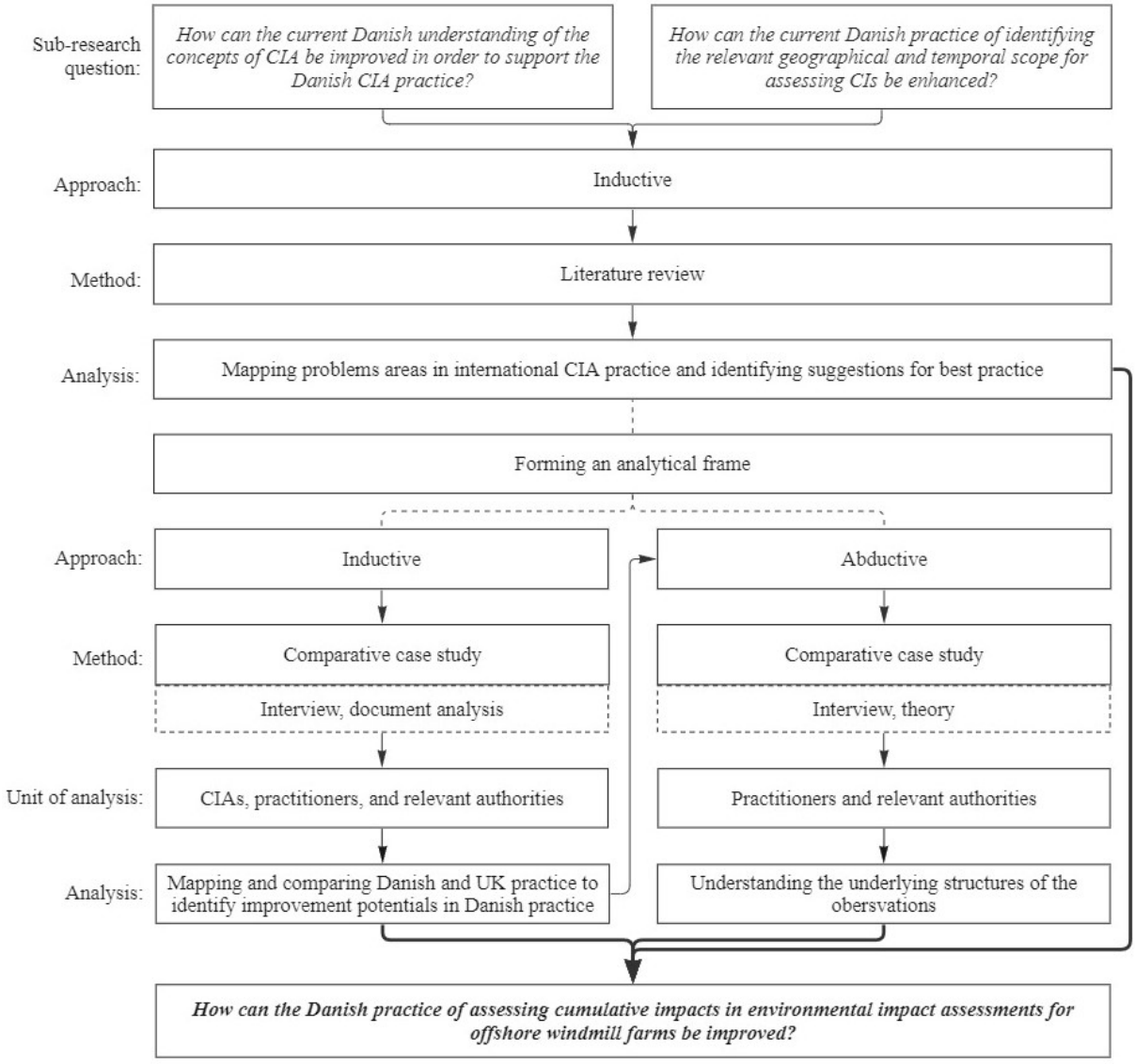

Figure 5.1. *Research design for this thesis.*

The purpose of the sub-research questions

The purpose of the first sub-research question is to investigate the current status and problem areas of conceptual understanding and analyse how the practitioners' current understanding of the concepts of CIA can be improved to support their practice of conducting CIAs. Based on the analyses, recommendations for definitions of key concepts are presented. The purpose of the second question is to uncover problem areas and improvement potentials by identifying the relevant geographical and temporal scope. Taking point of departure in the findings of the literature review and the case study, it will be investigated how current practice can be supported by developing recommendations and presenting practice-oriented guidance for how to identify the relevant scope.

The chosen approach

As illustrated on figure 5.1, the same overall approach is used to answer both sub-research questions. Both an inductive and an abductive approach are used to examine the problem area. When working with an inductive approach, the specific examples form the base of the analysis, and general tendencies are presented based on these [Plowright, 2015]. The inductive approach is thereby used to draw up specific tendencies from observations of literature, CIAs, and practitioners' current work, which is then used to present general rules about the current international practice, Danish practice, and the practice of the United Kingdom (UK), in terms of conducting CIAs. When working abductively, the underlying causes of the trends and rules are sought to be explained and understood [Plowright, 2015]. The abductive approach is thereby used to gain an understanding of the underlying structures influencing the current CIA practice and present hypotheses, qualified guesses, that can explain the current practice.

To gain a broad insight into the current international practice of defining the concepts of CIA, and identifying the relevant temporal and geographical scope for a CIA, a literature review focusing on current practice, problem areas, and recommendations is conducted. The literature review is a continuation of the problem areas mapped in chapter 3, and problem areas, appertaining consequences, current practice, and recommendations for *best practice* are further mapped. The literature review forms the base of the analysis and an analytical framework arises from the findings of the international CIA practice. The analytical framework thereby guides the following comparative case study of Danish and UK practice, and it is investigated whether the literary findings are present in respectively Danish and UK practice of conducting CIAs. The case study will provide an understanding of the current Danish and UK practices, the underlying aspects of the practices, and illustrate whether and why there is a difference between the two practices. By comparing UK and Danish practice, and whether the problem areas and recommendations found in the literature review are present in the current practices, improvement potentials of the Danish practice will be put forth. The chosen theories are further applied to explain and understand how current practice has been formed, and how guidance should be created to be able to influence practice and become an embedded part hereof. Recommendations for how to support the Danish practice of defining and understanding the concepts of CIA, will be presented based on the findings of the literature review and the case study.

5.1 Theory of science

There are different scientific theoretical directions, describing what science is and should be. The theories of science build on different understandings of the true nature of the world (ontology), and different ways to acknowledge and perceive the world - meaning how to gather knowledge (epistemology). The theories of science thereby evolves around how to create knowledge through science, and what kind of knowledge science is able to provide [Juul and Pedersen, 2014].

Given that this thesis investigates how the current practice of conducting CIAs is constructed and how it can be improved, the thesis takes point of departure in *critical realism*. As a critical realist, it is acknowledged that the world has an objective existence that is independent of any conviction of it [Buch-Hansen and Nielsen, 2014]. Critical realists further acknowledge that reality consists of more than the observed reality, meaning that there are deeper dimensions that can not simply be observed. The critical realist strives to identify the underlying and unobserved structures that are influencing the observed reality, and the goal of a critical realist is therefore to uncover the connection between an action and underlying structures that makes this happen. When analysing the connections, there is awareness of how the authors' view of the world and current standpoint influences the research and analyses [Egholm, 2014].

With point of departure in critical realism, this thesis seeks to observe the current practice of conducting CIA, and explain this by understanding the underlying mechanisms influencing practice. It is thereby the connection between the two dimensions that is investigated, in order to understand the current state of practice. The findings of the literature review and case study are critically examined, and it is investigated why the findings are present.

5.2 Theory

Theory is used to describe and explain a phenomenon, as well as to describe the parameters and factors that are part of a relation [Boess, 2023]. When applying theory, a certain perspective is used to explain the phenomenon being investigated. The theory can be a tool to guide and inform the research process, and when a theory is used, it is important to be aware that the investigation is conducted with a specific mindset [Williamson, 2002]. In this thesis, the phenomenon being investigated is both the current practice and suggestions for future *best practice* of CIA in relation to the understanding of the concepts of CIA and the approach to determining the geographical and temporal scope. Institutional theory, Practice theory, and theory about structure and agency will be presented and it will be elaborated how these theories relate to and play a role in the practice of CIA. Additionally, focus will be on how to conceptualise best practice in this thesis.

Institutional theory, Practice theory, and structure and agency

Mahoney and Thelen [2021] present institutions as *"features of political and social life (rules, norms, procedures) that structure behavior and that cannot be changed easily or instantaneously"*. March and Olsen [1983] state that the behavior of individuals is constrained by social and cultural norms. This can be applied to the Danish CIA practice. If there are existing guidelines and legal requirements, the practice will follow these. In addition, it can also be applied to practice that has been formed over several years, where practice is constrained by habits and experiences that are likely to be fixed in the way practitioners work and assess. By examining practice and the

institutions behind practice, it may be possible to gain an insight into which parts of EIA practice are in focus, and which have not been given much attention. The underlying motives behind the current guidance, and the requirements presented in the law, of what the CIA must contain, are the institutional background that is important for practice.

Johnson [2008] theorises human agency, and states that agencies and structures define and create practice. Structures cover the applicable rules and the resources that are present. Agencies are defined similarly by Nicolini [2012] and Johnson [2008], as individuals trying to satisfy their needs and achieve their goals. The agency consists of *"active agents whose knowledge and abilities are employed constantly in the ongoing production and reproduction of the social world"* [Nicolini, 2012], this means that the practitioners are an essential part of creating and shaping practice. This is further emphasised by Zhanga et al. [2018], stating that *"practitioners contribute to decision-making in arenas where they can use their discretionary powers"*. It is elaborated that practitioners make a series of decisions when working with the EIA. Practitioners influence practice with their professional judgments and expertise and are either conscious or unconscious of the choices they make in practice, and how they affect practice. They assess which guidelines should be used, which factors should be the focus, and which approach to use to conduct the assessment, and thereby they automatically contribute to creating practice [Zhanga et al., 2018]. The structures that practitioners follow can be rules, guidance, and legislation. An aspect contained in this theory is that the structures are not carried out in reality and practice if individuals do not use them in practice. This means that it is important to have practitioners who can contribute to creating, shaping, and implementing the final practice [Johnson, 2008].

Practice theory is built on the belief that human behavior is shaped on the basis of the structures that are present. In addition, practice theory focuses on the concept of agency, where agency is individuals' capacity and resources to fulfill their potential. It is the agent's/individual's responsibility to use their capacity to seek to fulfill the given structures [Nicolini, 2012]. This indicates that the output seen in CIAs, is prepared on the basis of individuals' thoughts and cooperation between practitioners. The practitioners strive to fulfill the structures they have been given, through e.g. legislation and guidance. The Danish legislation is based on the EIA Directive from the European Commission. As a result of the law, the Ministry of the Environment has prepared a draft of a guidance document for projects, and plans, and programmes. The directive, the law, and the drafts of the guidance documents are what practitioners can follow when conducting an EIA and CIA. The member countries of the EU prepare legislation and guidance themselves and therefore different practices may arise. Practice theory points out that the introduction of guidance documents does not necessarily mean that practice is then shaped according to these documents. It will only be part of practice if practitioners use the guidance, and thereby practitioners are perceived as a necessity for implementing a practice. The practice is formed by practitioners sharing their skills, knowledge, and practical concerns, as this is when practice is implemented in the process of conducting e.g. a CIA. Thus, according to Durning and Broderick [2019], practice depends on whether there are practitioners who take responsibility. Practitioners use guidance if it is found suitable, meaning that in order to create a practice and obtain results, the guidance needs to be developed by applying the practitioners' current knowledge and experience. Cashmore et al. [2015] further emphasise that practice is not just what is given in guidance documents but is dependent on the practitioners, and that: *"guidance may be reinterpreted, used selectively, and ignored in contested fields of practice (...). We do not*

expect, therefore, that the virtual expert practitioners in guidance will be replicated in practice" [Cashmore et al., 2015].

Conceptualising *best practice*

There are many examples of what best practice is. Best practice can illustrate what should be aimed for in practice and be a motivational element for actors, pushing them to improve the way they act. This means that practice will be improved, and thus better results can be achieved, and potentially meet the statutory demands more successfully. Morgan [2017] states that best practice can be defined by the government, trade organisations, specialists, researchers, and so on. Best practice is suggestions on how a current practice or task should be handled. The importance of developing best practice criteria is that they can be used by the relevant actors. When best practice is defined it is based on choices made by certain people, and this is a very important note because it will vary according to who is defining the criteria. When defining the best practice, it is important to be aware of what the purpose is; why produce best practice criteria? who are the criteria intended for? In the end, it is important that the *"practices that are identified as 'best' emerge from a process of nomination, evaluation, and selection that reflects judgments about their real or imputed effectiveness, about their usability, and about how beneficial it would be for others to emulate, adapt, and implement them"* [Morgan, 2017]. The purpose of defining best practice is to improve the assessment of CIs, which is more important than ever, given the planned expansion of offshore wind in Denmark. The planned expansion brings forth a need for more comprehensive assessments to protect the marine environment in the best possible way. In this thesis best practice is defined based on the findings in the literature and through a comparative case study. Both scientific articles and guiding documents are included in the literature, where the articles contribute to academic critical literature and the guidelines provide suggested solutions to practitioners. Best practice is defined by analysing and critically evaluating literature, and comparing the findings with the Danish and UK practice, to assess whether these are present or not, and whether they are perceived as best practice by practitioners and authorities. If there is alignment between the literature review and the case study as to whether the aspects are realistic, requested, and effectful, then these are defined as best practice. It is further investigated whether it appears to be possible to introduce best practice in the Danish practice, which is highlighted as an important aspect by Morgan [2017].

By using literature, interviews, and CIAs, guidance and recommendations are prepared for how the concepts of CIA ought to be defined, as well as how the relevant temporal and geographical scope must be identified. By creating guidance, the authors behind this thesis strive to influence practice. The guidance can become part of the structures and thereby become something practitioners can follow and incorporate into their workflow and practice. But it is acknowledged as important and a necessity that practitioners adapt and use this guidance since it will otherwise not be incorporated into practice. It is a great responsibility to suggest best practice as there currently is a large expansion of offshore wind and a window of opportunity for influencing practice since practitioners are currently requesting clarification as to how CIAs ought to be conducted.

5.3 Case design

In this thesis, a comparative, embedded multiple-case study has been conducted. Several units of analysis are investigated and by using this approach it is possible to use both qualitative and quantitative methods to generate data. In this thesis, only qualitative data methods in the form of interviews, document analysis, and literature review, have been used. When an embedded approach is used, the focus is on organising and integrating knowledge from the various units in the case, which contributes to creating an understanding of what is happening. The embedded approach is used because several aspects of the CIA practice have been analysed. The selected case is perceived as an average case, since the aim is to analyse typical projects selected amongst many equal projects and to deduce a general trend and development from these. It is stated by Yin [2009] that a multiple-case study is considered more compelling because multiple aspects are investigated. The chosen case study is a multiple case study since two contexts are investigated - OWF projects in Denmark and UK, which is illustrated in figure 5.2.

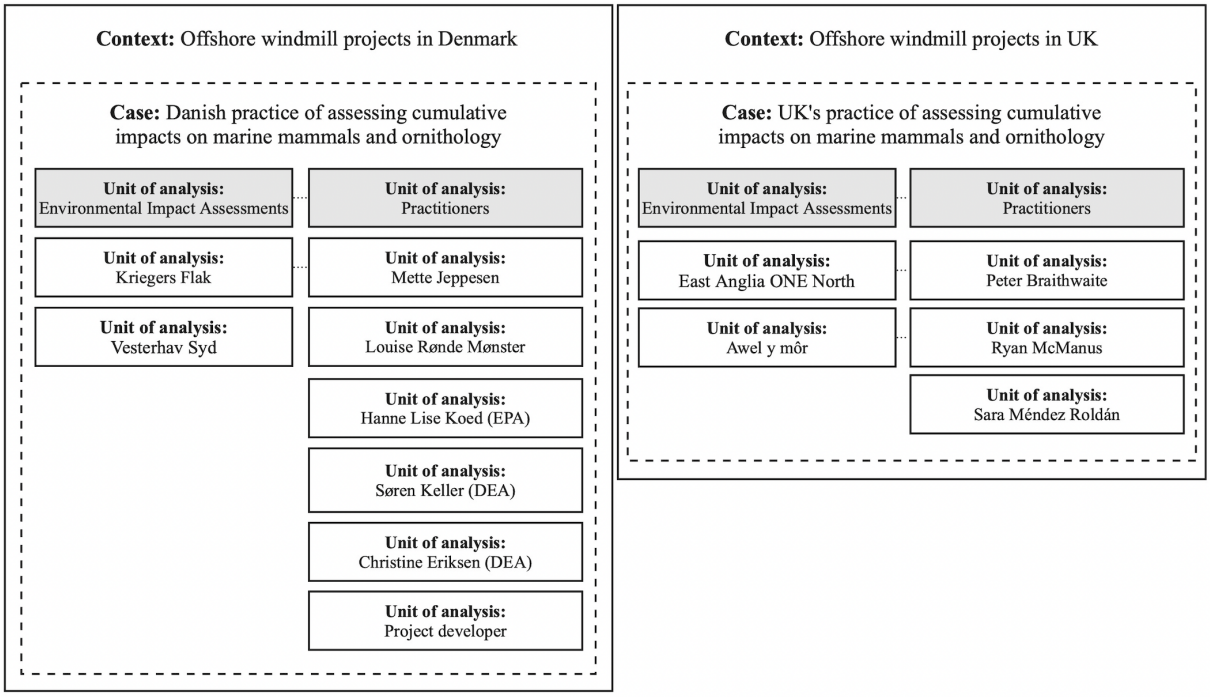

Figure 5.2. *Comparative, multiple case study.*

The case study is comparative because the Danish and UK practices will be compared. It is chosen to compare the Danish practice with the UK practice because practice is more developed in the UK, given that more CIAs have been conducted during the past years. To compare practices, Denmark has a total of 15 operational OWFs equivalent to 2,9 GW [Danish Energy Agency, 2023], whereas the UK has 38 OWFs equivalent to 10 GW [UK Department for Business and Trade, 2023]. This indicates that UK practitioners have more experience with CIAs of OWFs, than Danish practitioners, and there could potentially be a learning potential. It is further found, that the UK practice is more supported by guidance about the assessment of CIs in general and in regard to OWFs specifically. Through the case study, knowledge about the CIA practices in Denmark and UK will be obtained. Knowledge will be acquired about how practitioners

currently work and why, and how they think practice should be - both in terms of how CIA should be defined and how to prepare the most adequate temporal and geographical.

The contexts and cases are interconnected because when establishing OWFs there must be conducted an EIA and as part hereof a CIA. To investigate the two cases, different units of analysis are included. In the Danish case, two CIAs, two consultants, three representatives of two statutory authorities, and two representatives of a project developer are included. In the UK case, two CIAs and three consultants are included. The units of analysis - the CIAs and practitioners - are interconnected since some of the interviewed practitioners have worked on the included CIAs, and will thereby elaborate and clarify why and how things have been done. Other practitioners and authorities are working closely with CIAs, and their thoughts and experience are representations of the current practice. It is thereby presumed that the practitioners' and authorities' experience and the findings of the CIAs, can provide an understanding of the Danish and UK practices.

The chosen Danish OWFs are Kriegers Flak (KF) and Vesterhav Syd (VhS). These are chosen because they are conducted by different consultancies, respectively NIRAS and COWI, and WSP. In the selection of cases it was further prioritised that the OWFs had different sizes. KF is 72 windmills and VhS is 20 windmills. These two criteria were chosen to obtain a broader insight into practice. The same criteria were applied when selecting cases from the UK practice, where Awel y Môr (AyM) and East Anglia ONE North (EA1N) were chosen. Table 5.1 presents the chosen cases.

OWFs	**Year of publication**	**Consultancy**	**Number of windmills**	**Distance from the coast**	**Area in km^2**
Kriegers Flak	2015	NIRAS and COWI	72	15 km	250
Vesterhav Syd	2020	Orbicon | WSP	20	9 km	46
Awel y Môr	2022	GoBe Consultants	34 - 50	11 km	78
East Anglia ONE North	2019	Royal HaskoningDHV	75	33 km	208

Table 5.1. *Information about selected OWFs.*

5.3.1 Document analysis in the case study

Document analysis is used in the case study to investigate the content of the chosen CIAs. The analysis of the CIAs contributes with knowledge of how marine mammals and offshore ornithology are assessed in the CIAs, and how CIAs are generally handled in practice. Four CIAs are chosen, where two are made by Danish consultancies and two by UK consultancies. It is chosen to focus on the chapters regarding general methodology, marine mammals, and offshore ornithology, and use these as exemplifying cases. It is prioritised to go in detail with some chapters in each CIA instead of assessing all biodiversity related chapters more superficially.

The purpose of the document analysis is to gain insight into the current practice of conducting CIAs. The authors behind this thesis are aware that the EIA of KF is a little old, and that practice can have evolved since, but when compared to VhS, which is five years newer, there is not a great difference. Therefore it is not perceived as a problem that KF is older.

The approach to conducting the CIA in each EIA is analysed by going through the CIA and assessing the steps visible in the documents. Furthermore, practitioners who took part in conducting the CIAs are interviewed, to gain further insight into the underlying structures and thoughts. NIRAS, WSP, GoBe Consultants, and Royal HaskoningDHV were contacted to get in touch with the practitioners relevant to the specific cases. It was not possible to get in contact with practitioners in WSP who worked on VhS, and therefore it is only possible to gain knowledge of the approach through the written text in the CIA.

5.3.2 Case study interviews

Interview is a method for collecting qualitative data. Interviews can be used to gather knowledge and gain perspectives on the cause of a problem and what a solution might be. In this project, interviews are used to gain more knowledge about the understanding of CIs and how practitioners identify the appropriate scope. The focus is therefore to obtain insight into the practitioners' underlying thoughts and considerations. The purpose of the interviews is to:

- collect information about CIs in the EIA process;
- achieve an understanding of which approach the practitioners use to assess CIs from OWFs;
- understand which challenges, barriers, and potentials there are in relation to assessing CIs;
- obtain an indication of how CIA should be accomplished in the future;
- investigate if the challenges and recommendations found in the literature review are present in practice.

All the interviews are semi-structured, with questions prepared before the interview to ensure that the problem area is covered. This approach was chosen so that it was possible to change direction if the interviewee mentioned an interesting aspect and to create a more fluid dialogue and discussion [Robson and McCartan, 2016]. An interview guide was prepared which was adapted according to which practitioners were to be interviewed. The interview guide ensured that the aim of the study was retained.

