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Governing biodiversity through offshore wind park tenders: A comparison of England and the Netherlands

Samantha G. Kristensen *, Annet P. Pauwelussen, Simon R. Bush

Environmental Policy Group, Wageningen University, the Netherlands

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ABSTRACT

As the construction of offshore wind parks expand globally, questions are being raised about their impacts on marine biodiversity. To mitigate these impacts, countries are embedding biodiversity conservation and restoration within their offshore wind tendering process. These tenders not only determine the technical design of offshore wind parks but also coordinate decisions on what kinds of biodiversity to conserve, enhance and/or restore. Using an inscription framework this paper compares how biodiversity assumptions and priorities influence the design of these tendering processes in England and the Netherlands. These cases show the different ways tendering processes constitute de facto approaches to biodiversity governance that demonstrate how institutional assumptions and priorities co-determine which future biodiversities are mitigated, enhanced or protected. By unpacking this black box of assumptions, priorities and ways of knowing, tendering processes can be made more reflexive, opening up deliberation on what kinds of biodiversity are being enacted through biodiversity assessments and tendering criteria, holding implications for future biodiversities associated with the expansion of marine infrastructure.

1. Introduction

Demands for offshore wind energy in Europe are increasingly coupled with restoring or enhancing marine biodiversity [34,73], intensifying novel marine-climate interventions which scholars argue are both a governance opportunity and a risk [53]. Both the Netherlands and United Kingdom have moved beyond mitigating the impacts of wind park development to also embed ambitions for biodiversity 'enhancement' and 'net gain' respectively into their tendering processes [9,22]. These tendering processes extend traditional price-based criteria to the use of non-price criteria, such as circular material flows, biodiversity mitigation and biodiversity enhancement [37]. In line with the new EU Restoration Law [25], these criteria incentivise wind developers to deliver renewable energy projects with net-positive biodiversity impacts (e.g. [57]).

At the same time, the ways that these tendering processes integrate biodiversity affects what kinds of biodiversity are conserved or enhanced in wind parks. Biodiversity, broadly referring to the variety of lifeforms and their interactions, is often taken as a neutral and widely accepted concept [12]. However, its definition can vary depending on the field of application, ranging from ecosystems to species or genetics [50,66,7]. As a formal competitive procurement method, tenders use biodiversity-related criteria based on, for instance, concepts such as 'mitigation', 'enhancement' and 'net gain', to evaluate bids [37]. These concepts are based on assumptions of how biodiversity is best protected or enhanced, and priorities regarding what species or habitats to focus on. These assumptions and priorities held by governments, scientists and investors alike, shape the design of wind energy infrastructure and monitoring practices, which in turn conditions what kinds of biodiversity are protected or enhanced. For example, previous research has compared assumptions and priorities underpinning environmental governance in England and the Netherlands, highlighting differences in how scientific ways of knowing biodiversity imposes rules around environmental impact assessment [49,56]. National authorities also frame biodiversity in different ways – e.g. as under threat, or a resource for enhancing ecosystem health [33,36,8] – which can in turn affect how biodiversity conservation and/or restoration is integrated into administrative processes such as tendering for offshore wind energy parks.

How assumptions, priorities and ways of knowing shape the ways in which biodiversity is embedded in policy and performed in practice can be understood as a process of 'inscription' [43,46]. Inscription refers to the way that scripts, such as policies, design choices and environmental

* Corresponding author.
E-mail address: samantha.kristensen@wur.nl (S.G. Kristensen).

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assessments, transform into outputs that are directly usable by other actors [1,44]. For instance, while mitigation inscribes meanings and priorities on minimising impacts on existing biodiversity by avoiding, reducing or offsetting impacts, net gain and enhancement imply deliberate changes to the diversity and biomass of species around offshore wind parks [35,55,90]. Additionally, assumptions and priorities based on the simplification and measurability of biodiversity can influence technical design choices, such as monopiles and scour protection, that favour certain habitats and species – for example, benthic over pelagic, or oysters over bacteria [70]. Understanding how biodiversity is inscribed in and through tendering processes is therefore essential for anticipating how present-day demands and requirements shape future biodiversities.