Besides the practitioners relevant to the chosen case CIAs, other practitioners from Denmark and UK were also interviewed to uncover as many aspects as possible concerning the assessment of CIs. It is defined as a selection criterion, that the practitioners and authorities should have experience with CIAs of OWFs in either Denmark or UK. By interviewing practitioners who meet the criterion and have different roles in practice, it is possible to uncover different standpoints and ensure that the answers are valid. As mentioned earlier, the focus of the investigation of this thesis is marine mammals, offshore ornithology, and the general CIA practice, and therefore it was made clear through the interviews that if the interviewees could answer the questions with these in mind it would be beneficial.

Table 5.2 contains an overview of the conducted interviews.

Organisastion	Respondent	Job title	Date
GoBe Consultants	Ryan McManus	Principal consultant	25/4
Danish Environmental Protection Agency	Hanne Lise Koed	Advisor on the protection of species and nature	27/4
Danish Energy Agency	Søren Keller Christine Eriksen	Environmental and permitting consultant Marine bioligist	28/4
Royal HaskoningDHV	Peter Braithwaite	Senior environmental consultant	
NIRAS	Louise Rønde Mønster	Project manager	1/5
NIRAS	Mette Jeppesen	Senior Consultant	1/5
Project developer	Project developer A Project developer B	Permitting and environmental manager Project manager	1/5
Ramboll	Sara Méndez Roldán	Senior consultant	3/5

Table 5.2. *Conducted interviews.*

Ryan McManus is a principal consultant at GoBe Consultants and has an education in environmental consultancy. He has six years of experience at GoBe Consultants and is primarily working with OWFs, where he was the project manager on the EIA for AyM.

Hanne Lise Koed is an advisor at the Danish Environmental Protection Agency (EPA) and is mainly focusing on protected species and nature conservation. Her work evolves around the Habitats and Birds Directives, and how to comply with this. As a representative of EPA, she has assessed whether EIAs are adequate in terms of fulfilling the demands presented in the directives.

Søren Keller has eight years of experience as an advisor at the Danish Energy Agency (DEA), and works with environment and permitting for offshore wind projects.

Christine Eriksen has one year of experience as a marine biologist at DEA. She primarily works with approvals of OWFs, and has experience with 'Open door projects' and CIAs.

Peter Braithwaite is a senior environmental consultant at Royal HaskoningDHV. He has a broader background with a focus on onshore projects, and is relatively new to offshore wind, where he has three years of experience. He was the project manager of East Anglia One North at the end of the process.

Louise Rønde Mønster has a degree in biology and has worked in NIRAS' department of EIA and SEA for 15 years. She has approximately 10 years of experience with OWF projects, both as a project manager and as a biologist writing chapters and conducting assessments of OWF projects.

Mette Jeppesen is a Senior Consultant and biologist. She has worked at NIRAS since 2008 and has much experience with the aquatic environment and EIA. She was the project manager on the EIA for KF.

Project developer A is a permitting and environmental manager, and works with environmental permits for Danish OWF projects. Project developer A is acquainted with CIs through previous positions related to OWFs and CIAs.

Project developer B is a project manager within a department for environment and permitting, and is new in the field of OWF, since focus so far has been onshore EIAs.

Sara Méndez Roldán is a senior environmental consultant in Ramboll and is based in Spain. She has experience in the assessment of marine infrastructure projects, and although has not conducted CIAs in regard to OWFs personally, she has reviewed a few. She was also involved in the development of a framework for CIA, that was prepared in the UK for the Marine Management Organisation. The framework does not cover OWFs specifically but covers all maritime activities.

The respondents and interviewers are located in different parts of the country, and in different countries, and the interviews are therefore conducted through Microsoft TEAMS. Doing the interviews the interviewers take turns in asking questions related to different themes. This approach is chosen to ensure that both of the interviewers can connect and familiarise with the respondent. The interviewer who is not asking questions is supportive and ensures that the relevant questions are asked. The interviews are recorded with approval by the respondents and afterward transcribed. The transcriptions can be found in the External Appendix A, B, C, D, E, F, G, and H.

The interviews with practitioners outside of Denmark were conducted in English, whereas the interviews with Danish respondents, were conducted in Danish. Quotes used are translated from Danish to English and a focus point has been to stay as close to the exact phrase as possible. The Danish language differs from the English and thereby the quotes are not always directly translated.

5.4 Literature review

Different problem areas related to the international practice of conducting CIAs are mapped in chapter 3. The problem areas which this thesis will be investigating are delimited to the definition and understanding of the concepts of CIA, and the identification of the geographical and temporal scope for such an assessment. A literature review is conducted in order to present a state-of-the-art of international practice of assessing CIs in EIAs, in relation to the chosen problem areas. The review is based on a 6-step framework by Paré [2015]. The steps within the framework are *(1) formulating the problem*, *(2) searching the literature*, *(3) screening for inclusion*, *(4) assessing quality*, *(5) extracting data*, and *(6) analysing and synthesising data*. It will be described in the following how this framework is applied and how it has guided the literature review.

Formulating the problem

The first step is to formulate and define the problem which will be investigated. This will underline why it is necessary to conduct a literature review, and what the purpose of it is. At the same time, it will define which concepts are relevant in the context of the problem. A preliminary research question is also defined to guide the study and highlight which information is needed [Paré, 2015]. The literature review is based on prior knowledge of how the current practice of conducting CIAs for OWFs is insufficient and inadequate, due to problems related to defining CIs and other concepts of a CIA, and the identification of a relevant temporal and geographical scope. The review aims to investigate the problem areas, the appertaining consequences, and suggestions for best practice. The review evolves around the preliminary question of how the

conceptual understanding, and the practice of identifying the relevant geographical and temporal scope, can be improved to support practice of conducting CIAs. The purpose of the review is thereby to further unfold the problem areas and present recommendations for how to support and improve practice. Based on this, a search string is made and presented in table 5.3:

	Concept	**Justification/purpose**
Theme	"impact assessment*" OR “Environmental impact assessment*” OR "Environmental assessment*" OR “environmental impact statement*” OR EIA OR EA	Concepts which are 'setting the scene' and defining the overall focus of the literature review
Theme	Cumulative OR “Cumulative effect*” OR “Cumulative impact*” OR CEA OR CIA	
All fields	"offshore wind farm*" OR "offshore wind power" OR offshore OR “Offshore wind*” OR "Marine renewable energy"	
All fields	assessment* OR scope OR scale OR geograph* OR delimitation OR "time frame" OR temporal OR time* OR definition* OR understand* OR "conceptual understand*" OR concept OR interpretation	Ensuring that the texts are related to the chosen problem areas, by including concepts related to conceptual understanding and the two scopes
NOT in title	social OR "life cycle assessment" OR LCA OR strategic OR spatial OR SEA OR coastal OR harbour OR land	Excluding texts outside the defined scope/purpose of this literature review

Table 5.3. *The search string, and justifications for the chosen concepts.*

When a literature review is conducted, there is a wish to retrieve all studies relevant to the chosen problem area. To fulfill this, it is important that the chosen search strategy, data sources, and restrictions of the search are thought through. Even though the focus of the present thesis is OWFs, the focus of the literature review is broadened to include all marine renewable energy developments and in general offshore developments. This is chosen because it is assumed that the context of all offshore projects is comparable, and that there thereby might be learning to retrieve from other offshore projects.

Searching the literature

The next step is to decide which search engines to use to search for literature and ensure that *"a relatively complete census of relevant literature"* is gathered [Paré, 2015]. In this thesis, Aalborg University's online search engine AUB is chosen as the primary database. The search string is used to search for articles in AUB. To supplement the search and ensure that relevant literature is not missed, simple searches are conducted in other relevant search engines. The simplified search string "EIA AND Offshore AND cumulative impact OR cumulative effect" is used in ProQuest, ScienceDirect, Taylor & Francis, Scopus, and Web of Science. Because the partial purpose of this literature review is to gather knowledge of recommendations on how to conduct CIAs, it is decided that *grey literature* such as guidance, articles from relevant authorities, and

so on, is also relevant for this review. A simple search is therefore also conducted in Google. To further ensure that relevant texts are not missed, the method of snowballing is used to retrieve relevant cited texts.

Screening for inclusion

In this step of the data collection, potentially relevant articles are identified and further assessed for relevance and inclusion. The purpose of the review forms selection criteria which constitutes the basis for including or excluding literature [Paré, 2015]. In AUB the search string gave 29 hits. The first step is to assess based on the title whether or not the article or document appears relevant. The abstract is then read through in all texts that appear relevant or where there is doubt solely based on the title. Based on the abstract, texts are then either included or excluded. The same procedure is applied in the simple searches and the Google search. The result is that 11 texts from AUB are included, 7 extra are found in other relevant databases, 8 are found through Google, and 10 are found by using the snowballing method. In the end, 36 texts are included in the literature review.

Assessing quality

Besides the screening for relevancy, the quality of the texts should also be assessed in order to ensure validity and uncover whether some aspects may potentially influence the quality of the conclusions of the review [Paré, 2015]. As previously stated the focus of the review is not only OWF but all offshore projects since it is assumed that they are comparable. In the review texts with a more general focus on EIA and CIA are also found. When including these, attention is given to the fact that the findings of the texts might not be directly applicable in an offshore context. The authors strive to explicitly state whenever a general text is used in the analysis, to underline that the statements may or may not be completely transferable. On the other hand, it can be argued that the general focus is both offshore and onshore and that the statements are therefore also relevant in an offshore context. As an example, some guidance documents included are not explicitly made for offshore projects but aimed at all EIA compulsory projects. Attention is also paid to the authors or publishers of the found texts. Academic databases are primarily used to ensure the validity and reliability of the texts. When searching Google it is prioritised that the authors or publishers are either authorities or relevant organisations.

Extracting, analysing, and synthesising data

In the final steps of the literature review, data deemed relevant for the study is extracted from the included texts, and then findings are analysed, compared, and conclusions are drawn. The problem area and research question define what data should be extracted. The data is presented and findings are interpreted and synthesised to conclusions and contributions to the current knowledge [Paré, 2015].

A spreadsheet is created to gather and organise the relevant data, which is then applied in respectively an analysis of the conceptual understanding and of determining the temporal and geographical scope. By synthesising the findings, problem areas, current practice, and recommendations for how to improve practice or obtain the best practice are presented in chapter 6.

A literature review on current international practice of CIA

6

Different problem areas influencing the quality of the current CIAs are presented in chapter 3. One of these is related to the definition and understanding of the concepts of CIA, where it is found that different definitions and interpretations are currently present in the international CIA practice, where the lack of a clear and comprehensive definition is leading to inadequate and inconsistent CIAs. Another is related to identifying the geographical and temporal scope, where current practice appears to be uncertain, inconsistent, and insufficient. Identifying the proper scope is presented as essential for practitioners, in terms of mapping and assessing potentially overlapping impacts. This chapter will present the findings of a literature review aimed specifically at mapping problem areas and recommendations for how to improve CIA practice. The problem areas will provide a basis for understanding whether and how practice needs further support. Recommendations will also be mapped and presented, to provide an overview of how literature and different guiding documents suggest practice should be, and which aspects could be introduced to further support practice. Both scientific articles and guidance documents are included in the literature review. The articles contain a more critical view on practice, whereas guidance documents are more focused on solving the challenges. The mapping of problem areas will strive to further unfold the problems presented in chapter 3, and add to these with further findings. The first part of this chapter evolves around the conceptual understanding, and the second part is about the temporal and geographical scope.

6.1 Conceptual understanding of CIA

The concept of CIA is presented as an umbrella term that holds a plethora of approaches and understandings [Willsteed et al., 2017]. This representation is in accordance with the literary findings of articles by Hague et al. [2022], Kirkfeldt et al. [2016], Willsteed et al. [2017], Foley et al. [2017], Hodgson et al. [2019], and guidance from UK by ORJIP Ocean Energy [2022], concluding that many different understandings of both a CI and a CIA exist in the academic world and amongst practitioners, but that there is no agreed definition. It appears that the terms are often used in practice, but that they are not well-defined by practitioners [Judd et al., 2015; Blakley and Russell, 2022].

According to Foley et al. [2017], the concepts of CIA are widely described in the academic literature, but not applied properly by practitioners. A study examining 93 EIAs published between 2009 and 2019 which are related to marine developments in UK waters, found that 26% of the examined CIAs did not contain a definition, and 9% of those that did, presented indefinite ones [Hague et al., 2022]. Hague et al. [2022] and Judd et al. [2015] explain these trends with the lack of a precise and standardised definition, and the fact that uncertainty exists among

practitioners about what CIs and CIAs are. Similarly, a study investigating the underlying causes of the current CIA practice, found that not all EA experts are able to define CIs and that some are only able to partially do so [Kirkfeldt et al., 2016]. The applied definition of the concept CIA is found to be decisive for the following assessments and the quality of these [Hague et al., 2022], and it is highlighted that inconsistencies in both the used terminology and the interpretations of CIA, lead to inconsistencies in the chosen approaches, and in the conclusions reached [Judd et al., 2015; Hodgson et al., 2019]. This indicates that it is not irrelevant how and whether the concept of CIA is defined.

When reading through the found literature it becomes evident that there is no agreement as to whether the assessments should be concerning impacts or effects, and in some cases, the terms are defined in the same way and thereby perceived as synonyms. But some authors mention the two terms explicitly and highlight that these are not interchangeable [Masden et al., 2010; Kirkfeldt et al., 2016; Ryan et al., 2019; ORJIP Ocean Energy, 2022]. An effect is defined as an event or action, e.g. a collision, and the impact is the change happening due to the effect, e.g. the change of a specific population or species. Meaning that the impact is the ultimate change on a receptor [ORJIP Ocean Energy, 2022; Masden et al., 2010]. According to UK guidance by ORJIP Ocean Energy [2022] the interpretation of the two terms can also differ, where 'impact' is perceived as a negative word, and 'effect' can be both a negative and positive change. This further emphasises that there are different interpretations of the concepts of CIA, which is also found by Masden et al. [2015], presenting the aspect *"linguistic uncertainty (or ambiguity)"*. This uncertainty arises when the meaning of concepts is unclear or unspecific, or if the meaning is different between sectors or has changed over time [Masden et al., 2015]. An example is the definition of CIs presented by Hyder [1999] in the European Commission guidelines, where Masden et al. [2015] and guidance from UK by RenewableUK [2013] state that the phrase *"reasonably foreseeable"* is ambiguous and unspecific. These unspecific terms and phrases leave room for interpretation by practitioners, and thereby room for uncertainty and inconsistency [Judd et al., 2015; Hague et al., 2022; Canter and Kamath, 1995]. Another aspect causing uncertainty amongst practitioners, is that existing definitions tend to be insufficient in terms of being able to guide and support practice [Masden et al., 2010; Judd et al., 2015; Canter and Kamath, 1995; King et al., 2009]. Legislation and directives require the assessment of CIs, but these do not provide sufficient definitions nor guidance on how to adequately comply. This creates an uncertain regulatory arena for practitioners since it is not clear what the legislative requirements are and when a CIA is adequately conducted [Masden et al., 2010].

In the UK guide by King et al. [2009] it is stated that the current CIA practice is constrained by the lack of sufficient and formal definitions. In articles, it is described as a general problem that differing definitions and interpretations are applied in CIA practice because it is causing inconsistent and insufficient CIAs [Kirkfeldt et al., 2016; Masden et al., 2010]. In the following section, the different definitions found in the literature review will be presented and compared.

6.1.1 Defining 'cumulative impacts'

It is stated in an article by Hague et al. [2022] that 41% of the CIAs that presented a definition, used the one from the European Commission's guidelines by Hyder [1999]. Hyder [1999] present CIs as:

"impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project."

Even though the definition was put forward more than 20 years ago, it still appears to be widely used with little or no changes in the specific wording. The definition is applied and/or referred to by five articles and three other guidance documents - one from the United States (US) and two from the UK [Durning and Broderick, 2019; Judd et al., 2015; Masden et al., 2010; ORJIP Ocean Energy, 2022; RenewableUK, 2013; Broderick et al., 2017; IEMA, 2020; IEA Wind, 2022]. IEA Wind [2022] state that this is the definition most commonly used in the EU. A newer EU guide published by The European Commission [2020b] use the word effect instead of impact, and defines cumulative effects as:

"(...) effects on the environment caused by the combined action of past, current, and future activities."

A guide from the UK defines CI similarly to the EU guide by Hyder [1999], but uses the word 'future' instead of 'reasonably foreseeable' [King et al., 2009]. As presented in the UK guidance by ORJIP Ocean Energy [2022], The Welsh National Marine plan defines CIs similarly, except 'impacts' are called 'effects' and 'other ... actions' is replaced by 'two or more ... actions', and it is more comprehensive in terms of what 'actions' is:

"These (actions) can be economic, social or environmental in nature. Cumulative effects could arise from single or multiple responses (environmental, economic or social) to single or multiple pressures from single or multiple activities" [ORJIP Ocean Energy, 2022].

A definition presented by the Canadian Environmental Assessment Agency uses 'change' instead of 'impact', and emphasise that the 'changes' to be assessed are the *"changes to the environment that are caused by past, present, and future human actions"* [Canter and Ross, 2012; Kirkfeldt et al., 2016]. A Scottish guide defines CI as:

"The additional changes caused by a proposed development in conjunction with other similar developments or as the combined effect of a set of developments, taken together. A cumulative impact assessment is therefore intended to estimate the impact of a planned project on a receptor, in combination with other projects" [RPS, 2010].

The definition by RPS [2010] is thereby the only guide originating from the UK that differs significantly in wording as compared to the EU definition by Hyder [1999]. It is presented by

IEMA [2020] that as a way to lessen the ambiguity of the definition of CI, the EIA regulations 2017 adopted by the UK government, presented a change in wording from 'reasonably foreseeable' to 'other existing and/or approved development'. The EU definition is also similar to the one presented in a US guide made by The Council on Environmental Quality [1997] in the US, where a CI is presented as the

"impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions."

This definition, or an older but completely similar definition published by the same agency, is referred to by three articles and two other guidance documents from the US [Canter and Ross, 2012; Canter and Kamath, 1995; Kirkfeldt et al., 2016; BOEM, 2021; IEA Wind, 2022]. Other definitions found in the scientific articles are somewhat similar but with slightly differing phrasing compared to the ones presented, in terms of the three-part time description of other actions [Broderick et al., 2017; Durning and Broderick, 2019]. One article refers to the definition given in the UK implementation of the Habitats Directive which encompass *"already carried out and proposed"* actions specifically on species and habitats covered by the directive, and where actions are defined as plans or projects [Masden et al., 2010]. As the only one, Caine [2019] defines a CI as an impact on a habitat or a species caused by a proposed development and *"at least one other operational development in the area"*. Two articles define CIs as the accumulation of effects caused by interacting human activities that causes changes in the environment [Blakley and Russell, 2022; Willsteed et al., 2018]. Willsteed et al. [2018] also define natural processes as another action that can cause CIs. A more narrow definition defines actions as *"several developments in relative close proximity to each other, considering both existing and future projects for which sufficient information is available"* [Busch and Garthe, 2016]. Another more broad definition which is referred to by Broderick et al. [2017], Durning and Broderick [2019], mention both cumulative 'effect' and 'impact', and defines CIs as *"changes in environmental systems over time and across space (...)"*.

Some articles also highlight that CIs can be classified in different ways, as presented in table 6.1.

Impact types	Explanation of the impact type
Homotypic	Impacts derive from several of the same types of projects [Canter and Kamath, 1995].
Heterotypic	Impacts derive from different types of projects [Canter and Kamath, 1995].
Inter-project	Impacts occurring from the same OWF [Therivel and Ross, 2007; Broderick et al., 2017].
Intra-project	Impacts occurring from different OWFs [Therivel and Ross, 2007; Broderick et al., 2017].

Table 6.1. *Explanation of different impact types.*

Furthermore, CIs can derive from different impacts produced by multiple actions or similar impacts produced by multiple actions [Foley et al., 2017; Durning and Broderick, 2019].

6.1.2 Suggestions for *best practice* in terms of defining the concepts of CIA

As presented above, several terms are currently used when describing and defining the concepts of CIA. It is presented in the UK guidance by ORJIP Ocean Energy [2022], that the linguistic ambiguity is influencing decision-making which highlights the importance of creating a more standardised vocabulary amongst practitioners, academia, and authorities. Foley et al. [2017] also highlight the importance of a standardised and comprehensive definition, by linking the inconsistent definitions to the varying practice of determining a baseline, deciding the temporal- and geographical scope, and assessing significance. Both Foley et al. [2017] and Masden et al. [2015] state that this ought to be the first step towards reducing the uncertainty that appears to be generally present in current practice since it can provide practitioners with greater clarity in terms of expectations. To sufficiently do so, it is stated that a simple definition is not adequate, because the definition should be complex enough to actually be able to guide practice [Broderick et al., 2017; Hague et al., 2022].

Given that the terminology that is currently used is not able to eliminate confusion, it is suggested that an agreed definition should also include a description of key concepts - such as a description of what 'foreseeable' means [ORJIP Ocean Energy, 2022; Broderick et al., 2017; Hague et al., 2022]. A supplementary glossary is suggested by Masden et al. [2015] to overcome ambiguous definitions, and case study examples are further suggested to reduce uncertainty. Such descriptions and guidance should clearly set the frame of legislative requirements to ensure adequate assessments and compliance, and it should thereby be able to support a uniform practice across sectors and countries [Hague et al., 2022; ORJIP Ocean Energy, 2022; Willsteed et al., 2017]. It is further suggested that it should be standardised which impact types ought to be included in the CIA [Foley et al., 2017], but also emphasised that such guiding should provide room for practice to evolve as new knowledge is obtained [Hague et al., 2022].

It is suggested that the terms 'effect', 'impact', and 'pressure' should be part of a definition. According to Judd et al. [2015], it is the assessment of whether and how the pressures cumulatively interact, leading to effects and ultimately impacts, that is the key of a CIA. Additionally, it is suggested that the terms 'source', 'pathway', and 'receptor' are also defined to ensure an understanding of linkages between these aspects [Judd et al., 2015].

6.1.3 Summary

It is found that there is a link between the applied definition, the chosen approach, the quality of the assessments, and the final conclusions - which is further influencing the decision-making. Some of the key problem areas are:

- Linguistic ambiguity
- Insufficient definitions leaving room for uncertainty of the exact meaning of terms and phrases
- Key concepts are not properly defined
- No agreed definition

Figure 6.1 highlights the variations that were found in the definitions through the literature review. The top row is the most commonly used definition by Hyder [1999], and below are the terms applied in other definitions. The definitions are not written coherently since some use

the same term in the first column but different terms in other columns. Given that the terms presented in the same column are not all synonyms, it is evident that the different definitions can lead to differing understandings of what a CIA is and should contain. Only few definitions contained elaborations on some of the terms, but for the sake of clarity, these are not presented in the figure.

The findings of the literature review are summarised into a few recommendations for how to improve CIA practice in terms of the understanding of the concepts of CIA:

- An agreed vocabulary should be established
- Implementation of a standardised definition
- The definition should be comprehensive enough to guide CIA practice
- There should be a clarification of the used concepts in each CIA
- A supplementary glossary or case examples can be used to provide clarity
- The statutory authorities should set up a clear frame of statutory requirements

Table 6.2 provides a mixed overview of suggested definitions of the concepts of CIA, found through the literature review.

Concept	**Suggested definition**
Activity/Source	The activity causing a pressure. E.g. pile driving.
Pressure/Effect	An event or action caused by an activity. E.g. vibrations from pile driving or bird/windmill collision.
Pathway	The mechanism exposing a receptor to an effect. E.g. foraging in the contaminated area.
Receptor	Social/cultural, economic, physical, or ecological entities that are expected to be affected by the effects. E.g. amenities or a specific species of fish.
Impact	A measurable change occurring due to the effect. E.g. the change of a specific population or species.

Table 6.2. *Suggested definitions of the concepts of CIA. Based on the work of Judd et al. [2015]; Masden et al. [2010] and ORJIP Ocean Energy [2022].*

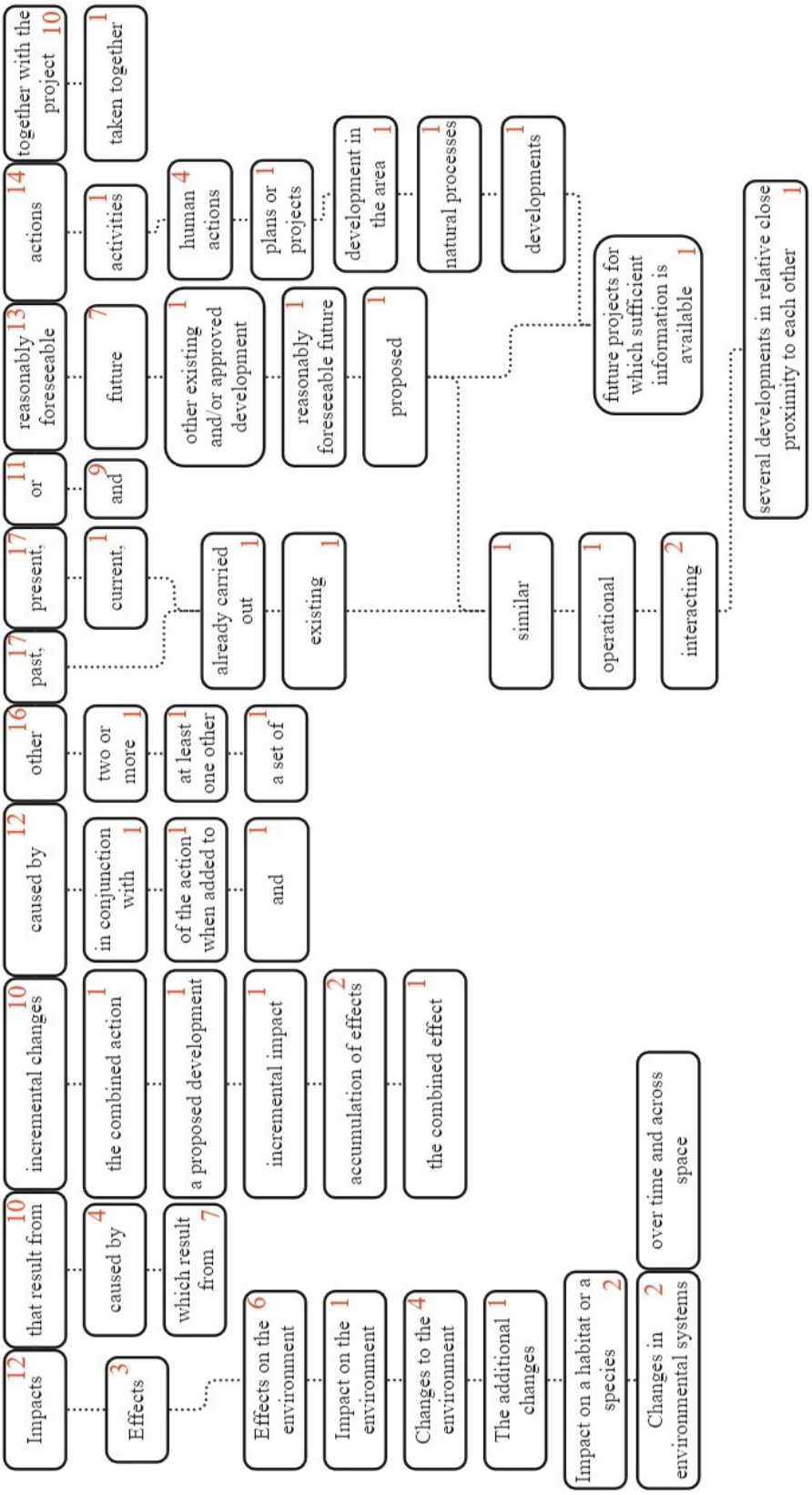

Figure 6.1. *An overview of the different wording applied in the presented definitions. The top row is the definition by Hyder [1999], and the terms below are the ones used in other definitions. The red numbers illustrate how many texts refer to the specific term.*

6.2 Geographical and temporal scope

When assessing CIs, it is important that the optimal scope is chosen. This is underlined in articles and guidance documents by Masden et al. [2010], Hyder [1999], Therivel and Ross [2007] stating that the quality of the CIA is linked to the chosen temporal and geographical boundaries since they will identify which actions and receptors ought to be included in the assessment. Furthermore, Judd et al. [2015] state that defining the geographical and temporal scope is crucial in terms of assessing impacts on species and habitat types since an insufficient scope can lead to impacts not being fully unfolded and understood.

The current practice of determining the scope of a CIA is described as limited by Therivel and Ross [2007], and it is highlighted that the descriptions of the approach to determining the temporal and geographical scope, are either unclear or not present. Furthermore, there is found to be insufficient consideration of other past and reasonably foreseeable actions [Therivel and Ross, 2007]. A review conducted by Hague et al. [2022] concluded that only 37% of the evaluated CIAs stated the temporal scope and 57% of the CIAs stated the geographical scope. It was thereby found to be unclear why plans, projects, activities, and effects were scoped in or out [Hague et al., 2022]. The lack of accounting for and defining geographical and temporal scope is further emphasised by Ryan et al. [2019], Canter and Kamath [1995], stating that this was found to be true in several cases.

Determining the appropriate temporal and geographical scope - especially for mobile species - is described as one of the key challenges in the current CIA practice [Hague et al., 2022]. The determination of scope is also described as challenging because the potential effects can vary across time and space [Hodgson et al., 2019], global effects such as climate change can also impact the local receptors, and the impact on a receptor varies in relation to the duration and frequency of effects [Hague et al., 2022]. In the European Commission guidelines by Hyder [1999], it is stated that other factors are also limiting the scope, such as data availability and knowledge of future actions. According to UK guidance and a scientific article, practice is further influenced by a lack of an agreed and standardised method for determining the temporal and geographical scope [King et al., 2009; ORJIP Ocean Energy, 2022; Lonsdale et al., 2017], which causes uncertainty amongst practitioners in regards to how to approach this in the best way [Lonsdale et al., 2017]. Mixed with a lack of guidance, this leads to inconsistencies and variations in approaches, which further causes CIAs to vary in scope, output, conclusions, and quality [ORJIP Ocean Energy, 2022; King et al., 2009; Lonsdale et al., 2017; Willsteed et al., 2017]. The variations in scope equal variations in the contexts the assessments are made. According to Willsteed et al. [2017], such variations in contexts can lead to inconsistent significance determination because the significance of an impact can vary depending on the chosen timescale or geographical extent. It is presented by Lonsdale et al. [2017], that to reduce the uncertainty it is necessary to implement a standardised approach, such will further enable a comparison of best practice and a sharing of experience.

It appears that neither the determination of geographical scope nor of the temporal scope is an easy task, but according to Willsteed et al. [2017], the determination of geographical scope is easier than the temporal scope, mainly because of the availability and advancement of geographical information systems. This is further emphasised by Willsteed et al. [2018], concluding that the geographical scope is described more comprehensively than the temporal - where most CIAs were found to be weak in terms of determining and describing the temporal

scope. It is stated in guidance from the US that it is relevant to support practice, since too broad a scope will cause the CIAs to become unmanageable, while too narrow a scope will potentially cause significant impacts to be missed [The Council on Environmental Quality, 1997]. The findings of the literature review further highlight that the scope is not described nor reasoned in many CIAs and that the practice appears to be inconsistent.

6.2.1 Determining the geographical scope

As presented, 43% of the CIAs evaluated by Hague et al. [2022] did not contain a description of the geographical scope. Furthermore, it is found that 13% set the scope to be a specific distance (from 0.5 to 100 km) around the project being assessed, and 14% determined the scope of the impact in relation to the relevant area of a species. Defining the geographical scope as a set radius can be appropriate for impacts with a known radius, such as piling noise, but inappropriate for the assessments of mobile species [Hague et al., 2022]. Another review by Ryan et al. [2019] found that 87.5% of CIAs addressed the geographical scope of activities partially or thoroughly, while respectively 37.5% and 62.5% addressed it partially or thoroughly for receptors and impacts.

Several elements can constitute a geographical scope. Country borders are clear boundaries, but these can be more challenging at sea, and defining the geographical scope as country borders is problematic since ecosystems do not stay within such boundaries. The geographical boundary must therefore in some cases go beyond political boundaries such as national waters [Gușatu et al., 2021]. In both guidance documents and articles, it is found that the geographical scope depends on the species in question [ORJIP Ocean Energy, 2022; Busch and Garthe, 2016; Masden et al., 2010; Ryan et al., 2019; Judd et al., 2015; Hyder, 1999; Willsteed et al., 2017; BOEM, 2021], as different boundaries may be necessary for different species [ORJIP Ocean Energy, 2022; Ryan et al., 2019]. In addition, some species are highly mobile and migrate [Busch and Garthe, 2016; Hague et al., 2022; Masden et al., 2010; Gușatu et al., 2021; Halpern and Fujita, 2013], which means that the geographical scope can be extensive and difficult to define [Busch and Garthe, 2016].

A way to determine the geographical scope is by screening/investigating which species are present in the area. According to a Scottish guide by RPS [2010], the species of conservation importance must be assessed and thus the scope must contain the areas that are relevant for these species. In a large area such as the sea, it can be difficult to uncover all relevant areas, and therefore cooperation is required to be able to assess impacts on species and populations [Judd et al., 2015; Hyder, 1999; Masden et al., 2010]. As an example, the relevant geographical scope can be extensive when assessing CIs on bird populations, since birds can interact with several OWFs [Mateos-Rodíguez et al., 2012]. The European Commission [2020b] present an example of how it is investigated whether birds are affected by the establishment of power lines and OWFs in the Flanders region. The geographical scope is based on birds' seasonal migration routes at a sub-regional level being the scale of the local flyway population, and the impacts from the proposed project are assessed combined with those from similar recent projects. It is perceived as unrealistic to assess all possible impacts, given that the necessary information and data are not available. To ensure that the assessments are as valid as possible, the impacts are assessed on a local or regional scale, since the data needed for a wider geographical scope is not available [The European Commission, 2020b]. To ensure that knowledge and data are available for the

assessments of ecosystems and overlapping projects, the chosen geographical scope is oftentimes set to be the jurisdiction of an agency [Foley et al., 2017]. Another approach, presented in UK guidance, to determining the geographical scope based on species, is to create a long-list of species at the scoping stage. Using survey data, the long-list should then be screened for inclusion [King et al., 2009].

It is found by Hague et al. [2022] that the two most commonly used approaches, in terms of how to consider CIs are: One type of impact from multiple actions, or multiple types of impacts from a single project. Another, but rarely used approach, is to consider multiple impacts from multiple actions, and it is found that 49% of the evaluated CIAs did not incorporate this approach at all. In comparison, 85% assessed one type of impact from multiple actions. This approach is criticised for not being representative of the actual impact on e.g. marine mammals since one type of impact is not isolated like this in reality. Other tendencies are, that CIAs only include co-occurring projects of the same type and that activities or impacts are only included when the available data is of high confidence. Lastly, it is found that many of the evaluated CIAs only included impacts that were assessed as significant for the project in isolation. It should though be considered that non-significant impacts can accumulate to significant impacts when assessed in a CIA [Hague et al., 2022].

6.2.2 Suggestions for *best practice* in terms of determining the geographical scope

It is suggested that the CIA should include impacts caused by both plans and projects [The European Commission, 2020b] and that not only actions in the immediate area should be included [Lonsdale et al., 2017]. The relevant geographical scope is context-specific and should be determined for the individual project and receptor [Hague et al., 2022; Therivel and Ross, 2007]. When determining what constitutes an appropriate scope, the principle of proportionality should be taken into account [The European Commission, 2020b]. Different approaches to determining the scope are presented in the literature and guidance. A Scottish guide states that the strategic area of the OWF, marine planning areas, or regional seas could define the general scope, where the area could be extended for species with large foraging- or migratory areas [RPS, 2010]. In an article by Foley et al. [2017], it is emphasised that the geographical scope should be large enough to include *"the distribution of the resource or system affected (e.g., habitat, watershed), the interactions between local and regional processes, and/or the geographic extent of ecosystem-level processes"*.

In the EU guidelines by Hyder [1999], it is stated that since CIs can extend beyond the project area, it is important that the geographical boundaries are defined beyond this, if relevant, in order to ensure an adequate assessment. It is further emphasised in a Scottish guide, that the relevant area could extend outside country borders [RPS, 2010]. Hyder [1999] point at different factors which should determine the geographical boundaries: *"the nature of the project; the nature of the impacts; sensitivity of the receiving environment; availability of data; natural boundaries"*. To which the UK guide by RenewableUK [2013] further emphasises that the nature of the impacts should be seen in relation to the specific population. The sensitivity of the receptor and receptor interactions should be given attention, and source-pathway-receptor interactions should be investigated [RenewableUK, 2013]. It is further stated in different guidance documents, that

when settling on a geographical scope, it ought to be done in agreement with relevant authorities and statutory advisors to ensure adequate assessments [RPS, 2010; RenewableUK, 2013; ORJIP Ocean Energy, 2022; Hyder, 1999].

It is both presented in UK and Scottish guidance, and by Broderick et al. [2017], that the geographical scope should be defined on the basis of receptors, where the receptors' foraging distances, migratory routes, and so on must be taken into account. In relation to bird species, the EU Habitats Directive and Natura 2000 guidance, can be used to find the relevant areas to assess, based on which migratory birds are near the site and thereby potentially affected by the given OWF [RPS, 2010; The European Commission, 2020b]. But it is highlighted in UK guidance that this approach is not without complications, as it is not certain whether there is data available for the areas in which the protected receptors are located, nor is it certain that the species is present in the entire area [King et al., 2009]. Additionally, it is important to focus on the geographical extent of the project's environmental impacts, e.g. which areas will be affected. By applying both approaches when determining the relevant scope, all potential impacts should be identified [Broderick et al., 2017; RenewableUK, 2013]. The scope should reflect the individual biological characteristics of the species or feature being assessed. This can be a challenging task for mobile and migratory species since the relevant areas can vary throughout the specific annual cycles [Busch and Garthe, 2016]. It is stated by Willsteed et al. [2017] that if a species is present in the area surrounding the project at any time, then the ideal geographical scope is the area of the global population - meaning that all actions interacting with the species at any time of the given life cycle would be included in the CIA. Furthermore, a Scottish guide by RPS [2010] and Willsteed et al. [2017] state that the ideal geographical scope may be the global level of a population, but that this is not always possible since the availability of data at this level may be limited. It is therefore recommended that smaller units are assessed instead [RPS, 2010]. Similarly Masden et al. [2010] state that adequate CIAs should be exhaustive and include all the receptors that may be affected by the project. However, Masden et al. [2010] also point out that this will be a comprehensive assessment and concludes that the geographical scope *"needs to be defined at these smaller action-based scales"*. Including many receptors and activities in a CIA is also described as resource-intensive. UK guidance by King et al. [2009] points out that it will have some merits, but is very time-consuming and in the end, the result may be that most of the assessed CIs are deemed insignificant. In addition, US guidance presented by IEA Wind [2022] points out that *"focusing on the species that may be the most vulnerable is the best use of the finite resources and time afforded to EIAs"*.

6.2.3 Determining the temporal scope

As presented in section 6.1.1, several articles and guiding documents refer to the three-part temporal scope of 'past', 'present/current', and 'future/reasonably foreseeable' actions. It is highlighted by most, that the practice of determining the temporal scope is challenging, and suggestions for what the terms should comprise are presented, but only few describe how the three-part temporal definition is currently interpreted in practice.

A review presented in an article by Hague et al. [2022] has found that 63% of the evaluated CIAs do not present a clear definition of the chosen temporal scope. In terms of approach to determine the temporal scope, 20% use the project's time frame - this is found to be the most common

approach, in addition few others include a few years post-project. This approach is criticised for being inappropriate for CIAs since impacts can continue after the activity has ended. Since the response of a receptor can be lagged, it is suggested that it would be more appropriate to extend the temporal scope to the time when the receptor will have recovered, even if this is after the operational phase of the project [Hague et al., 2022]. A study of CIA practice based on interviews with practitioners has found that only practitioners considering CIs from similar project types predominantly use the project's or activity's time frame to define the temporal scope. Whereas the most common approach found by Foley et al. [2017] is to base the temporal scope on the time span of the impact - this approach was found in 81% of the evaluated CIAs. It is also discovered that some base the temporal scope on the recovery time of the receptor [Foley et al., 2017].

Hague et al. [2022] also found that 3% used a set amount of years, varying from 5-7 years, and 5% defined the scope based on *reasonably foreseeable future*. Another study by Willsteed et al. [2018] has concluded that all assessments are weak or very weak in terms of determining and describing the relevant temporal scope of impacts. Rather than considering the temporal scope of an impact relative to the receptor being assessed, the common approach is to assume that the time frame of the impact follows the time frame of the activity. The current practice of determining the temporal scope is constrained by a lack of available knowledge and data [Hyder, 1999]. Furthermore, it is stated in UK guidance that the overall uncertainty is found to increase as more activities are scoped in [ORJIP Ocean Energy, 2022]. Another tendency, presented by Kirkfeldt et al. [2016], is a lack of transparency and exhaustive descriptions of the temporal scope, which makes it unclear whether and how past, present, and future activities are included in the CIA. This could be explained by the fact that practice is facing challenges and insecurities of how to define an appropriate temporal scope for which activities and thereby effects to include in the assessments [Willsteed et al., 2017]. An approach presented by Busch and Garthe [2016] is *the year-round assessment*, which includes future OWFs that are consented to or at the planning stage. It is highlighted that some of the included future OWFs may never reach the construction or operational phase, but that these conceivable projects should still be considered.

It is evident that not many of the articles in the literature review provide examples of how temporal scope has been defined in previous CIAs. The two articles examining practice, provide differing conclusions as to how temporal scopes are oftentimes defined. This could be an indication of the current lack of standardised methodology, and thereby that the few assessments clearly stating the temporal scope, are not in agreement of how it is appropriately defined.

6.2.4 Suggestions for *best practice* in terms of determining the temporal scope

It is presented in UK guidance by RenewableUK [2013], that the time frame must be *"periodically reviewed; interaction-specific; specific to the project being assessed; and specific to the receptors with significant impacts"*. Whereas the guide by Hyder [1999] underlines that the temporal boundary should be determined on the basis of " *"historical use of the area, e.g. industrial activities or landfill; information available; the local, or national planning horizons for future development; lifespan of the project from construction to decommissioning"*. Thus, there are several factors that must be taken into account when the temporal scope is to be defined.

It is suggested in articles and guidance documents, that the temporal scope should be based on the project's time frame, and divided into the stages *construction, operation, and decommissioning* [Ryan et al., 2019; RenewableUK, 2013; Hague et al., 2022; Broderick et al., 2017; Hyder, 1999]. But this should not be the only influential aspect when determining which past, present, and future actions to include. According to Ryan et al. [2019] a second aspect should be the extent and frequency of the different effects being assessed. Given that some impacts may be lagged, Hague et al. [2022], Masden et al. [2010], and Foley et al. [2017] highlight that it might be relevant to extend the temporal scope to go beyond the project's lifetime. Broderick et al. [2017], Foley et al. [2017], Masden et al. [2010], and RenewableUK [2013] suggest that the duration of impacts caused by the project, and the recovery time and life cycles of receptors should be taken into account. But UK guidance by RenewableUK [2013], states that the temporal scope should not exceed the lifetime of the applicant's OWF. Furthermore, Broderick et al. [2017] and RenewableUK [2013] highlight that the CIA should include the impacts of any of the three phases of both current and reasonably foreseeable activities potentially overlapping with the project being assessed. It is emphasised by Kirkfeldt et al. [2016] that it should not only be the effects from projects or stages occurring simultaneously that are included since impacts from past and present actions can also contribute to an accumulation of impacts. According to IEA Wind [2022], Masden et al. [2010], and Judd et al. [2015], the temporal scope should also take the characteristics and seasonal variations of specific receptors into account. This is because some receptors' sensitivity to impacts varies with the season, e.g. in relation to a fish's spawning season [Judd et al., 2015].

UK guidance presented by ORJIP Ocean Energy [2022] states that it is *"currently advised that only existing plans and projects should be considered for CIA"*. But elaborates that The Chartered Institute of Ecology and Environmental Management has made guidelines that include projects from the foreseeable future. A guide from the US by IEA Wind [2022] states that to define an appropriate temporal scope for CIA it should include both *"past and current impacts, but also potential future events"*. The scope should also be reviewed periodically to ensure that updates or new planned and proposed projects are included [RenewableUK, 2013]. Several articles and guidance documents propose that the following activities ought to be included as part of the three-part definition of the temporal scope:

- Projects identified in plans [Broderick et al., 2017], both drafts and adopted [ORJIP Ocean Energy, 2022].
- Proposed projects [King et al., 2009], which are announced by other project developers [Broderick et al., 2017].
- Project for which an application has been filed [King et al., 2009; ORJIP Ocean Energy, 2022], and where it is reasonably possible that consent will be given [Broderick et al., 2017].
- Refused project proposals which are under appeal [ORJIP Ocean Energy, 2022].
- Projects that are consented to, but where construction has not started or is not completed [ORJIP Ocean Energy, 2022; King et al., 2009; Broderick et al., 2017].
- Proposed projects which need no consent from the competent authority, and which a public body will implement [ORJIP Ocean Energy, 2022].
- Projects directly connected to the project being assessed [Broderick et al., 2017].
- Existing projects whose full predicted impacts have not yet become effective [ORJIP Ocean Energy, 2022; King et al., 2009]

- Existing projects [ORJIP Ocean Energy, 2022; King et al., 2009].
- Past historic projects [King et al., 2009].