In the rest of the paper we ask: How is biodiversity inscribed in the offshore wind energy tendering process and with what implications for how future offshore marine biodiversities are anticipated in the present? To answer this question, we analyse the biodiversity inscription process of England and the Netherlands– representing two spatially contiguous cases of how biodiversity is increasingly being integrated into tendering processes for wind energy parks. In doing so, we compare the tender processes in these two countries to understand how present-day assumptions, priorities and ways of knowing enact the anticipation of future marine biodiversities. The findings from this comparative analysis contributes insights into the expanding role of tendering as a mechanism for governing future marine biodiversity in the North Sea and beyond.

The following elaborates an inscription framework for understanding how assumptions and priorities are embedded in offshore wind tendering processes. This framework is then used to empirically compare the tendering processes in England and the Netherlands. These results demonstrate the different ways biodiversity is inscribed in the two countries, with varying perceptions and frames of risks and uncertainty related to biodiversity. Finally, we discuss the implications of these different inscriptions on how future biodiversities are shaped, enacted and adapted surrounding offshore wind infrastructure.

2. Inscribing biodiversity

Tendering processes for offshore wind energy parks prescribe technical design choices and anticipate which ecological impacts are deemed politically and socially acceptable. However, within these tendering processes, assumptions and priorities are embedded in environmental assessments and requirements that privilege certain species and habitats over others, thereby shaping which forms of biodiversity are selected for protection, enhancement, and/or restoration [32,87]. Tendering processes are, as such, neither neutral nor objective. They instead ‘curate’ biodiversities by setting tendering rules and requirements that affect what and whose assumptions, priorities and ways of knowing are deemed relevant for assessing and managing – conserving, enhancing and/or restoring - biodiversity [32,87]. Following Wyborn et al. [96], both incumbent and yet-to-be-known biodiversities can therefore be understood as outcomes of a normative process – one in which institutional assumptions, priorities and ways of knowing simultaneously enact certain futures for biodiversity while excluding others.

Building on previous STS research on inscription [1,96,95] we argue that the inclusion and/or exclusion of assumptions, priorities and ways of knowing biodiversity in tender processes constitutes a form of inscription. Inscription, as introduced by Latour and Woolgar [46], and elaborated by Kristensen et al. [70], involves translating external assumptions and priorities into ways of knowing biodiversity practices through ‘inscription devices’ such as scientific instruments, materials and papers [4,46]. These devices are, in turn, products of structured knowledge practices - meaning that knowledge, as well as the assumptions and priorities on which it is based, are mobilised for use by other actors [42]. As tendering processes for offshore energy inscribe the external assumptions and priorities of the state and other actors, they shape how biodiversity is assessed and understood and thereby shape the design of mitigation strategies that anticipate and enact future kinds of biodiversity in the present [74]. Seen as such, tendering is both “a process through which meaning is created” and “the material manifestation of meaning” ([23], p. 30). Consequently, the way that biodiversity is inscribed in the tender process - through these assumptions, priorities and ways of knowing - shapes and enacts what biodiversity is made manageable.

To explore how biodiversity is inscribed through tendering for offshore wind energy, we adopt three iterative heuristic steps (Fig. 1) based on Kristensen et al. [70]. We use these steps to explore how (1) assumptions and priorities of state institutions shape (2) different ways of knowing biodiversity through the requirements placed within the tender process which in turn (3) enacts specific ideas of what future biodiversity should look like by adapting biodiversity assumptions, priorities and requirements in subsequent tender rounds. These steps are elaborated below.