Willsteed et al. [2017] highlight the importance of including past and current impacts in the CIA and not in the baseline, in order to avoid shifting baselines where *"assessments of change are measured against a baseline which is significantly different from the original state of the receptor"*. It is stated in the guidelines by King et al. [2009], that the actions contained in 'past, present, and future' can be both other OWFs, other project types, and activities such as boat traffic or fishing - meaning that 'project' in the above list should be all of these.

In terms of determining the temporal boundary of which activities to include, it is suggested by Hyder [1999], that it is dependent on the availability of data, and the quality hereof. The time boundary of past activities should be based on an assessment of the previous use of the area, and whether impacts possibly still persist. In terms of defining a boundary for reasonably foreseeable, it is stated that five years should be the limit. The validating argument is, that there is uncertainty regarding most proposals for future projects [Hyder, 1999]. In a study of the general CIA practice, it is stated that when assessing the impacts of actions scheduled close to the projects being assessed, and of which knowledge is available, thorough assessments of CIAs are expected. But when considering actions further out in the future, *"only a broad-brush picture of effects is needed, given the uncertainty of these hypothetical futures"* [Therivel and Ross, 2007]. According to US guidance by BOEM [2021] this can be handled by classifying potential actions in *tiers* of certainty. These can be based on the project's stage, the amount of available information, and economic viability. An updated approach to classifying actions in tiers is *"based on four factors necessary for a project to occur: resource potential, area available, demand, and level of planning"*, and the availability of knowledge [BOEM, 2021]. In relation to the amount of available knowledge and data it is emphasised in UK guidance by RenewableUK [2013], that:

> *"Developers are only able to assess quantitatively those projects with a sufficient level of data, i.e. number of turbines, hub height, blade tip length, clearance above sea level, separation distances between turbines, cable route, landfall and scoping report. Projects without this level of detail cannot be assessed as comprehensively, and where information is lacking or sparse, developers' consideration of CIs will be necessarily at a lower resolution. It may not always be easy for developers to assess potential impacts fully due to lack of available information. In such circumstances, developers should take a pragmatic approach when determining what is feasible and reasonable"* [RenewableUK, 2013].

6.2.5 Summary

It is highlighted in the literature, that the quality of the CIA is conditional of the temporal and geographical scope because an insufficient or improper scope can cause significant impacts to be overlooked. The current practice is generally described as limited, unclear, and uncertain. Some of the key problem areas found in the literature study are:

- No agreed and standardised definition of what a CIA ought to contain.
- Inconsistent practice of determining the relevant scope, causing inconsistencies in the assessments of significance.

- Unclear practice in terms of what is scoped in or out, and why.
- Lack of data and knowledge - both of receptors and other projects.

- Specifically for geographical scope:
    - It is difficult to determine the relevant scope for highly mobile species, and the scope can be extensive.
    - Difficult to define due to the presence of many influencing elements.
    - The bigger the area, the bigger uncertainty.

- Specifically for temporal scope:
    - Difficult to decide which projects should be included because it is unclear what *past, present, and future/reasonably foreseeable actions* are.
    - The more actions included, the bigger insecurity.

Together, the determination of geographical and temporal scope defines the area that should be assessed [Canter and Ross, 2012]. A single geographical or temporal scope can not be defined, since the appropriate scope is dependent on the specific impact or receptor [Broderick et al., 2017; Hyder, 1999; King et al., 2009]. To reduce uncertainty and support practice and the quality of the CIAs, it is relevant to devise guidelines and a standardised approach [Lonsdale et al., 2017]. The scope should also be defined in cooperation with relevant stakeholders and authorities to ensure adequateness [RPS, 2010; RenewableUK, 2013; ORJIP Ocean Energy, 2022; Hyder, 1999]. The findings of the literature review are summarised into some recommendations for how to improve CIA practice in terms of determining the geographical and temporal scope:

- Specifically for geographical scope:
    - The scope should cover more than the immediate area, meaning that it should extend beyond the projects' areas and potentially cross national boundaries.
    - There should be a focus on the extent of the impact.
    - There should also be a focus on source-impact-pathways and the receptors' annual cycles, including foraging, resting, and movement areas.
    - A screening should be conducted to identify which species should be included in the CIA.
    - The ideal area is the area of the global population, but due to practicalities and availability of data, it is recommended that smaller units (e.g. regional populations) are assessed.
    - If resources are constrained, vulnerable species should be prioritised.
    - The scope should not only include similar project types.

- Specifically for temporal scope:
    - The three-part definition of time should be considered in the CIA.
    - It must be defined what the three-part definition entails.
    - 'Current' and 'future' projects should be understood as operational, approved, and proposed projects.
    - The actions to be included are both plans, projects, and other activities.
    - The scope should not solely be based on the project's time frame. The extent and frequency of an effect and the recovery time should also be taken into account.
    - Data availability is essential in terms of conducting valid assessments. Future projects can be categorised in tiers of certainty to account for this.

A case study of the current CIA practice

7

This chapter will contain two parts; the conceptual understanding of CIA, and determining the geographical and temporal scope. As a part of the investigation of the Danish CIA practice, two Danish OWF projects are assessed and interviews with four experts and three authorities are conducted. To investigate the UK practice two UK OWF projects are assessed and interviews with three experts are conducted. Firstly, the focus will be on the conceptual understanding of CIA where respectively the Danish practice and UK practice will be presented and analysed by reviewing the CIAs and interviews. After presenting the two practices, a comparison will be made, where the focus is on the similarities and differences between the two practices. The same approach will be used for the analysis of how to define the temporal and geographical scope.

7.1 Conceptual understanding of CIA

7.1.1 Danish practice

The EIA for KF is divided into different subreports, where subreport 2: Purpose and background, and subreport 3: The marine environment are included in this case study. In the second subreport of the EIA for KF, cumulative *effects* are defined as:

> *"environmental impacts arising as a result of the stepwise increased impacts from the project and other existing, utilised, and unutilised consent, or approved plans for other projects. Cumulative effects can be inflicted by individual smaller impacts, which are significant when combined with other impacts from the same or other projects"* [NIRAS and COWI, 2015a].

The definition presented in the third subreport differs slightly from the one above. The phrasing differs a bit, but there is consistency in the terms that are applied. The last sentence of the above definition is not included, but instead, it is highlighted that it should be assessed whether an effect will intensify or decrease when assessed cumulatively with the effects of other actions. Additionally, the actions that should be assessed in connection with the given project are extended to include other activities as well [NIRAS and COWI, 2015b]. Mette Jeppesen [External Appendix F], who works at NIRAS and was the project manager on the EIA for KF, mentions that her work with CIs has been based on a previous guide and the Danish law of EIA, but that there is room for interpretation in these since the content is more headlines than specific guidelines. Furthermore, these are not explicitly referenced in the CIA chapter of KF, making it opaque what the definitions are grounded on. Compared to the definitions in KF, Jeppesen's understanding of CIs has evolved to be more receptor-led. Jeppesen defines CIs as *"impacts on a receptor from the given project and other projects within the same zone of influence"*, where it

is the intensified effect on a receptor that is being assessed. The initial definition presented by Jeppesen only contained other projects, but as the interview progressed, it became clear that her understanding of which actions are included in the definition of a CIA is broader, and further entails activities and plans within the same zone of influence [Jeppesen, External Appendix F]. The definition in KF and the one presented by Jeppesen include a definition of 'future/reasonably foreseeable' and 'current'.

The CIA for VhS does not contain an explicit definition in the same way as KF. When reading through the introduction to the CIA chapter, it can be derived that the CIA is based on a definition of CIs as impacts on environmental receptors from the given project together with *"other existing and already implemented projects, (projects with) unutilised consent, and plans for other projects, as well as future plans and projects that are already known"* [Orbicon | WSP, 2020]. The report is thereby not incorporating the temporal aspects in the same way as the definitions found in the literature review, instead, the definition in VhS is unfolding and defining the concepts of 'current' and 'future/reasonably foreseeable'. Actions are defined as projects and plans, and other activities are thereby not included. It is further defined in the CIA for VhS, that 'other projects' are not only projects of the same type but also other types of projects which have potential impacts on the receptor being assessed. Furthermore, it is presented in the CIA for VhS, similar to the definition of CIA in KF, that the impacts to be included in the CIA can be impacts that are insignificant when assessed isolated since they can accumulate to a significant impact when combined with other impacts of other actions [Orbicon | WSP, 2020].

Project developer A and B [External Appendix H], and Louise Rønde Mønster [External Appendix G] define CIs as the accumulated impacts arising from the given project together with impacts from existing and future, planned projects. Project developer A additionally defines that CIs can both arise from activities within the project itself and with other activities in the locality. Mønster, who works at NIRAS, includes the aspect of how it is the planned projects for which there is a certainty that they will be carried through, in the definition. According to Mønster, her understanding of which temporal aspects are included in the definition has changed over the past couple of years, where existing projects were previously not perceived as a part of the CIA but as embedded in the baseline [Mønster, External Appendix G].

Conceptual understandings presented by representatives of Danish statutory authorities

Søren Keller [External Appendix D] from the Danish Energy Agency (DEA) presents a simple definition based on the Danish law of EIA: *"your own project in connection with other plans and projects, and how it affects the surroundings. (...) look at which possible projects are within the impact distances of the given project. Then you have to look at the overall effect it has"*. Hanne Lise Koed [External Appendix E] from the Danish Environmental Protection Agency (EPA) presents a more comprehensive definition of CIs. It is defined that a CI is an impact occurring when the impacts of a given project are added to the impacts of plans, and existing, consented, and planned projects. The term 'future' is defined as those projects that have been applied for, since this is perceived as a reasonable scope. Koed [External Appendix E] further emphasises that *"something else that is also part of the concept, is that it is all plans and projects that can affect the species or nature type you are assessing, and there must be a focus on the relevant geographical and temporal boundaries"*. Where the temporal aspects are not just defined as

overlapping phases, but also phases in succession. According to Koed, current practice does not live up to her definition of a CI, since some for example only focus on other OWFs, and thereby do not include the impacts of other project types.

Differentiating *impact* and *effect*

When questioned about the use of the two terms, both Mønster [External Appendix G], Jeppesen [External Appendix F], and Project developer A [External Appendix H] mention that they are used indiscriminately. Keller [External Appendix D] and Koed [External Appendix E], representing DEA and EPA, state that they understand the two terms synonymous - according to Keller, this could possibly be criticised, but it is currently not something DEA would clamp down on, since results of the assessments that matter. According to Jeppesen and Keller, the essential thing is, that it is described what happens with a receptor in the end. Keller from DEA, states that no matter how the terms are used in the CIAs there is no doubt about how to understand the assessments - *"I do not think that it matters that much in relation to the understanding of the specialist's reporting"*.

Differing usage and understandings of the terms are present both in the reviewed CIAs and amongst the interviewees. Table 7.1 summarises and illustrates the different understandings of the two terms, and compares them with the definition presented in table 6.2

From table 6.2	Activity/ Source	Pressure/Effect	Impact
Vesterhav Syd		Effect	Impact/Effect
Kriegers Flak		Impact/Effect	
Jeppesen		Exposure/Impact	Impact/Effect
Project developer A	Effect	Environmental impact/Impact	Impact/effect
Project developer B		Impact	
Mønster		Impact/Effect	
Keller (DEA)		Impact Impact/Effect	Effect
Eriksen (DEA)		Effect	Impact
Koed (EPA)		Effect Impact/Effect	Impact

Table 7.1. *Different understandings of the concepts, and how they match with the definitions presented in table 6.2.*

7.1.2 UK practice

The EIA for AyM is divided into several parts and in Volume 1, Annex 3.1: Cumulative Effects Assessment Methodology, cumulative *effects* are defined as:

"the effects on a receptor that may arise when the development is considered together with other existing and/or approved projects, plans and activities. A fundamental requirement of undertaking the Cumulative Effects Assessment (CEA) is to identify those projects, plans and activities with which AyM Offshore Wind Farm may interact to produce a cumulative effect.

These interactions may arise within the construction and operation and maintenance (O&M) phases of the project" [GoBe Consultants, 2022b].

It is further stated that all existing, and/or reasonable foreseeable projects, plans, and activities that can result in a cumulative effect in interaction with any part of AyM, should be taken into consideration in the CEA. Existing projects are a part of the baseline environment unless there is an ongoing effect e.g. bird collisions, whereas benthic habitat loss is a part of the existing baseline [GoBe Consultants, 2022b]. Definitions are both presented in the methodology chapter for CEA and in the specific chapters regarding Marine Mammals and Ornithology [GoBe Consultants, 2022a]. The definitions in the chapters are consisting of the same information as the general definition but differ a bit in wording since it is highlighted that the effect can occur from proposed and reasonably foreseeable plans and projects and that it is not only OWFs that should be included in the assessment [GoBe Consultants, 2022a,c].

In the methodology chapter, GoBe Consultants [2022b] has included six different definitions, from legal documents, policies, and guidance documents, which indicates that there is guidance and several definitions that can be used when consultants are conducting CEAs in the UK. This is further emphasised by Ryan McManus [External Appendix A], from GoBe Consultants who was the project manager on AyM, stating that there is a lot of guidance, because OWFs are perceived as *"nationally significant infrastructure projects"* and therefore get attention from the government. In the definitions from laws and policies presented in AyM, the temporal aspects of 'current' and 'future/reasonably foreseeable' are defined as *"projects for which consent has been sought or granted, as well as those already in existence"* [GoBe Consultants, 2022b]. McManus [External Appendix A] further states that the planned projects should also be considered as part of the 'future' projects.

In the case of EA1N a cumulative *impact* is defined as *"a result of the project in conjunction with other existing or planned projects within the study area for each receptor"*. This indicates that the three temporal aspects, that were commonly found in the definitions presented in section 6.1, are not incorporated, but that the focus is on 'current' and 'future/reasonably foreseeable'. It is further defined that:

"The CIA identifies areas where the predicted impacts of the construction, operation, maintenance and decommissioning of the project could interact with impacts from different plans or projects within the same region and impact sensitive receptors" [Royal HaskoningDHV, 2019a].

Opposite of GoBe Consultants [2022b], explicitly listing and presenting different definitions, it is not clear which definitions have formed the base of the definition presented in the CIA of EA1N [Royal HaskoningDHV, 2019c]. It is stated by Peter Braithwaite [External Appendix B], who was the project manager of EA1N in the end, that the legal team is an important part of the work with defining CI. The legal team will pay close attention to whether the definition used lives up to the legal demands and whether it can be misinterpreted. This indicates that the approach to synthesise a definition is more implicit and opaque, whereas AyM explicitly lists the various legal demands and policies that must be included in the process when a CIA is made.

When conducting assessments in EA1N, the approach 'source-pathway-receptor' is used. Receptor is defined in the CIA as "*the element of the receiving environment that is impacted*" [Royal HaskoningDHV, 2019c]. Source and pathway are respectively defined as "*the origin of a potential impact*", and "*the means by which the effect of the activity could impact a receptor*". By including definitions of the different terms a greater transparency is created. In the CEA Methodology for AyM, transparency is also created by defining terms such as *potential impact-receptor pathway, spatial effect interaction, and temporal effect interaction.*

The temporal aspects are further defined in the CIA of EA1N, where a definition from The Planning Inspectorate (2015) Advice Note 17 is presented. The temporal aspects of 'future' is further defined as:

- *"Projects that are under construction;*
- *Permitted applications, not yet implemented;*
- *Submitted applications not yet determined;*
- *Projects on the Planning Inspectorate's Programme of Projects;*
- *Development identified in relevant Development Plans, with weight being given as they move closer to adoption and recognising that much information on any relevant proposals will be limited; and*
- *Projects identified in other policy documents as development reasonably likely to come forward"*
  [Royal HaskoningDHV, 2019c].

Both AyM and EA1N present multiple definitions with similar meaning and wording. Sara Méndez [External Appendix C] from Ramboll, explains that in Ramboll UK they define and distinguish between two types of cumulative effects; inter-project and intra-project cumulative effects, as presented in the literature review. Méndez does not include the aspects of 'past', 'present', or 'reasonably foreseeable' in her definition.

Differentiating *impact* and *effect*

McManus [External Appendix A] explains that in AyM, 'impact' is the action that is happening, e.g. noise impacts. The impact combined with the sensitivity of the receptor creates an 'effect', and 'effect' is thereby the change on the receptor. When comparing the definitions presented by McManus and Braithwaite, the meanings are swapped around. McManus explains that GoBe Consultants defines the terms in this way because this is how they are defined in industry guidance. Table 7.1 summarises and illustrates the different understandings of the two terms, applied in UK practice.

From table 6.2	Pressure/Effect	Impact
McManus/Awel y Môr	Impact	Effect
Peter Braithwaite/East Anglia ONE North	Effect	Impact
Méndez	Impact	Effect

Table 7.2. *Different understandings of the concepts, and how they match with the definitions presented in table 6.2.*

7.1.3 Differences and similarities between practices

Different definitions of the concepts of CIA have been found both within the UK and the Danish practice. None of the presented definitions are completely similar, but there are different similarities between some of them. When comparing the four CIAs it is evident that the two from the UK have a greater level of detail, and include definitions of several concepts of CIA [GoBe Consultants, 2022b; Royal HaskoningDHV, 2019c; NIRAS and COWI, 2015b; Orbicon | WSP, 2020]. Furthermore, AyM incorporates several definitions, both a general one, some specific to the CIA for ornithology and marine mammals, and some presented in relevant legal documents and guidance [GoBe Consultants, 2022b,c,a]. In contrast to the definition presented in AyM, VhS does not explicitly provide a definition, and Keller [External Appendix D] presents the shortest definition.

That the CIA should focus on the relevant zone of influence (ZOI), is also incorporated in the definitions by Royal HaskoningDHV [2019c] and Jeppesen [External Appendix F]. Another aspect incorporated in some of the definitions is that the projects that should be included in the CIA, should not only be OWFs [GoBe Consultants, 2022b; Orbicon | WSP, 2020; Koed, External Appendix E]. In terms of which actions to include, one Danish consultant and CIA, and one UK consultant and CIA, defines that both plans, projects, and activities ought to be considered [Jeppesen, External Appendix F; NIRAS and COWI, 2015b; McManus, External Appendix A; GoBe Consultants, 2022b]. In comparison, one Danish CIA, three Danish experts, one representative of DEA, and one UK CIA, define that it is plans and projects which ought to be considered [Orbicon | WSP, 2020; Project developer A, External Appendix H; Project developer B, External Appendix H; Mønster, External Appendix G; Keller, External Appendix D; Royal HaskoningDHV, 2019c]. Both UK CIAs, one Danish consultant, VhS, and the representative of EPA incorporate a focus on receptors in the definition [GoBe Consultants, 2022b; Royal HaskoningDHV, 2019c; Jeppesen, External Appendix F; Orbicon | WSP, 2020; Koed, External Appendix E]. Both AyM and EA1N further define which of the given project's phases are to be assessed in the CIA [GoBe Consultants, 2022b; Royal HaskoningDHV, 2019c].

In terms of incorporating a definition of the relevant temporal aspects, all definitions containing temporal aspects, mention 'current' and 'future' in some way. The definitions mention either 'other projects' or 'existing projects', whereas the definitions contain several different descriptions of which 'future' actions are part of a CIA. Table 7.3 presents the different descriptions, and highlight which projects and experts include them in the definition.

	KF	Jeppesen	VhS	Koed (EPA)	Project developer A and B	Mønster	AyM/ McManus	EA1N/ Braithwaite
Applied projects				+			+	+
Consented/approved projects				+			+	+
Utilised consent	+							
Unutilised consent	+		+					
Planned/future projects			+ (known)		+	+ (certain that they will be implemented)		
Future plans, that are known			+					
Plans		+		+			+	
Approved plans for other projects	+		+					
Projects identified in plans, policies, and programs								+

Table 7.3. *Different descriptions of which 'future' actions are expected to be part of a CIA. + marks that the interviewee or CIA incorporates it.*

As the table illustrates, there are different definitions of which 'future' actions are contained in a CIA. The majority of the definitions indicate that 'future' projects are those that are consented or applied for. This is the case for 4/5 UK definitions and 3/8 Danish definitions. It should be noted, that not all interviewees explicitly mention temporal aspects, or elaborate these in the definition, but that does not necessarily mean that they do not see it as relevant. All interviewees presented their understanding of which temporal aspects ought to be included when questioned about it - this will be presented in section 7.2. None of the four CIAs for OWF projects include 'past' in the definition. Neither do any of the interviewed practitioners, project developers, or authorities. It is argued either in the reports or by the project managers of the EIAs, that the past actions are not relevant to include in the CIA, since they are part of the baseline [NIRAS and COWI, 2015a; Jeppesen, External Appendix F; GoBe Consultants, 2022b; McManus, External Appendix A; Royal HaskoningDHV, 2019c; Méndez, External Appendix C; Mønster, External Appendix G]. This is further emphasised by Méndez [External Appendix C] and Project developer B [External Appendix H], who state that they have never experienced that past projects have been included in a CIA. Given that none of the definitions found in the case study, focus on past projects, it can be argued that this is not perceived as a necessary temporal aspect to include in the CIAs, by practitioners, even though it is included in several definitions found in the literature review. Even though the definitions do not include the three temporal aspects, some of the definitions are more elaborated in terms of other aspects. The definition in KF elaborates that impacts should not be excluded from the CIA based on the isolated assessment [NIRAS and COWI, 2015a], and both AyM and EA1N define some of the concepts relevant to a CIA [GoBe Consultants, 2022b; Royal HaskoningDHV, 2019c] - as requested in the literature review.

When assessing the use of respectively 'impact' and 'effect' in the definitions, the practice in UK appears to be more certain and streamlined. The two terms are clearly distinguished and defined by experts and in the CIAs. McManus [External Appendix A] and the definitions in AyM [GoBe Consultants, 2022b] do however describe them opposite of how it is done in EA1N [Royal HaskoningDHV, 2019c] and by Méndez [External Appendix C]. According to Méndez, it does not

matter which of the two terms are applied, and using them interchangeably will not affect the result, as long as it is described up front how they are used in the specific CIA. In Danish practice, there seems to be a greater uncertainty as to whether they are synonymous or distinct, and in terms of how they should be defined. Furthermore, it is not clearly defined in the Danish CIAs how the two terms are defined and used [NIRAS and COWI, 2015a,b; Orbicon | WSP, 2020]. The results indicate that even though the findings of the literature review suggest that both terms are described and included in the definition, it is not necessarily the case in practice. The practice in UK does however appear more aligned with the recommendations found in the literature review, than the Danish practice where most of the key problem areas appear to be present. A general tendency is, that the definitions are more elaborated, and supplementary definitions of key concepts are provided in the UK CIAs, whereas the Danish practice and understanding is more opaque. Table 7.4 is a compilation of whether the practitioners agree with the challenges identified in the literature review.

	Linguistic ambiquity	**Insufficient definitions leaving room for uncertainty**	**Key concepts are not properly defined**	**No agreed definition**
Koed (EPA)	+	+	+	+
Jeppesen		+	+	+
Project developer A		+	+	+
Project developer B			+	
Keller (DEA)		+ (not perceived as a problem)	+ (not perceived as a problem)	+
Eriksen (DEA)		+ (not perceived as a problem)		+
Mønster		+		+
Méndez	-	+ (not perceived as a problem)	-	-
McManus	-			-
Braithwaite				-

Table 7.4. *Practitioners' understanding of whether the challenges found in the literature review are present in current practice. + marks that the interviewees agree with the challenges. - marks that the interviewees disagree with the challenges. Fields are left empty if the practitioners have not explicitly commented on it.*

Definitions influencing practice

In the literature review, it is found that different definitions lead to differing understandings of what a CIA is and should contain, which leads to differing approaches in the CIA practice. Koed [External Appendix E] from EPA emphasises that practice is influenced by the lack of clear definitions and guidance, and states that by creating a guidance document on how to conduct CIAs, the assessments and practice will become more consistent. The request for guiding definitions was mentioned several times during the interviews [Project developer B,

External Appendix H; Mønster, External Appendix G; Jeppesen, External Appendix F; Koed, External Appendix E]. Mønster emphasises that it is her understanding that practitioners are currently requesting guidance to be able to standardise practice. Since it is a challenging task, proper guidance can support practice and make the process easier for the consultants, and it will also be easier for the authorities to respond to the reports given that they will be more consistent. Jeppesen highlights that having multiple different definitions results in assessments that are not sharp enough. It is further elaborated that there is missing clarity of what is meant when using terms such as 'pressure', 'impact', and 'receptor' [Jeppesen, External Appendix F]. Méndez [External Appendix C] states that it is not a problem within her organisation, that different definitions occur in practice because they ensure that everyone working on the specific EIA and CIA has the same understanding of the concepts. Méndez further emphasises that it is her impression that the different UK consultancies strive to do the same, and underlines that the most important part is to *"describe them (the terms) up front, then it doesn't really matter which one you use"* [Méndez, External Appendix C].

7.2 Determining the geographical and temporal scope in CIAs

7.2.1 Danish practice

Neither of the Danish EIAs has a method chapter or sections explicitly stating the approach to identifying the relevant temporal and geographical scope. It will therefore be deduced from the topic-specific CIAs and the conducted interviews, what the current Danish practice is. The first step presented in KF and by Jeppesen, is to conduct a screening of which planned projects the impacts from KF can potentially accumulate with. This is done by assessing how large an impact zone the project has - this zone must be defined for each receptor. Projects, plans, or activities within the impact zone, are listed and included in the CIA [Jeppesen, External Appendix F; NIRAS and COWI, 2015b]. The list of projects is then screened using the time schedule for KF, in order to investigate which projects or other activities may have phases overlapping with the ones of KF - either in the construction or operational phase [NIRAS and COWI, 2015b]. But it can be difficult to know for sure, whether there are potential overlaps if projects are only in the planning stage. The final list of projects to include in the CIA was prepared in collaboration with Energinet[1] and DEA. The practitioners did not think that they could be responsible for finalising the list, and therefore they cooperated with DEA to ensure that they covered all relevant actions [Jeppesen, External Appendix F]. Existing projects that are fully established are not part of the CIA, because they are perceived as part of the existing conditions [NIRAS and COWI, 2015b; Jeppesen, External Appendix F]. This does not live up to the definition presented in KF, because it is defined that 'future/reasonably foreseeable' and 'current' projects, plans, and activities should be included in a CIA [NIRAS and COWI, 2015b].

Mønster states that it is not necessarily all the projects included in the assessment, that are relevant for all environmental topics, and elaborates that the scope is very dependent on the specific topic. So she recommends taking one topic at a time and examining how big an area is relevant to include, in order to create an adequate assessment. The approach can be to focus on the receptor, and the extent of the impact from the OWF in question, as well as the extent of the other projects' impacts. It is further highlighted that it is important to argue for decisions made

[1] A public enterprise owned by the Danish Ministry of Climate, Energy and Utilities.

in relation to the scope [Mønster, External Appendix G]. Jeppesen explains that when identifying the scope, they are not allowed to use standardised distance requirements, and cannot use it as an argument that an area is X kilometers away and therefore there is no impact. They must argue and explain why it is not relevant to include the projects in the cumulative assessment [Jeppesen, External Appendix F]. The approach used in KF to determine which projects must be screened in, differs dependent on whether the focus is on birds or marine mammals. In the case of birds, the focus is on the migration areas and the birds' bio-geographic areas:

- Bio-geographical area: Mapping the birds' migrating, foraging, and resting areas, which are species-specific and differs from population to population.
- Migration areas: Focusing on how large the migration area is, and whether there are other parks within the migration area of the species in question. This can e.g. be migrating common cranes, where German offshore wind farms are included in the CIA for KF because they are within the common cranes' migration area.
  [NIRAS and COWI, 2015b]

Jeppesen [External Appendix F] explains that experts were included in the identification of the relevant scope, in connection with the CIA for KF. This is also mentioned by Mønster, who also worked on the EIA for KF. Mønster explains that there was cooperation between Danish practitioners and UK practitioners in relation to conducting the CIA for birds. It was her experience, that the UK practice was more

"systematic, methodical, and developed. (...) many hours were spent on it - and it was made many years ago, and we were like 'wow, do we really have to do all of this'. So they are definitely ahead in the UK" [Mønster, External Appendix G].

The more systematic UK-influenced approach is evident in the lists presented and approaches applied in the assessment of CIs on common cranes in KF. In the case of marine mammals, the aspect determining the scope is noise propagation from the activity, and there is a focus on different sources of noise [NIRAS and COWI, 2015b]. When comparing the CIAs for birds and marine mammals, it is clear that the one made in cooperation with UK practitioners is more in-depth, detailed, and transparent method-wise, compared to the one only made by the Danish practitioners. Project developer A [External Appendix H] and Mønster [External Appendix G] refer to an approach similar to the one presented by Jeppesen [External Appendix F], where the focus is on the distribution of the impact and the patterns of the receptor.

The approach to identifying the scope of the CIA for VhS is somewhat similar to the one applied in KF. There is likewise a focus on migration routes, migration areas, and resting and foraging areas, in order to identify which actions should be included in the CIA, and a list of relevant actions is presented. Just as for KF, there is a focus on which projects and plans are in the area, and which coincide in time and are thus included in the CIA. In the assessment, activities such as sailing and fishing are not included, but the actions that are included are other OWFs and raw material extraction. Existing projects are also not included in the CIA but in the existing conditions [Orbicon | WSP, 2020]. This does not live up to the definition presented in VhS, where it is defined that 'future' and 'current' projects should be included in a CIA [Orbicon | WSP, 2020] - it is thereby apparent that both Danish CIAs do not fulfill the definition they present.

The approach applied in VhS is not very transparent, leaving the reader a bit confused as to why some projects are scoped in while others are not. The lack of an interview with the project manager of VhS further complicates the understanding of how the scope is identified. Given that the approach is as opaque as it is, it can be concluded that there is room for improvement in terms of methodology.

In terms of defining the temporal scope, Mønster explains that practice used to be, that existing projects would not be included in the CIA, but it is something that, in her opinion, is now being done to a greater extent. Current CIAs are therefore striving to include both projects that are operational and planned. But it is highlighted that it is difficult to know when a plan is reasonably foreseeable and should be included in the assessment. Mønster mentions that the OWFs in the Danish maritime spatial plan are unspecified and thus they should not necessarily be included. This is because there is no knowledge of *"where these mills will be located and how much they will fill"*. Plans where there is more concrete knowledge, where there e.g. has been a publicity phase, or where something is publicly available on DEA's website, should however be included in the CIA [Mønster, External Appendix G]. This is further emphasised by Project developer A, stating that it is generally a difficult task, but if the projects are approved, they ought to be included. In addition, Project developer A [External Appendix H] and Mønster [External Appendix G] agree that it is important to cooperate with the DEA when identifying the scope, as they have a greater overview of which projects, plans, and activities are in the pipeline.

In the starting phase of the CIA, it is important to create a temporal overview of which other actions may overlap with the OWF in question. Mønster explains that when creating this overview, it is usually divided into the phases of construction and operation:

> *"Much of the cumulative is about the construction phase, and if you know there are no overlapping construction phases, then you can screen out those projects quite quickly. Then there is the operation phase, and that is something else, where you have to look at a longer time perspective"* [Mønster, External Appendix G].

The projects' operational phases do not necessarily need to be overlapping, but if they are in continuation of each other, the projects' ought to be included in the CIA [Mønster, External Appendix G; Project developer A, External Appendix H].

Danish statutory authorities' expectations to practice of identifying the scope

Representatives from DEA and EPA present different focus areas for identifying the relevant scope for a CIA. Amongst these are migration routes, the distribution of impact, and a focus on the relevant receptors [Keller, External Appendix D; Koed, External Appendix E]. Keller presents an approach similar to the one mentioned by Jeppesen and applied in KF, where an initial screening is carried out. The initial screening is of a gross list of which projects are likely to be established. Keller explains that:

"We look at the gross list and look primarily at how far they are in the planning phase, but we also look at the relevance in relation to the distances (...). We use these gross lists, but you can't always see them. Sometimes they are in the appendices and sometimes they are only used in the beginning in dialogue with the consultant. But of course, it should be included in the EIA, but I'm not sure that it always is" [Keller, External Appendix D].

Although Keller mentions that this gross list is shared with consultants, it is not obvious to the consultants which projects DEA expect to be considered. Mønster explains that she is not aware of a gross list, but that it would be optimal to have a joint gross list in practice, and emphasises that for this to work in practice, it is important that the list is regularly updated [Mønster, External Appendix G].

DEA put forth a rule of how an area must be included in the CIA, if 1% of the flyway population is present. Keller [External Appendix D] and Koed [External Appendix E] express that the assessment should not include the entire area of the entire flyway population, since that could quickly become unmanageable and unrealistic. Keller elaborates:

"In individual projects, we have tried to map the entire flyway population and the entire distribution area, and this causes some problems and it does not quite make sense in practice".

In addition, Keller and Koed point out that it will make more sense in practice to focus on the regional level to make the assessment manageable. Koed further explains that it is difficult to decide which actions should be included in the temporal scope, but mentions that projects that have applied for consent should be included. Keller states that in DEA they are following a guiding principle that states, that projects with consent must be included in the scope. Projects without consent must be investigated further to assess whether they are relevant to include. Keller and Koed both mention that other project types than OWFs have to be included, but Keller explains that according to DEA, fishing, sailing, and other human activities should be part of the baseline. Keller explains that DEA perceives it as important to be transparent in the assessments and justify which projects are included and which are not.

7.2.2 UK practice

Both EA1N and AyM have method chapters presenting the general approach used for conducting CIAs. These method chapters also contain a general definition of the concepts of CIA, e.g. CI, 'future' project, and impact-pathway, and they state which other project types and plans are relevant to be considered in the CIA. Both approaches appear to be mainly based on *Advice note 17* published by the UK Government [Royal HaskoningDHV, 2019c; GoBe Consultants, 2022b]. The advice note contains *"advice regarding a staged approach and the use of consistent template formats for documenting the CEA within an applicant's Environmental Statement"* [The Planning Inspectorate, 2019]. The staged approach from Advice note 17 is presented in AyM as:

> *"**Stage 1** - Establish the project's zone of influence (ZOI) and identify a long-list of 'other development'*
> ***Stage 2** - Screening of long-list: Identify a short-list of 'other development' for the CEA*
> ***Stage 3** - Information gathering*

> ***Stage 4*** *- Assessment"*
> [GoBe Consultants, 2022b].

In EA1N an initial long-list of projects is made, based on which projects have the potential to interact with EA1N. As presented in section 7.1.2, EA1N contains a definition, from Advice note 17, of which 'future' projects ought to be included in the CIA. EA1N further presents that the advice note describes that *"projects which were sufficiently implemented during baseline survey are considered as part of the baseline"*, being valid for both 'past' and 'current' projects [Royal HaskoningDHV, 2019c]. An example is background activities such as fishing, which is part of the baseline of the existing environment [Royal HaskoningDHV, 2019a]. Once an initial long-list is made, the actions are allocated into *Tiers of certainty*. The CIA in EA1N works with the following tiers originating from guidance by Joint Nature Conservation Committee and Natural England:

> *"**Tier 1:** Built and operational projects;*
> ***Tier 2:** Projects under construction;*
> ***Tier 3:** Projects that have been consented (but construction has not yet commenced);*
> ***Tier 4:** Projects that have an application submitted to the appropriate regulatory body that have not yet been determined;*
> ***Tier 5:** Projects that the regulatory body are expecting to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects); and*
> ***Tier 6:** Projects that have been identified in relevant strategic plans or programmes"*
> [Royal HaskoningDHV, 2019c].

For each topic that should be assessed in the CIA, a ZOI is identified. For offshore ornithology, this is based on the *"Biologically Defined Minimum Population Scale/size regions"* [Royal HaskoningDHV, 2019d]. A UK guide that defines these regions based on the species' annual cycles (breeding and non-breeding) is used for this step. Then the long-list is screened for which projects are within the defined ZOI for ornithology, and which of these cause impacts that can potentially accumulate with those from EA1N. It is further assessed which long-list projects within the ZOI have temporal overlaps with EA1N [Royal HaskoningDHV, 2019d]. The approach is similar for marine mammals, except that it is specified, that the temporal overlap is for all phases, and not just overlap of e.g. construction phases. It is further specified, that to take potential delays and changes into account, it is assumed that construction of tier 3 consented projects can occur within seven years from the date where consent is given [Royal HaskoningDHV, 2019b]. When identifying the relevant short-list, impact distances defined in guidance specific for the assessment of impacts from noise on harbour porpoise, are applied. In this way, it can be identified which projects have impacts reaching into the specified ZOI [Royal HaskoningDHV, 2019a]. According to Braithwaite [External Appendix B], the determination of the relevant scope is made on a topic-to-topic basis, but with a well defined approach. The general approach is defined in the methodology chapters or sections, making it apparent how and why specific actions are excluded or included. The project specific long-lists and topic specific short-lists are also presented in the relevant chapter or sections. During the process of determining the relevant scope, authorities and expert groups are also consulted, to ensure that nothing is missed [Braithwaite, External Appendix B].

AyM is based on the same staged process but explicitly defines a ZOI for each project type deemed relevant for the topics included in the CIA. Examples of ZOIs from the long-list are 500 km from AyM for offshore energy projects and up to 200 km for oil and gas projects [GoBe Consultants, 2022b]. According to McManus [External Appendix A] these are defined in cooperation with the relevant authorities and stakeholders. Once a long-list is created, the actions are allocated into tiers. McManus explains that the projects or plans that are in the earliest phases have the lowest level of certainty meaning that they would be in the less certain tiers, and weigh less in the assessment. AyM applies an approach from Advice note 17 as presented in table 7.5:

Tiers	Development stage
Tier 1	Projects under construction. Permitted applications, whether under the Planning Act 2008 or other regimes, but yet implemented. Submitted applications, whether under the Planning Act 2008 or other regimes, but not yet determined.
Tier 2	Projects on the Planning Inspectorate's Programme of Projects where a scoping report has been submitted.
Tier 3	Projects on the Planning Inspectorate's Programme of Projects where a scoping report has not been submitted. Identified in the relevant Development Plan (and emerging Development Plans with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited. Identified in other plans and programmes (as appropriate) which set the framework for future development consent/approvals, where such development is reasonably likely to come forward.

Table 7.5. *Tiers presented in Advice note 17 and incorporated in AyM (table 4.4 in report by GoBe Consultants [2022b]).*

It is presented that dividing projects and plans into tiers:

"allows the cumulative impact assessment to present several future development scenarios, each with a differing potential for being ultimately built out. This approach also allows appropriate weight to be given to each scenario (tier) when considering the potential cumulative impact. The proposed tier structure is intended to ensure that there is a clear understanding of the level of confidence in the cumulative assessments provided in this report" [GoBe Consultants, 2022b].

The tiered long-list is then screened for interactions and by using topic-specific screening ranges. For some receptors, topic-specific km ranges are defined, whereas it is *"dependent on the reference population extent, i.e. the Celtic and Irish Seas management unit for harbour porpoise"*, and *"dependant on the maximum foraging range of the bird species in question"*. The topic-specific screening ranges are used to identify the relevant short-list of plans and projects [GoBe Consultants, 2022b]. For example, the topic-specific range for offshore ornithology is based on breeding bio-season and non-breeding bio-season, as in EA1N, and foraging distances. Gannet is the key receptor that has the largest foraging distance (509 km from the project), and this distance is used to define the ZOI for all key receptors. For marine mammals, the geographical

scope is based on the relevant management unit, and the temporal scope is defined as the construction phase of AyM +/- one year. Projects or plans are screened out if the interaction criteria are not fulfilled. These are presented in table 7.6:

Term	Criteria
Potential impact-receptor pathway	There is the potential that a pathway exists whereby an impact could have an effect on a receptor. For example, increases to suspended sediment concentration could have an impact on fish and shellfish receptors, but underwater noise could not have an effect on aviation and radar receptors.
Spatial effect interaction	The impacts on a receptor from AyM and one more other plans/projects have a geographical overlap. For example, underwater noise contours from piling AyM could overlap with those of another offshore wind farm project, if it is sufficiently close to AyM. If there is no spatial interaction, there is no potential cumulative effect.
Temporal effect interaction	The impacts from AyM and one or more other plans/projects have the potential to occur at the same time. If there is no temporal interaction, there is no potential for a cumulative impact.

Table 7.6. *Screening criteria for interaction presented in AyM (table 4.5 in the report by GoBe Consultants [2022b]).*

The presented steps in table 7.6, are followed in the specified order, to ensure transparency in terms of why projects or plans are screened in or out. During the screening, projects for which there is limited or no data available and for which the effects are uncertain, are also screened out [GoBe Consultants, 2022b]. According to McManus [External Appendix A], whether or not a project or plan is scoped out due to low data confidence, depends on what is missing. If there is no available data or timeline, it won't be possible to conduct a meaningful assessment, but if there e.g. is information about the project but no timeline, it would still be included. McManus explains, that

"Then you could do a high level assessment of what that impact might look like if it did occur at the same time, but it would have a lower degree of certainty attached to it, and it should be given less weight in any decision because you don't have confidence that it is actually going to happen. That project could be delayed or when information does come out about the time frame, it could occur many years in the future, once your project has already been built."

The main aspect of determining which projects or plans should be included in the short-list for a given species is whether there is a conceptual impact-receptor-pathway, meaning that if the ZOIs are not overlapping, the project is not relevant. Then the second step is to assess whether there are temporal overlaps of the specific project's activities and the activities of the projects identified within the defined ZOI [McManus, External Appendix A]. Méndez [External Appendix C] agrees that the geographical scope should be based on the ZOI because the impacts of projects

or plans beyond this can not accumulate with those of the project being assessed. According to Méndez, the ZOI can be identified for each topic, or a precautionary approach can be applied, where the biggest ZOI is used for all topics. For birds, the ZOI ought to be defined for each species, where *"you'll have to look at both breeding sites, foraging sites, and distribution"*, and if data is not available, worst-case assumptions must be made [Méndez, External Appendix C].

Both EA1N and AyM are primarily focusing on identifying 'future' projects, where the 'current' are most often included in the baseline. It is however stated in the definition of CIs in AyM, that ongoing impacts such as bird collision should be included in the CIA and not in the baseline. This is further emphasised by McManus and Méndez, stating that 'current' or 'past' projects and impacts that have already had an affect, are in the baseline, whereas the ongoing impacts from 'current' projects should be included in the CIA. Both EA1N and AyM include impacts from different types of projects in the assessment, and McManus [External Appendix A] express that *"you would take into account any projects, plans, and activities that were having the same impacts that you were having basically, so anything that's resulting in a habitat loss or disturbance"*. This is further emphasised by Méndez [External Appendix C], stating that during the expected construction period of the specific project, the impacts from other projects within the identified ZOI which are also undergoing construction or are under operation should be included in the CIA. The overlap of impacts from a project under construction and one in operation might be limited for some aspects, but both phases can e.g. pose a barrier to birds' movements.

7.2.3 Differences and similarities between practices

Different approaches to identifying the relevant scope in a CIA have been found in the reviewed CIAs and presented by the interviewees. Some of the approaches are very similar, while others differ. When comparing the four CIAs it is evident that the two from the UK have a greater level of detail, and include more thorough descriptions of the applied methodologies. The CIA of AyM has an appendix designated for the description of the legislative background of the CIA and the methodology for identifying the relevant scope. Of the 81 pages describing the CIA, 18 are solely describing the overall approach to identifying which projects, areas, and receptors are relevant to include. The long-list is presented as an annex in the appendix, and the topic-specific chapters present the specific method applied to create the individual short-list [GoBe Consultants, 2022a,b,c]. EA1N has a general methodology chapter, where four pages are designated for the description of the overall CIA methodology for identifying the scope. Each topic-specific chapter presents which actions are to be considered for the CIA, and there is an appendix describing the specific approach to identifying the individual short-list [Royal HaskoningDHV, 2019a,b,c,d]. It is evident that the Danish EIAs do not have an equivalent focus on describing the methodology of the CIA. In KF, less than one page is used to describe the applied approach to identifying the scope [NIRAS and COWI, 2015a,b], whereas there is no explicit description in VhS [Orbicon | WSP, 2020]. The Danish practice thereby appears superficial and opaque compared to the one of UK. It should be noted that quantity is not perceived as equivalent to quality, but as the four CIAs were reviewed, greater confusion was present when trying to figure out the approach applied in the two Danish CIAs as compared to the ones from UK.