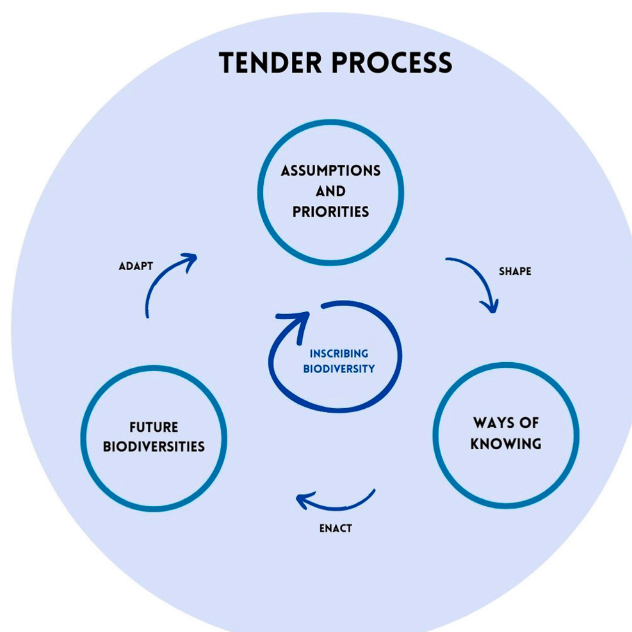

Fig. 1. Inscription of biodiversity in tendering process.

First, to understand how biodiversity is inscribed into knowledge and action, we identify key assumptions and priorities of state institutions related to biodiversity that are embedded in the tender process. Definitions of biodiversity formalised in policy and regulation reflect the assumptions, priorities and prevailing knowledge of state institutions that produce them [19,33,76]. States, for instance, create formal rules about the status of different species and habitats, shaping which biodiversity is to be protected, restored or enhanced [28,71]. Underlying such rules are often uncertain assumptions about which kinds of species and habitats are important and should be managed. These are embedded in the definition and use of the 'mitigation hierarchy' and precautionary principle in Environmental Impact Assessments (EIAs). The mitigation hierarchy assumes that 'on site' compensation of biodiversity loss - or off-site offsetting to ensure no net loss - aligns with public values when direct impacts cannot be avoided or projects cannot be redesigned [2,29,59]. Such assumptions, also underwritten by priorities for energy sovereignty, have generated new practices such as 'nature-inclusive design' in offshore wind development [41]. We therefore focus on how assumptions and priorities are institutionalised in tendering processes and how they shape what biodiversity becomes known and managed.

Second, assumptions and priorities shape preferences for which ways of knowing biodiversity are required in tenders to inform decisions on conservation, enhancement and/or restoration. There is no standardised way of knowing biodiversity within the tendering processes. As a result, assumptions and priorities of state actors can affect whether biodiversity assessment is required in *a priori* EIAs, if enhancement ambitions are assessed against 'non-price criteria', or if *ex ante* monitoring is embedded in site requirements. These inscription devices – EIAs, non-price criteria and site requirements – therefore shape how biodiversity is measured and known, which in turn influences which kinds of biodiversity are ultimately enacted [3,74]. Moreover, the primary role of monitoring plans, biodiversity assessments and other ways of knowing biodiversity – especially under conditions where there is dearth of existing knowledge – highlights the *de facto* governing role that those writing tenders play in determining which species and habitats count [31,89]. In the analysis that follows, we focus on how different inscription devices translate institutionalised assumptions and priorities in tendering processes, and how the knowledge they produce shapes mitigation strategies that, in turn, determine which kinds of future biodiversity are ultimately enacted.

Third, we explore how biodiversity mitigation strategies in tenders also feedback on and affect the kinds of assumptions, priorities and ways of knowing that states hold for marine biodiversity around offshore wind park development. We assume that strategies such as 'nature inclusive design', 'marine net gain' or 'biodiversity enhancement' represent the enactment of current assumptions, priorities and ways of knowing. However, as new knowledge emerges through biodiversity monitoring or as public demands for conservation, restoration and enhancement evolve, the assumptions and priorities of the state communicated through tendering processes can also change. Such changes may reinforce existing ways of knowing and managing biodiversity or enable alternative inscriptions that enable a shift from site-specific or species-specific forms of mitigation to ecosystem-based forms of mitigation [6]. Seen in this way, inscription is not prescriptive but continually enacted through policy processes such as tendering, with consequences for how ideas of what future biodiversities should and could look like are ultimately realised.