Besides having more thorough and explicit method descriptions, UK practitioners appear more confident and certain as to how a CIA should be undertaken. Whereas the Danish practitioners appeared more insecure and often appeared to be in doubt as to what would be the proper way to conduct a CIA. It also appears that all UK practitioners reference different guidance, and base their practice on this. In comparison, the Danish practitioners seem to base their practice on previous experience to a higher degree. Jeppesen [External Appendix F] explains that when looking through the current Danish guidance, it becomes obvious that *"it says nothing about cumulative impacts"*. The current lack of guidance is a reflection of one of the key problem areas found in the literature review: That there currently is no agreed approach as to how the geographical and temporal scope ought to be identified.

There are also similarities between the CIAs, and both KF and VhS do, like the UK CIAs define a list of relevant projects. The approach to defining these lists is however not similar. The UK approach is more comprehensive and step-wise, where it is obvious how and why actions are scoped in or out. The Danish lists are also shorter than the UK short-lists, indicating that the Danish practice of CIA might be more local than the one of UK. This is also in accordance with the expectations expressed by Keller [External Appendix D] from DEA and Koed [External Appendix E] from EPA, since it is stated that the assessments should be done at a manageable level and that a regional focus is perceived as suitable. This approach can be a way to overcome the challenge found in the literature review, of how the level of insecurity rises as more actions are included in the scope, where a focus on smaller units such as regional populations is also recommended. The scope in the UK assessments and the one for KF are however larger and focus on the relevant bio-geographic area for the given species. Given that the CIA for the common crane in KF was conducted in close cooperation with UK colleagues, it can be assumed that this is why KF has a broader focus in this assessment.

When identifying which projects ought to be included on the lists, it is found to be common practice both in UK and Denmark, that only 'future' projects are included because 'current' operational projects are perceived as being part of the baseline. In UK 'current' projects are however scoped in for the CIA if they have ongoing effects [McManus, External Appendix A; Méndez, External Appendix C]. This is presented as an evolving tendency by some of the Danish practitioners because the concept of 'shifting baselines' has gained attention [Mønster, External Appendix G; Jeppesen, External Appendix F].

There appears to be a common focus on receptors and areas relevant to the specific species, where both UK and Danish practitioners strive to define the relevant ZOI - noting that all UK practitioners mention ZOI specifically whereas the Danish practitioners are more vague in the phrasing and not all interviewees mention this aspect. In relation to defining the ZOI and screening which projects ought to be scoped in or out, the problem of data availability, which was also found in the literature review, is a reoccurring aspect. Two barriers related to data availability have been put forth by the interviewees. One, which is mainly mentioned by Danish practitioners, is related to knowledge about the specific species [Eriksen, External Appendix D; Keller, External Appendix D; Koed, External Appendix E; Jeppesen, External Appendix F; Project developer A and B, External Appendix H], another mentioned both by UK and Danish practitioners is related to knowledge of other projects [Eriksen, External Appendix D; Keller, External Appendix D; Koed, External Appendix E; Jeppesen, External Appendix F; Project

developer A and B, External Appendix H; Mønster, External Appendix G; McManus, External Appendix A; Braithwaite, External Appendix B; Méndez, External Appendix C]. There seems to be more data and knowledge of species available in the UK, where both AyM and EA1N refer to e.g. mappings of offshore ornithology [GoBe Consultants, 2022c; Royal HaskoningDHV, 2019d], and the lack of knowledge of other projects is handled through tiers of certainty, where scenarios and assumptions are made [Royal HaskoningDHV, 2019c; GoBe Consultants, 2022b]. In comparison, there is currently no standardised way to handle this lack of knowledge of other projects in the Danish practice.

Eriksen and Mønster also highlight that one of the biggest problems is, that it is unclear how to identify the proper scope - both in terms of approach, which aspects to consider, and the level of detail. In contrast, both McManus and Méndez indicate that there are not really any problems related to the current practice of identifying the relevant scope. This indicates a Danish need for greater clarification of the fundamental aspects, such as how to approach a CIA. This can also be derived from table 7.7, highlighting whether the different practitioners experience the problem areas found in the literature review, in the current practice.

	Unclear practice: What is in/out, and why?	*Lack of data/ knowledge*	*Difficult to determine for highly mobile species*	*Bigger area = Bigger uncertainty*	*No agreed approach (geographical)*	*No agreed approach (temporal)*	*Unclear which past, present and reasonably foreseeable project to include*
VhS	+ (observed in CIA)						
Jeppesen/ KF	+	+	+	-	+	+	+
Project developer A		+	+		+	+	+
Project developer B					+	+	+
Mønster	+	+	+	+	+	+	+
Keller (DEA)		+	+	+	+	-	
Eriksen (DEA)	+	+	+	+	+	-	+
Koed (EPA)	+	+	+		+	+	+
Méndez		+	+		-	-	-
McManus/ AyM		+ (future)	+		-	-	-
Braithwaite/ EA1N		+ (future)	+		-	-	-

Table 7.7. *Practitioners' understanding of whether the challenges found in the literature review are present in current practice. + marks that the interviewees agree with the problem areas. - marks that the interviewees disagree with the problem areas. Fields are left empty if the practitioners have not explicitly commented on it.*

7.3 Statutory requirements and guidance

To investigate why the current Danish practice appears more uncertain than the one in UK, all interviewees were asked whether they found it clear which statutory requirements must be fulfilled. Keller [External Appendix D] from DEA explains that

> *"We (DEA) strive to (clarify statutory requirements and expectations), but we do not know if we have done it properly. (...) We have some basic requirements and opinions in terms of how things should be done, but we have not written them down on paper and shown that this is the way it should be done. (...) We know most consultants and cooperate with most of the big ones (consultancies), so they know our opinion of how things should be and we know their view of the matter"* [Keller, External Appendix D].

Koed [External Appendix E] from EPA states that the authorities, both EPA and others, have not necessarily presented their requirements and expectations clearly, because the practice of conducting CIA is an area that still needs to be developed and it is something everyone finds difficult. The interviewed Danish experts agree that it is not clear what the statutory expectations for a CIA are [Jeppesen, External Appendix F; Mønster, External Appendix G; Project developer A, External Appendix H]. Project developer A elaborates that *"it is not super clear, but you kind of know what they want"*. Project developer A and Keller further mention that project developers, consultants, and authorities align expectations through dialogue. Because there is no clear definition of the concepts and expectations of CIA, the work is dependent of continuous talks with different stakeholders and authorities [Project developer A, External Appendix H]. Both Mønster, Koed, and Keller state that it could be beneficial to create some sort of common ground.

Keller further emphasise that there are different approaches to defining CIs and identifying the relevant scopes, in Denmark, and that this is the case because *"since there are no guidelines, the advisers are free to do it as they please"*. Koed states that there are different definitions and understandings, which are expressed by a non-uniform practice in terms of what is included in an CIA. The Danish experts also agree that different definitions and understandings are present in the current practice [Mønster, External Appendix G; Project developer A, External Appendix H; Jeppesen, External Appendix F]. Project developer A further express that *"there is a really big difference (in understandings) because it can easily become a section that is quickly run over"*. Méndez explains that the practice within Ramboll UK is uniform and that she is unsure whether practice differs amongst other UK practitioners. McManus expresses that Advice note 17 forms a good basis for defining and understanding the concepts of CIA, and that it applies to all of UK, except Scotland.

Opposite of the Danish practitioners' experience, the practitioners from UK state that they feel certain in regards of statutory requirements and expectations [McManus, External Appendix A; Méndez, External Appendix C]. Different reasons for this are presented by UK practitioners. Both McManus, Braithwaite [External Appendix B], and Méndez mention that there is guidance from the government, the Planning Inspectorate, and industry guidance, developed by different industry bodies and expert groups. There is also some guidance specific for CIAs of OWFs, defining and elaborating on how to approach the task of conducting a CIA. This is not the case

in Denmark, where Mønster states that the statutory requirements are not clearly described in the current guidance for the Danish law of EIA, *"because it is a guide that should be able to accommodate all sorts of things"*. This indicates that sector specific guidance is more applicable than broadly aimed guidance, and Mønster states that more specific guidance is requested since *"it would make it easier for us as consultants to relate to"* [Mønster, External Appendix G]. Besides having more specific guidance available, Méndez also mentions that *"I think it is because of the number of offshore wind EIA that have been prepared and been reviewed by the authority, I think there is already a common understanding of what should be covered and what not"* [Méndez, External Appendix C]. This indicates that the greater certainty expressed by UK practitioners, in terms of how to define, understand, and approach CIAs can be attributed to the specific guidance and amount of experience with CIAs of OWFs. According to Jeppesen and Koed, the current lack of guidance and clarified expectations can be attributed to a lack of resources and prioritisation by Danish politicians.

7.4 Sub-conclusion

Through the process of reviewing the Danish and UK practice in terms of the conceptual understanding, and the approach to identifying the temporal and geographical scope, it has been discovered that the UK practice is ahead compared to the Danish practice. The Danish practice is less transparent and it is not as easy to follow the different decisions made in the CIA. When looking through the CIAs from UK there are explicit and specific steps to follow, and it is explained how they have reached the decision of which projects, plans, and activities to include in the CIA. This is not possible when looking through the Danish CIAs. This gives the impression, that the Danish CIAs are prepared less thoroughly than the ones from UK, and they appear superficial compared to the UK CIAs. The UK CIAs are to a greater extent based explicitly on guidance. The CIA of AyM and EA1N provide a detailed description of which approaches and methods they have applied and emphasise that it is based on UK guidance. It is expressed by Project developer A [External Appendix H] that the UK practice is ahead of the Danish CIA practice because *"the Englishmen, are generally very good at preparing manageable guidance for different aspects"*. It is discovered that Danish practitioners are more uncertain when conducting CIAs, and experience that there are ambiguities in relation to how the assessments should be prepared. This uncertainty does not appear to be present in the UK practice, where the practitioners express that there is a clear framework outlining what they have to do, that there is a lot of experience with CIAs to lean on, and that there is close cooperation with the relevant authorities. It can thereby be concluded, that the challenges discovered in the literature review related to the conceptual understanding and identifying the proper temporal and geographical scope, are more evident in the Danish practice than in the UK practice.

Supporting the Danish CIA practice 8

The need for guidance that can support the practice of conducting CIAs is not new. The literature review indicates that more standardised methods and a more thoroughly defined frame have been requested since 1995. The majority of the academic articles included in the literature review are published between 2012 and 2019, indicating that the need for an improved practice was already present before the currently planned Danish expansion of the OWF industry was settled. This means that under the current circumstances, where most of the problem areas found in the literature review are still present in the Danish practice, the need for more standardised methods and a more thoroughly defined frame is more relevant than ever. This chapter will therefore investigate what should be in focus to ensure that tangible guidance - that will be used by practitioners - is created. By combining the results from the literature review, interviews, and the CIAs, recommendations for how to define and understand the key concepts of CIA, and how to identify the relevant scope, by using a standardised and practice-oriented approach will be put forth.

8.1 Tangible guidance

As mentioned in chapter 3 the European Union and Danish authorities have not provided any concrete and practice-oriented guidance to the Danish practitioners [European Union, 2017; The Ministry of Environment and Food of Denmark, 2018]. This is quite the opposite in UK, where there is more guidance on how the practitioners should carry out the CIAs. GoBe Consultants [2022b] and Royal HaskoningDHV [2019b] mention several guidance documents that have been used in the composition of AyM and EA1N. Advice note 17 is developed by The Planning Inspectorate [2019], which is a governmental agency working with different planning-related tasks, where the applications for OWFs is one of these. The Planning Inspectorate [2019] have compiled: "Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects", and Ryan McManus [External Appendix A] emphasises that this guidance is commonly used at GoBe Consultants when producing CIAs of OWFs. Another guidance document, referred to by Royal HaskoningDHV [2019b] is "Suggested Tiers for Cumulative Impact Assessment" by Scottishpower Renewables [2013]. Additionally, Royal HaskoningDHV [2019b] use knowledge and data from the guidance document "Non-breeding season populations of seabirds in UK waters" published by Furness [2015]. The guidance documents mentioned, are only a small part of the documents included in AyM and EA1N. This indicates that there is more guidance in the UK compared to Denmark. The practitioners from the UK highlight that they feel there is an adequate amount of guidance and that it is manageable to use in practice [McManus, External Appendix A; Braithwaite, External Appendix B].

As stated in section 5.2 practice requires both structures and agencies to be established [Johnson, 2008]. In the current Danish CIA practice, the only present structures that the practitioners/agents can follow, are the legislation and guidance that are currently described as inadequate. Practice is carried out in several different ways and different approaches are used because there is a lack of in-depth, detailed, and practice-related guidance on how CIAs should be prepared. As presented earlier, there is currently not much focus on the CIA in Danish legislation and guidance, which leaves room for practitioners to create their own practice. They have to fill out the lack of guidance by using their own knowledge, professional sense, and experience. Søren Keller [External Appendix D] points out that less strict guidance can be a good thing, as it provides room for freedom in the choice of methods. Keller further emphasises that he understands, why the practitioners find it challenging to conduct a CIA without further guidance. It can be argued that at present there is too much freedom of method and too much responsibility assigned to the practitioners, as the interviewed practitioners agree that the current practice is influenced by uncertainty [Jeppesen, External Appendix F; Mønster, External Appendix G; Project developer A and B, External Appendix H; Koed, External Appendix E]. According to Johnson [2008] and Nicolini [2012], the practice will be influenced by the practitioners no matter how much thorough guidance is put forth, because without practitioners, the guidance documents will not become an embedded part of practice. As several practitioners are unsure of how CIAs should be prepared, it is evident that a change in practice must be made in order to create the best conditions for protecting the marine environment. It is evident that the Danish practitioners are requesting further guidance to support their practice and ensure adequate CIAs [Jeppesen, External Appendix F; Mønster, External Appendix G; Project developer A and B, External Appendix H; Koed, External Appendix E]. This indicates that there currently is a window of opportunity for introducing guidance. For guidance to influence practice, it has to be embedded in practice and applied by practitioners, and it appears that there currently is a potential for implementing guidance. But the guidance must be practice-related and meet the needs of the practitioners to ensure that it will not end up being ignored.

Sara Méndez [External Appendix C] has experience with developing guidelines to assess CIs, and states that it is important to focus on making it practice-oriented to ensure that it is applicable in practice. Méndez explains that in cooperation with participants from e.g. NGOs and stakeholder groups, she developed guidance for The Marine Management Organisation in 2014. She elaborates that many departments and different industries took part in creating the guidelines and that *"there were so many different opinions about how to tackle the issue that I think it became apparent that it had to be on an 'industry by industry' basis"* [Méndez, External Appendix C]. Méndez highlights that it was her experience that it was too ambitious and unrealistic to combine all sectors in one guidance document, and concludes that *"It (the guidance document) was too complicated, too many layers - not practical"* [Méndez, External Appendix C]. Even though practitioners took part in developing the guidelines, it was too theoretical, confusing, and not applicable in practice, and therefore it is important to focus on making the guidance documents as manageable as possible. Louise Mønster [External Appendix G] mentions that a really important aspect, when it comes to developing guidance, is that the practitioners are included in the process to ensure that it is manageable. But it is not only guidance and legislative demands that can form structures. A structure is also reliant on the resources that are present, so the practitioners can only work from the structures that are available. Mette

Jeppesen [External Appendix F] and Hanne Koed [External Appendix E] emphasise that lack of resources and political prioritisation is a considerable problem in the Danish CIA practice, which can also explain why the Danish practice is less developed, compared to the one of UK, where the government has prioritised to develop sector and topic-specific guidance.

Suggestions for best practice are compiled throughout this thesis, to propose how the CIA practice should develop. When creating suggestions for best practice it is important to be aware that the proposals should be applicable for practitioners. The authors behind this thesis are not yet practitioners but strive to develop practice-oriented guidance by involving practitioners and gaining insight into how practice should be. To ensure that the guidance is useful in practice, it would be ideal to review the results with those who will actually use it to prepare CIAs for OWFs. This is an important aspect, in relation to increasing the chances of practice being developed. The structures must be applicable before the agents incorporate them into their CIA practice and thus create a change in practice. The recommendations for guidance will be developed in the following sections.

8.2 Developing guidance to support the conceptual understanding

When examining the guidance documents[1] mentioned by UK practitioners [McManus, External Appendix A; Braithwaite, External Appendix B], it does not immediately seem like there are definitions more thorough than the ones found in the Danish and EU guides. But there are many supplementary definitions of different concepts and approaches, providing a greater understanding of what a CIA is. The UK guidance thereby sets up clear frames as to what a CIA is and how it ought to be conducted. The definitions presented by UK practitioners and in the UK CIAs are thereby derived from the authorities' expectations which are clarified in the different guidance documents, and through the continuous cooperation during the work with CIAs. The current UK understanding and practice of defining the concepts of CIA is thereby both based on politically defined structures presented in guides and formed through practice during the years of conducting CIAs for OWFs. Compared to Denmark, UK has more than double the amount of operational OWFs, and thereby a more developed practice. The current UK practice is thereby based on two aspects: guidance based on clear statutory expectations, and experience. It takes time to develop experience, and with the planned expansion of Danish OWFs, it can be argued that there is no more time for using a 'trial and error' approach, and more clarified guidance must be put forth.

8.2.1 Key recommendations found in the literature review

Six key recommendations for how to improve and support the current CIA practice are presented in the literature review. These are that an agreed vocabulary should be established; a standardised, agreed definition should be implemented; this definition should be comprehensive enough to clarify key concepts; and the definitions must be based on a clear frame of statutory requirements - see section 6.1.3. There is complete agreement amongst the practitioners, in terms

[1] Advice note 17, National Policy Statement for Renewable Energy Infrastructure (EN-3), Guidelines for Ecological impacts Assessment in the UK and Ireland, Natural England Commissioned Report NECR164

of the need for a standardised and agreed definition of CIA. There is also unanimity about how a clear frame of statutory requirements should be presented as part of this standardised definition. Some agree with how an agreed vocabulary should be established, while others disagree - because as long as the applied terms are defined within the individual CIA, it does not matter that there are differences in the terms applied.

It is suggested in the literature review that a more standardised definition is implemented. Keller [External Appendix D] from DEA emphasises that there would be benefits of agreeing on a standardised definition that can guide the CIA practice, but explain that they, as an authority, do not focus on the specific wording that is used, but on the result and how the environment will be impacted by the actions. This point is supported by Eriksen [External Appendix D] who states that it will be easier to understand the assessments if there is a clear definition, but underlines that *"in relation to our work, we understand the meaning of what is written no matter what. But when there are others who may have to read through a cumulative assessment, it could be smart"* [Eriksen, External Appendix D]. Keller elaborates that even if a standardised definition is put forth, it is important that there is freedom of method, so the consultants can influence the approach and adjust to the specific project. Koed [External Appendix E], Mønster [External Appendix G], and Jeppesen [External Appendix F] all emphasise that there is a need for a standardised and clear definition. Koed states that it is important that the consultants have a definition to follow from the beginning when conducting the assessments.

By introducing a clearer and more elaborated definition, practice could become more consistent - as observed in the UK cases [Project developer A, External Appendix H; Jeppesen, External Appendix F; Koed, External Appendix E; GoBe Consultants, 2022b; Royal HaskoningDHV, 2019c; McManus, External Appendix A; Méndez, External Appendix C; Mønster, External Appendix G]. It is further suggested in the literature review that putting forth a common dictionary can reduce uncertainties in practice [Masden et al., 2010]. This is also emphasised by Koed, stating that it is important to create a dictionary that can explain and clarify what the different terms mean, and what is expected of these, because it is also her perception, that if the terms are defined, less confusion will be present among practitioners.

8.2.2 Recommendation: A standardised and elaborated definition

The difference between the current UK and Danish guidance is that the UK guides provide manageable definitions of different concepts of CIA. Specific terms such as 'impact' and 'effect' are not explicitly defined, but concepts such as 'impact-receptor-pathway' and 'ZOI' are defined. These definitions of key concepts, provided by governmental bodies, are able to support the UK practitioners so they do not feel the same uncertainty as the Danish practitioners [Méndez, External Appendix C; McManus, External Appendix A; Braithwaite, External Appendix B]. The guidance documents do therefore not necessarily need to provide an aggregated definition, as long as the concepts necessary to conduct a CIA are defined. Advice note 17 presents a staged approach for conducting CIAs and defines the steps and terms contained in this. It is a compilation of these aspects and experience, that form the foundation for the current definitions of CIs applied in UK practice, and the definitions of the concepts of CIA are thereby guiding and supporting the current UK practice. Most of the UK guidance does not have statutory power but is presented by governmental bodies and is thereby an expression of the statutory expectations -

as is recommended in the literature review. Such guidance is not currently present in the Danish practice, and it is thereby relevant that proposed definitions are created in cooperation with the relevant authorities.

An aspect of great importance for the clarity of the CIA, according to the practitioners, is that the specific terms applied in the CIA, are defined within the report. This indicates that a guide can provide definitions, which can be described with several terms. It is thereby not important if it is specifically called e.g. ZOI, CI, or impact-receptor-pathway, as long as there is an agreement of how e.g. pathways need to be included and what a pathway is. These findings of the case study, indicate that the finding of the literature review, related to establishing an agreed vocabulary can be met by implementing standardised definitions of key concepts, and increasing the transparency by incorporating these and presenting the terms used to cover these.

The definitions found in the literature review all contain temporal aspects, and it is presented as a relevant aspect that both 'past', 'current', and 'future' projects and plans are included. None of the definitions found in the case study include 'past', and only 'current' projects with ongoing impacts are included. Many of the definitions presented in the literature review are based on the one by Hyder [1999], which is generally applicable for all sectors and not made specifically for OWFs. It is suggested that all three temporal aspects are contained in the definition, but it should be noted that there should be an assessment for each project in relation to whether there are both 'past', 'current', and 'future' actions that are relevant for the given assessment of a given topic. The definition should specify which temporal aspects ought to be considered, and which actions and areas are relevant to consider. A discussion of which aspects are relevant to include for these will be presented in the following sections presenting recommendation for the identification of the relevant scope.

Some of the key concept of CIA, that has been found to influence the current UK practice are presented and defined in table 8.1. The definitions are based on both the findings of the literature review and the case study, and form the base of implementing more standardised definitions that can guide the CIA practice - as recommended in the findings of the literature review and requested by Danish practitioners.

Concept	Definition
Activity	The activity causing an effect. E.g. pile driving
Effect	An event caused by an activity. E.g. vibrations from pile driving or bird/windmill collision.
Impact	A measurable change occurring due to the effect. E.g. the change of a specific population or species.
Pathway	The mechanism exposing a receptor to an effect. E.g. foraging in the contaminated area.
Receptor	Social/cultural, economic, physical, or ecological entities that are expected to be affected by the effects. E.g. amenities or a specific species of fish.
Zone of Influence	A defined range, representing a precautionary maximum distance at which impacts from other projects can produce CIs with the specific project. E.g. other OWFs within 500 km from the project.

Table 8.1. *Definitions of key concepts.*

The standardisation of the definition thereby lies in the agreement of key concepts and the incorporation of these in the specific CIA to ensure transparency. By providing such definitions, a form of supplementary glossary is established, and there will also be less room for uncertainty. A definition should refer to the presented definitions and specify requirements for how to identify the relevant scope. A suggestion for an aggregated definition containing all key concepts will be presented as a summary of this chapter.

8.3 Developing guidance to support the identification of the relevant scope

Practitioners in UK express that they have the guidance and knowledge needed to identify the relevant temporal and geographical scope and that the necessary cooperation between authorities, stakeholders, and practitioners is in place. Advice note 17 presents a staged approach for the entire process of conducting a CIA (presented in section 7.2.2) [The Planning Inspectorate, 2019], and Scottishpower Renewables [2013] further elaborate on how practitioners should work with tiers in the CIA. In UK there is also detailed guidance specific for the assessment of offshore ornithology and OWFs [Furness, 2015]. It appears to be a tendency, that the Danish practitioners are more insecure about how to conduct a CIA due to the general lack of guidance, whereas the UK practitioners are supported by the practice-near guidance available in UK. UK practitioners express a lack of data for 'future' projects, whereas Danish practitioners express a general lack of data and knowledge.

8.3.1 Key recommendations found in the literature review

Different recommendations for deciding the temporal and geographical scope were identified through the literature review. The literature suggests that the scope should take the extent of the impact into account; investigate source-impact-pathways; consider multiple project types; include the three-part temporal definition, and hereunder both consider operational, approved,

and proposed projects; etc. - see section 6.2.5. The practitioners agree with several of the mentioned recommendations from the literature. There is complete agreement that the scope should cover more than the immediate area and potentially cross national boundaries. There is also unanimity as to how there should be focus on the source-impact-pathways, and that a screening should be conducted to identify which species should be included in the CIA. Most of the interviewees state that both plans, projects, and activities should be included in the CIA, whereas some express that it is only plans and projects. The practitioners and authorities are not in agreement with the literature review, in terms of incorporating the three temporal aspects. All practitioners agree that 'future' projects ought to be considered in the CIA, and that approved, and proposed projects should be considered, most of the practitioners also state that 'current' operational projects should be included, and none of the practitioners believe that all of the three-part definition of time should be included in the CIA.

Introducing a standardised approach to identifying the relevant scope, that entails a greater level of detail and transparency than what is currently the case in the Danish CIAs, will bring both benefits and drawbacks. It will potentially make the CIA practice more thorough and unified, and ensure that the relevant aspects are covered. It will also potentially make the CIAs overwhelmingly detailed and long. Several studies indicate that the extent of EIAs has grown over time, where interested parties and statutory authorities are overwhelmed by all the information [Borioni et al., 2017; Wende, 2002; Landim and Sánchez, 2012; Lyhne et al., 2015]. Braithwaite explains that one of the problems related to the current CIA practice - and EIA practice in general - in UK, is that too much is included in the assessments, and the reports become too extensive and unmanageable. When introducing a more elaborated approach in the Danish practice, attention should therefore be given to whether the process becomes too extensive in relation to the benefits gained.

8.3.2 Recommendation: A standardised and practice-oriented approach

The difference between the current UK and Danish guidance is that the UK guides are in accordance with the recommendations of the literature review, and provide an explicit and manageable approach to conducting a CIA. The Danish practitioners express a need for clarification of expectations, and a more standardised approach to conducting a CIA. The UK practitioners do not express the same need, and base their approach on a *staged approach* presented in Advice note 17, where each stage is described. By proposing guidelines for the Danish practitioners, based on the thinking of a staged approach, a standardised base for conducting CIAs can be created, and the practice can be supported. This thesis will therefore suggest a standardised and practice-oriented approach to identifying the relevant scope for CIAs of OWFs. Based on the findings the following overall approach is suggested:

1. Identifying the ZOI and establishing a long-list
2. Identifying the topic-specific short-lists
    - Screening for receptors - identifying impact-receptor-pathways
    - Identifying the relevant receptor-specific ZOI
    - Screening for temporal overlaps
3. Allocating projects, plans, and activities into tiers

The suggested steps will be elaborated and the relevance of these will be discussed in the following sections.

ZOI and a general long-list

The first step is evolving around agreement with the statutory authorities, and taking departure in a precautionary approach. In the UK practice, ZOI distance criteria are defined for different project types and activities, in cooperation with authorities and stakeholders. The distance criteria are defined distances in which other actions can potentially cause an impact that can cumulate with the ones of the specific project. It can be a resource-heavy task since it is done for each individual project. Given that it has been found that the Danish statutory authorities do not currently appear to have an overflow of resources, it can be argued that a standardised set of ZOI distance criteria could be developed instead. This would still provide the practitioners with something to take a point of departure in, but it would not make each process more comprehensive. The criteria would, however, have to be reevaluated from time to time, to ensure that they are still valid. When defining the distance criteria, it is also defined which project types and activities are relevant to include in the CIA. Examples of defined ZOI distance criteria in AyM are presented in appendix A. Figure 8.1 illustrates an example of a ZOI for offshore oil and gas projects.

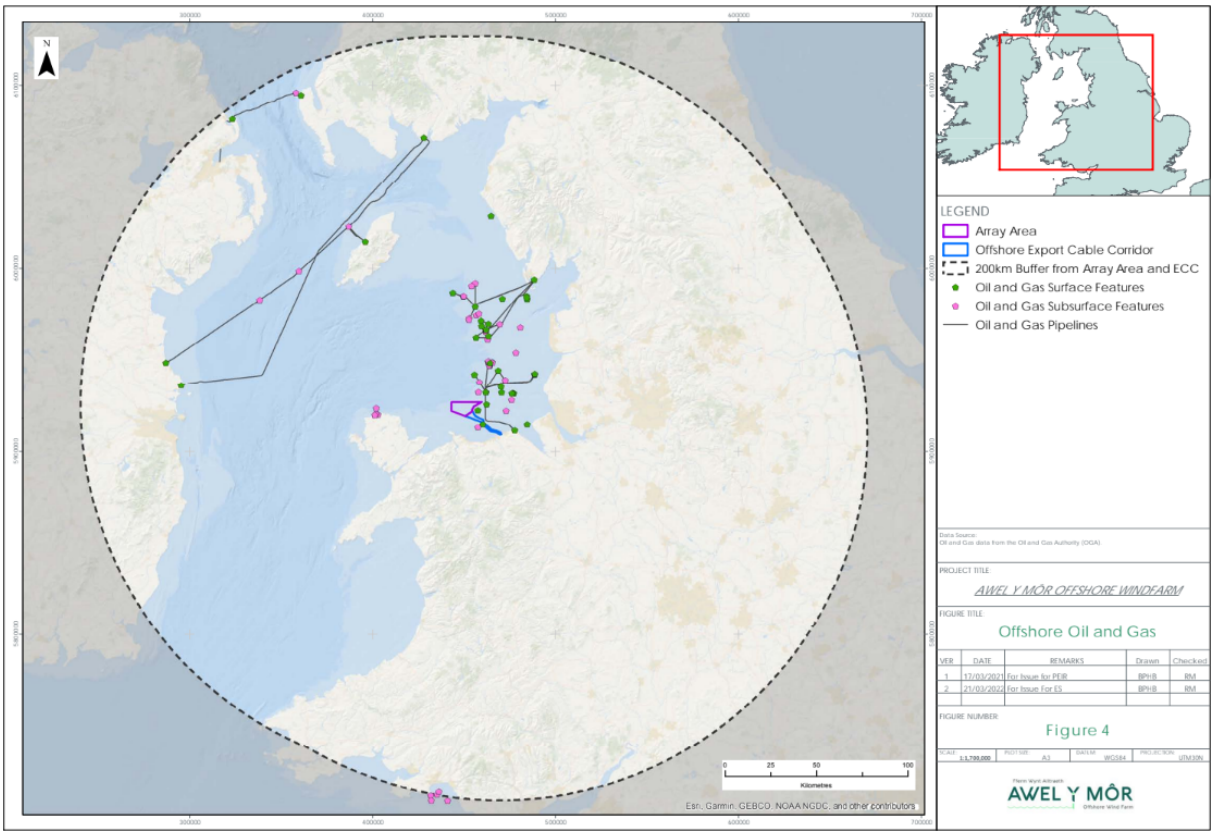

Figure 8.1. *AyM ZOI for oil and gas (figure 4 in GoBe Consultants [2022b]).*

As presented, there is agreement across the case study and the literature review, that not only similar project types should be included, and predominantly agreement in terms of also including

other activities in the assessment. The statutory authority, DEA, does however explicitly state that activities such as fisheries are not expected to be included, since it is an ongoing and constant background activity. This is not in agreement with McManus' perception of how ongoing impacts should be included in the assessment and not in the baseline. Koed from EPA underlines that activities such as fisheries and shipping are adding pressure to the receptors, and states that they should be a constituent part of the activities that should be included in a CIA. The recommendation put forth in this thesis is, that if it is possible to gather data on activities such as fisheries and shipping, these should be included in the CIA to provide an assessment as close to the real situation as possible. Attention should though be given to whether such activities are already incorporated in the data available for creating a baseline, to avoid double accounting.

Based on the agreed ZOI distance criteria a long-list can be prepared. The long-list is created through a study of which existing actions are present within the defined distances, and through an investigation of which 'future' actions will potentially occur within the defined distances. The long-list is thereby an initial mapping of actions that forms the base of the practitioners' work with the CIA. A GIS layer of the long-list projects, plans, and activities can be created and used for further analysis of which of these are relevant for each topic being assessed. In order to know which actions to include on the list, it must also be clarified which temporal aspects are perceived as important - this clarification is also requested by Danish practitioners and presented as a recommendation in the findings of the literature review. It is found in the case study that the primary focus should be 'current' and 'future' actions. 'Future' should at minimum be understood as *consented projects*. Only including consented projects as 'future', can be perceived as a minimum compared to the UK practice, where projects that have applied for consent and projects incorporated in governmental plans are also included. The incorporation of impacts from 'current' projects is perceived in different ways, and the concept of *shifting baseline* is given thought by some practitioners. Some interviewees explain that it will be most appropriate to assess the CIs against an unaffected baseline state since an impact assessed against the already affected environment might seem insignificant, whereas it might be deemed significant if assessed against the unaffected environment [Koed, External Appendix E; Jeppesen, External Appendix F]. Keller states that it is a relevant problem, but that it is not always possible to find data from an unaffected state of the environment. It is thereby argued that whether 'current' actions should be in the baseline or in the CIA depends on the available data, but actions with ongoing activities should be assessed in the CIA. Based on the finding of the literature review and the case study, it is suggested that the actions presented in table 8.2 are considered when creating a long-list.

Types of actions to consider	Similar project types
	Other project types
	Activities causing ongoing pressures on the receptor being assessed
Temporal aspect: Current	Existing projects with ongoing impacts
	Projects under construction
Temporal aspect: Future	Consented projects
	Projects for which consent is applied
	Projects in governmental plans

Table 8.2. *Actions to consider when creating the long-list.*

Defining criteria for identifying ZOI and long-list, will thereby provide practitioners with a clarification of which project types and distances are relevant to consider, as requested by Danish practitioners and recommended in the literature review. As stated by practitioners and found in the literature review, it can however be difficult to identify which other projects and activities are going to be established in the future. This is applicable to other OWFs but especially for other sectors, where it is challenging to know which actions are in the pipeline. In the UK there is a joint database where it is possible to find 'future' actions, for all sectors [The Planning Inspectorate, n.d.]. This database makes the process of identifying relevant actions easier, and it would be an asset for Danish practitioners if a website equivalent to this was set up in a Danish context.

Receptor-specific ZOI and short-list

The next step is to screen the long-list and create topic-specific short-lists. These short-lists identify which projects, plans, and activities should be incorporated in the CIA for the given topic. The process of screening the long-list and identifying the short-list provides transparency in the process and illustrates why an action is screened in or out, which is requested in the literature and by interviewees. The steps for identifying the short-list are: Screening for receptors and identifying impact-receptor-pathways; identifying the relevant receptor-specific ZOI; and Screening for temporal overlaps. These will be elaborated in the following.

The first step is to conduct a screening of which species are present and can be impacted. This is also an approach recommended in the lit-rev and which is already used by most practitioners. By mapping, collecting data, or using existing knowledge, the practitioners investigate whether impact-receptor-pathways exist for any species. Subsequently, a ZOI for each relevant receptor is identified, by using topic-specific screening ranges. Through the interviews, it has become clear that the Danish practitioners already focus on each receptor when identifying the relevant scope, but that there are uncertainties about how to do so. For offshore ornithology, the specific screening range can be based on the foraging and breeding range, as recommended in the literature and the case study. During the interviews, it is found that these areas can be extensive, and the assessment can become unmanageable. All of the interviewees express uncertainty regarding how large an area the assessment should cover. The majority of the interviewees state that the identified scope must be possible to work with and assess. The literature review and some of the interviewees recommend that the focus should not be on the global population because it will become intangible. If the focus is on the global population, there will be a lot to take into consideration, but it can be argued that the full extent of the impact is assessed since the total population is assessed. However, if much data is missing and the assessments are primarily based on estimates and become too superficial, they can lose credibility.

In the conducted case study, there has been a focus on marine mammals and offshore ornithology, and for these two topics, different approaches have been found. For ornithology, it is recommended to focus on the bio-geographic area of the relevant species, and for marine mammals, it is recommended to include the different species' management units, e.g. the North Sea population. These scales are chosen to ensure a manageable assessment and an assessment that covers the area relevant to the given population, which is also recommended in the literature

review. This means that the different pressures affecting the species are included in the CIA, while the scope is still kept smaller than global and thereby more manageable, as recommended in the literature review. It should however still be acknowledged that identifying and assessing the bio-geographical area can be a challenging and resource heavy task. To ensure a meaningful assessment, it can be argued that an assessment of the regional population can be an alternative in cases where there is no data available for the bio-geographic area, but if it is possible then qualified assumptions should be made. The fact that there currently is not much guidance available for the Danish practitioners to use does not make the task easier. It is therefore relevant that the proper data and guidance is provided - such as the UK guide focusing on the assessment of different bird species. Developing topic and species specific guidance is also a resource heavy task, and it will require political prioritisation to be able to do so.

When the relevant topic-specific area is found, the long-list will be screened to identify which actions should be included in the CIA, by investigating whether there is a spatial effect interaction. This can be done by creating a map where the defined long-list is added as a layer on top of the identified ZOI for the specific receptor, whereby it is illustrated whether there is a potential spatial interaction between the receptor, the specific project, and others actions. If there is no overlap between the OWF and other actions there is no potential for a cumulative impact, whereby the action should not be included in the CIA. It is important to be transparent when actions are either screened in or out and thereby argue why this decision is made.

The last step is to screen for temporal overlap. There is agreement amongst all practitioners as to how there should be a potential overlap of impacts or phases for a project, plan, or activity to be relevant in the CIA. As recommended in the findings of the literature review, most practitioners state that the project's time frame should be decisive for what is screened in or out. Koed from EPA does however state that it is not only relevant whether there is an actual overlap, but that consecutive phases or impacts should also be considered. By incorporating this aspect, it is taken into account that a temporary impact can potentially become long-lasting if e.g. several OWFs are constructed after one another. It is therefore recommended that projects, plans, or activities with impacts that can potentially cumulate with those of the specific OWF, should be included if there are overlapping impacts or phases, or if the impact or phase is predicted to occur one year before or after the one of the specific project.

Allocating the short-list into tiers of certainty

It has been expressed by Danish practitioners that one of the biggest obstacles to conducting a CIA, is the limited knowledge of future projects and the current lack of a way to handle the insecurities related to future projects. Mønster express that it would not be appropriate to screen actions out because of lack of data or timeline if the impacts from the action could cumulate with those from the specific project. As presented, the UK practitioners handle this by allocating projects, plans, and activities into tiers of certainty. It is still expressed, by practitioners, as an obstacle that there is not full knowledge of future projects, but they are taken into account in the way it is found possible. The current Danish guidance does not provide any suggestions on how to handle the insecurities of future projects, and such is requested by Danish practitioners. In comparison, it is found that the UK guidance provides descriptions of how to use *tiers*. Incorporating tiers in practice is also found as a recommendation in the literature review. It is

recommended that this approach is also embedded in the Danish practice of conducting CIAs, to ensure that potential future impacts are accounted for in a precautionary manner. A suggestion is, that the tiers presented in section 7.2.2 from Advice note 17 can be translated and incorporated into the Danish practice.

Once the long-list has been screened to identify the topic-specific short-list and the projects on this have been allocated into tiers of certainty, then scenarios of potential CIs can be created and the CIA for the specific receptors can be conducted.

8.4 Summary

Based on the literature review and the case study, it is recommended that a more structured and clearly defined approach is introduced in the Danish practice. Taking point of departure in the recommendations found in the literature review and the shortcomings of the Danish practice compared to the UK practice, the following approach is suggested:

1. Identifying the ZOI and establishing a long-list
2. Identifying the topic-specific short-lists
    - Screening for receptors and identifying impact-receptor-pathways
    - Identifying the relevant receptor-specific ZOI
    - Screening for temporal overlaps
3. Allocating projects, plans, and activities into tiers

Summarising the recommended approach and the definitions of the key concepts, the following overall definition of CIs is presented as:

"impacts on a receptor resulting from incremental changes caused by current projects or activities with ongoing effects; projects in governmental plans; applied projects; consented projects; and projects under construction, together with the project. The relevant scope of the cumulative impact assessment is identified by investigating whether impact-receptor-pathways exist, and a zone of influence for each relevant receptor is identified, by using topic-specific screening ranges, and both impacts from similar project types and other project types are taken into consideration."

Related problem areas 9

Through this thesis, the focus has been on conceptual understanding and identification of the temporal and geographical scope. But there is also awareness of how other challenges influence the CIA practice. The authors behind this thesis are aware that the given recommendations are not covering all the challenges related to the current practice of conducting CIAs.

Data availability

A challenge mentioned by all of the interviewees is the lack of data. It is highlighted by practitioners from both UK and Denmark when asked about the biggest barriers to CIA practice. Project developer A, McManus, and Braithwaite highlight the lack of knowledge of future projects, both nationally and internationally, since this makes it difficult to conduct a meaningful assessment. Keller, Eriksen, and Koed point toward a general lack of data of e.g. the location of species.

Koed mentions that economy and lack of political prioritisation are posing barriers to clarifying how a CIA ought to be conducted. Kirkfeldt et al. [2016] elaborate that the problem can be rooted at a political level if politicians are not able to promote the necessity of gathering data that can be used to assess CIs. One approach to address this issue of missing data is to conduct more post-construction monitoring and collect data using this measure [Masden et al., 2010; Busch et al., 2012]. If there is a greater focus on collecting data by using monitoring, it is also important to prepare a more comprehensive, systematic, and standardised database. This is pivotal to ensure that the collected data is used in the future and that as many practitioners as possible can use it, thus protecting the environment to a greater extent [Hague et al., 2022].

It can be difficult to obtain data regarding impacts from OWFs because it is a competitive industry and project developers are not necessarily interested in sharing the data they have collected, and thus it can be difficult to acquire enough knowledge to conduct an adequate assessment [Masden et al., 2010; Blakley and Russell, 2022]. This indicates that even if practitioners are given a clear frame on how to conduct the CIA, it is not necessarily possible to do so, because the data needed is not necessarily available. This is a significant problem area, that needs to be given more attention and be higher prioritised before practitioners can produce fulfilling CIAs. This problem is not covered in this thesis, but it should be investigated what data missing, how it can be collected and provided, and who should be responsible for this.

Strategic environmental assessments

Another aspect found through the literature review and the interviews is that there needs to be a greater focus on strategic environmental assessments since it is not everything that can be solved at the project level. It is also a discussion of how much can be demanded by the project developer, and how much should be the responsibility of the relevant authority. Is it correct that the project developer should assess the impacts of other projects, or is it beyond what can be demanded? It can be argued that the relevant authority, responsible for the consenting process, is responsible for addressing these things at a strategic level, thereby ensuring the best premises for the environment and the project developers. Mønster also explains that *"the EIA of the individual project can not dictate that 'because this many OWFs are coming, we should stop regulating common scoter'. This will not be done in the EIA of the individual project, but it can be done at a higher level"* [Mønster, External Appendix G]. So for CIAs to accomplish their purpose, they must be prioritised at a higher, more strategic level. This indicates that to be able to fully understand and mitigate the CIs, CIAs should be conducted at a more overall and strategic level. The planning should from the beginning assess potential CIs and locate the OWFs in a way that CIs are minimised. When EIAs are conducted, the project is already quite set, and a location has been chosen. Ideally, to better be able to avoid CIs, strategic environmental assessments should play a bigger role, and identify the areas where OWFs can be located with minimal impacts and low risk of CIs. The CIs that can not be avoided can then be handled and mitigated at a higher and more strategic level.

Conclusion 10

A large-scale expansion of OWFs is planned in the Danish waters. Such an expansion can have impacts on the marine environment, and it is important to take measures to ensure the protection of the environment in the best possible way. When establishing multiple OWFs it is important to conduct CIAs as part of the EIA process. The general CIA practice is however found to be influenced by different problems and barriers, whereof the lack of applicable guidance is dominant. To ensure the protection of the marine environment, this thesis will investigate problem areas influencing the Danish CIA practice, and map opportunities for improvement. The thesis is therefore evolving around the following research question:

How can the Danish practice of assessing cumulative impacts in environmental impact assessments for offshore windmill farms be improved?

In the literature review of international CIA practice, it is found that the applied definition influences which approach will be used, and thereby the quality of the assessments. It is found that aspects currently influencing the conceptual understanding of CIA are; insufficient definitions leaving room for uncertainty, linguistic ambiguity, and that the key concepts of CIA are not properly defined. In the literature, it is recommended that an agreed and standardised definition, with a supplementary dictionary, should be implemented to guide the CIA practice. Through the case study, it is however found that developing standardised definitions of key concepts is adequate in terms of supporting the Danish practitioners' conceptual understanding. These key concepts are found through the literature review and the case study of the current UK practice. It is thereby suggested that agreed definitions are developed and embedded in the current Danish practice. It is further found that it is important that key terms are defined in the individual CIA and that it is explicitly stated in the beginning, which terms will be applied throughout the assessment.

Several problem areas related to the international practice of identifying the relevant temporal and geographical scope are also found in the literature review. The current CIA practice is described as unclear, uncertain, and limited, and is influenced by the fact that there is no agreed definition of what a CIA should contain. It is further influenced by the lack of an agreed standardised approach, which leads to inconsistencies in the practice of identifying the relevant scope, and it is found to be common, that it is unclear what is scoped in and out, and why. The findings of the literature review suggest that more specific frames for how to determine the relevant scope are needed. This is also found to be requested by all Danish practitioners. Through the comparative case study, it is further found that the UK practice is more thorough and consistent, and that the UK practitioners do not appear to be uncertain of how a CIA ought

to be conducted. The differences between the UK and Danish practice found to be influential, is the availability of practice-oriented guidance and experience. Based on the recommendations found through the literature review, and the conclusions drawn in the case study, a standardised approach that can support the Danish practice of conducting CIAs, is put forth. The main aspects of the recommended approach - which are based on the recommendations from the literature study, the requests from Danish practitioners, and the differences between Danish and UK practice - are that it is step-wise and approachable, that it focuses on relevant ZOIs of receptors, that expectations to temporal aspects and actions types are clarified, and that uncertainties of 'future' actions are handled through tiers of certainty. It is highlighted in the literature that the ideal area is the area relevant to the global population of a given species, but due to practicalities, smaller units such as bio-geographical areas and management units are recommended. In terms of the temporal scope, it is highlighted in the literature review that the three-part definition should be considered. It is however found that 'past' is currently not included in the CIAs, due to lack of baseline data. It is therefore recommended that it should be assessed for each project whether there are relevant 'past' projects, and whether it is possible to incorporate these in the CIA, or if they are already accounted for in the baseline.

By analysing whether the findings of the literature review are present in respectively the Danish and UK practice, and by investigating the underlying structures of each practice, recommendations for how to support and improve the Danish CIA practice are put forth. Suggested definitions of key terms are presented, an aggregated definition of CI is suggested, and a standardised and elaborated approach to identifying the relevant temporal and geographical scope is also presented. Suggested key terms are: Activity, effect, impact, pathway, receptor, ZOI, current projects, future projects, and actions. The suggested approach contains the following steps: identify the ZOI and establish a long-list; identify the topic-specific short-list where impact-receptor-pathways are identified; identify the relevant receptor-specific ZOI; screen for temporal overlaps; and allocate projects, plans, and activities into tiers.

References

Bailey et al., **2010**. Helen Bailey, Kate L. Brookes and Paul M. Thompson. *Assessing environmental impacts of offshore wind farms: lessons learned and recommendations for the future*, 2010.

Bennun et al., **2021**. L. Bennun, J. van Bochove, C. Fletcher, D. Wilson, N. Phair and G. Carbone. *Biodiversity impacts associated to offshore wind power projects*, 2021.

Blakley and Russell, **2022**. Jill Blakley and Jessica Russell. *International progress in cumulative effects assessment: a review of academic literature 2008-2018*, 2022.

BOEM, **2021**. BOEM. *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the South Atlantic Outer Continental Shelf*, 2021.

Boess, **2023**. Emilia Ravn Boess. *Practitioners' pursuit of change: A theoretical framework*, 2023.

Borioni et al., **2017**. Rossana Borioni, Amarilis Lucia Casteli Figueiredo Gallardo and Luis Enrique Sánchez. *Advancing scoping practice in environmental impact assessment: an examination of the Brazilian federal system.* Impact assessment and project appraisal, Volume 35, No 3, 200–213, 2017.

Braithwaite, **External Appendix B**. Peter Braithwaite. *Transcript of interview*, External Appendix B.

Brignon et al., **2022**. Jean-Marc Brignon, Morgane Lejart, Maëlle Nexer, Sylvain Michel, Alan Quentric and Léa Thiebaud. *A risk-based method to prioritize cumulative impacts assessment on marine biodiversity and research policy for offshore wind farms in France*, 2022.

Martin Broderick, Bridget Durning and Luis E. Sánchez. Cumulative effects. In Riki Therivel and Graham Wood, editor, *Methods of environmental and social impact assessment*, chapter 19, pages pp. 649–677. Routledge, 2017.

Buch-Hansen and Nielsen, **2014**. Hubert Buch-Hansen and Peter Nielsen. *Samfundsvidenskaberens videnskabsteori - en indføring.* Hans Reitzels Forlag, 2014. ISBN 978-87-412-5656-6. kapitel 8.

Busch and Garthe, **2016**. Malte Busch and Stefan Garthe. *Looking at the bigger picture: the importance of considering annual cycles in impact assessments illustrated in a migratory seabird species*, 2016.

Busch et al., **2012**. Malte Busch, Andreas Kannen, Stefan Garthe and Mark Jessopp. *Consequences of a cumulative perspective on marine environmental impacts: Offshore wind*

farming and seabirds at North Sea scale in context of the EU Marine Strategy Framework Directive, 2012.

Caine, **2019**. Cathrine Ann Caine. *The Race to the Water for Offshore Renewable Energy: Assessing Cumulative and In-combination Impacts for Offshore Renewable Energy Developments*, 2019.

Canter and Ross, **2012**. Larry Canter and Bill Ross. *State of practice of cumulative effects assessment and management: the good, the bad and the ugly*, 2012.

Canter and Kamath, **1995**. Larry W. Canter and J. Kamath. *Questionnaire checklist for cumulative impacts*, 1995.

Cashmore et al., **2015**. Matthew Cashmore, Tim Richardson, Jaap Rozema and Ivar Lyhne. *Environmental governance through guidance: The 'making up' of expert practitioners*, 2015.

Danish Energy Agency, **2023**. Danish Energy Agency. *Ansøgte og etablerede havvindmølleparker*, 2023.

Duinker and Greig, **2006**. Peter N. Duinker and Lorne A. Greig. *The Impotence of Cumulative Effects Assessment in Canada: Ailments and Ideas for Redeployment*, 2006.

Durning and Broderick, **2019**. Bridget Durning and Martin Broderick. *Development of cumulative impact assessment guidelines for offshore wind farms and evaluation of use in project making*, 2019.

Durning and Broderick, **2015**. Bridget Durning and Martin Broderick. *Mini review of current practice in the assessment of cumulative environmental effects of UK Offshore Renewable Energy Developments when carried out to aid decision making in a regulatory context*, 2015.

Egholm, **2014**. Liv Egholm. *Videnskabsteori - perspektiver på organisationer og samfund*. Hans Reitzels Forlag, 2014. ISBN 978-87-412-5656-6.

Eriksen, **External Appendix D**. Christine Schultz Yde Eriksen. *Transcript of interview*, External Appendix D.

European Union, **2017**. European Union. *Environmental Impact Assessment of Projects*, 2017.

Foley et al., **2017**. Melissa M. Foley, Lindley A. Mease, Rebecca G. Martone, Erin E. Prahler, Tiffany H. Morrison, Cathryn Clarke Murray and Deborah Wojcik. *The challenges and opportunities in cumulative effects assessment*, 2017.

Furness, **2015**. Robert W. Furness. *Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS)*, 2015. Natural England Commissioned Reports, Number 164.

GoBe Consultants, **2022a**. GoBe Consultants. *Volume 2, Chapter 7: Marine Mammals*, 2022a. Project developer: RWE Renewables UK.

GoBe Consultants, **2022b**. GoBe Consultants. *Volume 1, Annex 3.1: Cumulative Effects Assessment Methodology*, 2022b. Project developer: RWE Renewables UK.

GoBe Consultants, **2022c**. GoBe Consultants. *Volume 2, Chapter 4: Offshore Ornithology*, 2022c. Project developer: RWE Renewables UK.

Gușatu et al., **2021**. Laura Florentina Gușatu, Stefano Menegon, Daniel Depellegrin, Christian Zuidema, André Faaij and Claudia Yamu. *Spatial and temporal analysis of cumulative environmental effects of offshore wind farms in the North Sea basin*, 2021.

Hague et al., **2022**. Emily L. Hague, Carol E. Sparling, Ceri Morris, Duncan Vaughan, Rebecca Walker, Ross M. Culloch, Alastair R. Lyndon, Teresa F. Fernandes and Lauren H. McWhinnie. *Same Space, Different Standards: A Review of Cumulative Effects Assessment Practice for Marine Mammals*, 2022.

Halpern and Fujita, **2013**. Benjamin S. Halpern and Rod Fujita. *Assumptions, challenges, and future directions in cumulative impact analysis*, 2013.

Hodgson et al., **2019**. Emma E. Hodgson, Benjamin S. Halpern and Timothy E. Essington. *Moving Beyond Silos in Cumulative Effects Assessment*, 2019.

Hyder, **1999**. Hyder. *Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions*, 1999.

IEA Wind, **2022**. IEA Wind. *IEA Wind White Paper Cumulative Effects Analysis for Wind Energy Development: Current Practices, Challenges, and Opportunities*, 2022.

IEMA, **2020**. IEMA. *Demystifying Cumulative Effects*, 2020.

IPCC, **2023**. IPCC. *Synthesis report of the IPCC sixth assessment report (AR6)*, 2023.

Jeppesen, **External Appendix F**. Mette Jeppesen. *Transcript of interview*, External Appendix F.

Johnson, **2008**. Doyle Paul Johnson. *Contemporary Sociological Theory*, 2008.

Judd et al., **2015**. A.D. Judd, T. Backhaus and F. Goodsir. *An effective set of principles for practical implementation of marine cumulative effects assessment*, 2015.

Juul and Pedersen, **2014**. Søren Juul and Kirsten Bransholm Pedersen. *Samfundsvidenskaberens videnskabsteori - en indføring*. Hans Reitzels Forlag, 2014. ISBN 978-87-412-5656-6. kapitel 1.

Keller, **External Appendix D**. Søren Keller. *Transcript of interview*, External Appendix D.

King et al., **2009**. Sue King, Ilya Maclean, Tim Norman and Andrew Prior. *Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers*, 2009.

Kirkfeldt et al., **2016**. Trine Skovgaard Kirkfeldt, Anne Merrild Hansen, Pernille Olesen, Lucia Mortensen, Kameliya Hristova and Alexander Welsch. *Why cumulative impacts assessments of hydrocarbon activities in the Arctic fail to meet their purpose*, 2016.

Koed, **External Appendix E**. Hanne Lise Koed. *Transcript of interview*, External Appendix E.

Korpinen and Andersen, **2016**. Samuli Korpinen and Jesper H Andersen. *A global review of cumulative pressure and impact assessments in marine environments*, 2016.

Lone Kørnøv, Per Christensen, Eskild Holm Nielsen and Nikolaj Bichel. Miljøkonsekvensvurdering (VVM og SMV). In Finn Arler, Mette Alberg Mosgaard and Henrik Risgaard, editors, *Bæredygtighed - Værdier, regler og metoder*, chapter 12, pages pp. 285–309. Aarhus Universitetsforlag, 2017. ISBN 978 87 7124 311 6.

Landim and Sánchez, **2012**. Stephanie N.T Landim and Luis E Sánchez. *The contents and scope of environmental impact statements: how do they evolve over time?* Impact assessment and project appraisal, Volume 30, No 4, 217–228, 2012.

Lonsdale et al., **2017**. Jemma Lonsdale, Keith Weston, Sylvia Blake, Ruth Edwards and Michael Elliott. *The Amended European Environmental Impact Assessment Directive: UK marine experience and recommendations*, 2017.

Lyhne et al., **2015**. Ivar Lyhne, Frank van Laerhoven, Matthew Cashmore and Hens Runhaar. *Quality control for environmental policy appraisal tools: An empirical investigation of relations between quality, quality control and effectiveness.* Journal of Environmental Policy and Planning, Volume 18, 121–140, 2015.

Mahoney and Thelen, **2021**. James Mahoney and Kathleen Thelen. *A Theory of Gradual Institutional Change*, 2021.

March and Olsen, **1983**. James G. March and Johan P. Olsen. *The New Institutionalism: Organizational Factors in Political Life*, 1983.

Masden et al., **2010**. Elizabeth A. Masden, Anthony D. Fox, Robert W. Furness, Rhys Bullman and Daniel T. Haydon. *Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework*, 2010.

Masden et al., **2015**. Elizabeth A. Masden, Aly McCluskie, Ellie Owen and Rowena H.W. Langston. *Renewable energy developments in an uncertain world: The case of offshore wind and birds in the UK*, 2015.

Mateos-Rodíguez et al., **2012**. María Mateos-Rodíguez, Antonio-Román Muñoz and Gonzalo M. Arroyo. *Assessment of Offshore Wind Farm Effects on Birds and Needs to Plan Their Future Development in Spain*, 2012.

McManus, **External Appendix A**. Ryan McManus. *Transcript of interview*, External Appendix A.

Morgan, **2012**. Richard K. Morgan. *Environmental impact assessment: the state of the art*, 2012.

Morgan, **2017**. Richard K. Morgan. *Conceptualising best practice in impact assessment*, 2017.

Méndez, **External Appendix C**. Sara Méndez. *Transcript of interview*, External Appendix C.

Mønster, **External Appendix G**. Louise Rønde Mønster. *Transcript of interview*, External Appendix G.

Nelson and Shirley, **2022**. Rebecca Nelson and L. M. Shirley. *The Latent Potential of Cumulative Effects Concepts in National and International Environmental Impact Assessment Regimes*, 2022.

Nicolini, **2012**. Davide Nicolini. *Practice Theory, Work, and Organization*, 2012.

Nielsen, **2021**. Niklas Asp Nielsen. *FN's Klimapanel slår fast: Helt entydigt, at klimaforandringerne er menneskeskabte*, 2021.

NIRAS and COWI, **2015a**. NIRAS and COWI. *Kriegers Flak Havmøllepark. VVM-redegørelse. Del 2: Formål og baggrund*, 2015a. Project developer: Energinet.dk.

NIRAS and COWI, **2015b**. NIRAS and COWI. *Kriegers Flak Havmøllepark. VVM-redegørelse. Del 3 Det marine miljø*, 2015b. Project developer: Energinet.dk.

Orbicon | WSP, **2020**. Orbicon | WSP. *Kriegers Flak Havmøllepark. VVM-redegørelse. Del 3 Det marine miljø*, 2020. Project developer: Vattenfall.

ORJIP Ocean Energy, **2022**. ORJIP Ocean Energy. *Information Note: Cumulative Impact*, 2022.

Paré, **2015**. Mathieu Templier ND Guy Paré. *A Framework for Guiding and Evaluating Literature Reviews*, 2015.

Plowright, **2015**. David Plowright. *Charles Sanders Peirce: Pragmatism and Education*. Springer, 2015. ISBN 978-94-017-7356-0.

Project developer A, **External Appendix H**. Project developer A. *Transcript of interview*, External Appendix H.

Project developer A and B, **External Appendix H**. Project developer A and B. *Transcript of interview*, External Appendix H.

Project developer B, **External Appendix H**. Project developer B. *Transcript of interview*, External Appendix H.

RenewableUK, **2013**. RenewableUK. *Cumulative Impacts Assessment Guidelines: Guiding Principles for Cumulative Impacts Assessment in Offshore Wind Farms*, 2013.

Robson and McCartan, **2016**. Colin Robson and Kieran McCartan. *Real World Research*. Wiley, 2016. ISBN 978-111-874-5236.

Royal HaskoningDHV, **2019a**. Royal HaskoningDHV. *Chapter 11 Marine Mammals*, 2019a. Project developer: Scottishpower Renewables.

Royal HaskoningDHV, **2019b**. Royal HaskoningDHV. *Appendix 11.3 Marine Mammal Cumulative Impact Assessment (CIA) Screening*, 2019b. Project developer: Scottishpower Renewables.

Royal HaskoningDHV, **2019c**. Royal HaskoningDHV. *Chapter 5 Environmental Impact Assessment Methodology*, 2019c. Project developer: Scottishpower Renewables.

Royal HaskoningDHV, **2019d**. Royal HaskoningDHV. *Chapter 12 Offshore Ornithology*, 2019d. Project developer: Scottishpower Renewables.

RPS, **2010**. RPS. *Assessment methodology for determining cumulative impacts of wave and tidal marine renewable energy devices on marine birds*, 2010. Scottish Natural Heritage Archive Report.

Ryan et al., **2019**. Kendra Ryan, Andy Danylchuk and Adrian Jordaan. *Consideration of scales in offshore wind environmental impact assessments*, 2019.

Scottishpower Renewables, **2013**. Scottishpower Renewables. *JNCC and Natural England Suggested Tiers for Cumulative Impact Assessment*, 2013.

The Council on Environmental Quality, **1997**. The Council on Environmental Quality. *Considering Cumulative Effects Under the National Environmental Policy Act*, 1997.

The Danish Energy Agency, **n.d.a**. The Danish Energy Agency. *Godkendelse af havvindmølleparker*, n.d.a. URL `https://ens.dk/ansvarsomraader/vindmoeller-paa-hav/godkendelse-af-havvindmoelleparker`. Seen 22/2 2023.

The Danish Energy Agency, **n.d.b**. The Danish Energy Agency. *Etablerede havvindmølleparker i Danmark*, n.d.b.

The Danish Energy Agency, **n.d.c**. The Danish Energy Agency. *Dansk klimapolitik*, n.d.c. URL `https://ens.dk/ansvarsomraader/energi-klimapolitik/fakta-om-dansk-energi-klimapolitik/dansk-klimapolitik`.

The Danish Maritime Authority, **2021**. The Danish Maritime Authority. *Havplanredegørelse*, 2021.

The European Commission, **2020a**. The European Commission. *EU Biodiversity Strategy for 2030*, 2020a.

The European Commission, **2020b**. The European Commission. *Guidance document on wind energy developments and EU nature legislation*, 2020b.

The Ministry of Climate, Energy and Utilities of Denmark, **2008**. The Ministry of Climate, Energy and Utilities of Denmark. *Lov om fremme af vedvarende energi*, 2008. LOV nr 1392 af 27/12/2008.

The Ministry of Climate, Energy and Utilities of Denmark, **2022**. The Ministry of Climate, Energy and Utilities of Denmark. *Klimaaftale om grøn strøm og varme 2022 - Et grønnere og sikrere Danmark*, 2022.

The Ministry of Environment and Food of Denmark, **2018**. The Ministry of Environment and Food of Denmark. *Vejledning til lov om miljøvurdering af planer og programmer og af konkrete projekter (VVM) - 2. del: Konkrete projekter*, 2018. Udkast.

The Ministry of Environment of Denmark, **2023**. The Ministry of Environment of Denmark. *Miljøvurderingsloven*, 2023. Bekendtgørelse af lov om miljøvurdering af planer og programmer og af konkrete projekter (VVM), LBK nr 4 af 03/01/2023.

The Ocean Institute, **2022**. The Ocean Institute. *Anbefalinger til bedre miljøhensyn ved vedvarende energianlæg på havet*, 2022.

The Planning Inspectorate, **2019**. The Planning Inspectorate. *Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects*, 2019. URL `https://infrastructure.planninginspectorate.gov.uk/legislation-and-advice/advice-notes/advice-note-17/`.

The Planning Inspectorate, **n.d.** The Planning Inspectorate. *National Infrastructure Planning: Projects*, n.d.

Therivel and Ross, **2007**. Riki Therivel and Bill Ross. *Cumulative effects assessment: Does scale matter?*, 2007.

UK Department for Business and Trade, **2023**. UK Department for Business and Trade. *Offshore wind*, 2023.

United Nations, **2022**. United Nations. *What Is Climate Change?*, 2022.

Wende, **2002**. Dr. Wolfgang Wende. *Evaluation of the effectiveness and quality of environmental impact assessment in the Federal Republic of Germany.* Impact assessment and project appraisal, Volume 20, No 2, 93–99, 2002.

Williamson, **2002**. Kirsty Williamson. *Theory: Its role in research and its development*, 2002.

Willsteed et al., **2017**. Edward Willsteed, Andrew B. Gill, Silvana N.R. Birchenough and Simon Jude. *Assessing the cumulative environmental effects of marine renewable energy developments: Establishing common ground*, 2017.

Willsteed et al., **2018**. Edward A. Willsteed, Simon Jude, Andrew B. Gill and Silvana N.R. Birchenough. *Obligations and aspirations: A critical evaluation of offshore wind farm cumulative impact assessments*, 2018.

Wärnbäck and Hilding-Rydevik, **2008**. Antoienette Wärnbäck and Tuija Hilding-Rydevik. *Cumulative effects in Swedish EIA practice — difficulties and obstacles*, 2008.

Yin, **2009**. Robert K. Yin. *Case Study Research - Design and Methods*, 2009.

Zhanga et al., **2018**. Jie Zhanga, Lone Kørnøv and Per Christensen. *The discretionary power of the environmental assessment practitioner*, 2018.

ZOI distance criteria presented in AyM

Type of project or activity	ZOI criteria	Rationale
Aggregate dredging and disposal	Up to 50 km from AyM array area and offshore ECC	This range represents a precautionary maximum distance at which effects from aggregate dredging and disposal could occur (e.g. changes to hydrodynamic regime/coastal processes).
Offshore energy	Up to 500 km from AyM array area and offshore ECC.	This range represents a precautionary maximum distance at which effects from offshore energy (e.g. underwater noise from piling) could occur.
Commercial fisheries	Up to 200 km from AyM array area and offshore ECC.	This range represents a precautionary maximum distance at which effects from commercial fisheries activities could occur.
Oil and gas	Up to 200 km from AyM array area and offshore ECC.	This range represents a precautionary maximum distance at which effects from oil and gas activities could occur.
Cables and pipelines	Up to 50 km from AyM array area and offshore ECC.	This range represents a precautionary distance at which effects from cables and pipelines (e.g. increases to Suspended Sediment Concentrations (SSCs) from installation) could occur.
Shipping	Up to 200 km from AyM array area and offshore ECC.	This range represents a precautionary maximum distance at which effects from commercial fisheries activities could occur.
Military, aviation and radar	Up to 200 km from AyM array area and offshore ECC.	This range represents a precautionary maximum distance at which effects from military, aviation and radar effects could occur.
Coastal developments (including ports)	Up to 200 km from AyM array area and offshore ECC.	This range represents a precautionary maximum distance at which effects from military, aviation and radar effects could occur.

Table A.1. Offshore ZOI distance criteria presented in AyM (table 4.2 in GoBe Consultants [2022b]).