In the rest of the paper, we explore these three dimensions (see Fig. 1) of inscription by comparing how tendering for offshore wind energy parks in England and the Netherlands have been conducted. In doing so we examine how assumptions and priorities have adapted based on previous rounds, initiating a new inscription process each time. Through identifying and analysing specific moments of inscription, each tender provides a learning opportunity for unpacking and highlighting not only current biodiversity inscriptions, but also the implications for future biodiversity inscriptions. These moments of inscription represent themes that emerged from the data, allowing for reflection on how biodiversity is demanded and inscribed through and within future tenders.

3. Methodology

Our analysis of offshore wind energy tendering rounds in England and the Netherlands adopts a comparative case study design, highlighting how "people, situations, events" ([51], p. 29) continuously enact and adapt socio-political processes [5,75,95]. This process-oriented approach to case comparison enables us to iteratively trace relevant actors, themes, information and policies that may emerge from comparing biodiversity in offshore tender processes. Following Bartlett and Vavrus [5], we use this comparative approach to explore how contextual or cultural boundaries and political structures of our cases enact and enable certain processes over others.

England and the Netherlands were chosen for comparison for several reasons. First, the United Kingdom has the highest offshore wind energy production in Europe [72] while the Netherlands is a frontrunner in non-price ecological criteria [94]. England was chosen amongst the nations of the United Kingdom (UK) due to its extensive history in offshore wind (going back to 2000) and the distinct regulatory requirements within countries in the UK. Second, England and the Netherlands are similar in the sense that they both have a tender process, they both attempt to incorporate biodiversity within this process, and their offshore wind markets are rapidly changing, making it valuable to unpack both the similarities and differences in their approaches. Lastly, the two countries differ in their perceived levels of acceptable risk when intervening in nature, offering a basis to compare how such factors influence the inscription of biodiversity in offshore wind development [33,36,8].

Three datasets were combined to triangulate the findings of how biodiversity is inscribed through the English and Dutch tendering processes. First, a scoping review clarified the tender processes in both countries and informed the interview guides (see 6 for interview guides for both the English and Dutch cases). Second, eighteen interviews were conducted with government (n = 5), NGOs (n = 3), consultants (n = 5), industry (n = 5), with expertise on England (n = 7) and the Netherlands (n = 8), or both (n = 3) (see Table 1 for codes and Table A in 6 for complete list of interviewees, their expertise and their codes).

The interview data was inductively coded in Atlas.ti based on the three steps within the inscription framework explained above, namely, the assumptions and priorities, ways of knowing and future biodiversities to identify inscription 'moments'. Through the coding process, seven moments of inscription emerged as essential in analysing the offshore wind tender process (see Table 2). These moments of

Table 1
Respondents and their reference codes.

	Respondents	Code
1	Technical Offshore Wind	TOW - E
2	Marine Planning and Technical	MPT-E
3	Senior Marine Ecologist	SME-E
4	Offshore Renewable Specialist	ORS-E
5	Biodiversity Specialist	BS-E
6	Environmental Specialist	ES-E
7	Marine Science and Policy	MSP-E
8	Sustainability and Biodiversity Innovation	SBI-ENL
9	Renewables Specialist	RS-ENL
10	Offshore Energy and Nature	OEN-ENL
11	Offshore Energy and Nature	OEN1-ENL
12	Offshore Wind Energy Policy	OWEP-NL
13	Senior Project Manager	SPM-NL
14	Marine Ecologist	MEN-NL
15	Marine Ecology and Nature Restoration	MENR-NL
16	Marine Ecologist	MEI-NL
17	Marine Nature Policy	MNP-NL
18	Business Developer	BD-NL

Table 2
Operationalisation of inscription to analyse how biodiversity is inscribed through the tender process.

Inscription process	Moments of inscription
Assumptions and priorities	1. Perceiving biodiversity 2. Framing biodiversity 3. Managing uncertainty and risk
Ways of knowing	4. Assessing biodiversity 5. Prescribing biodiversity
Future biodiversities	6. Emerging biodiversity frameworks 7. Adapting future offshore wind tenders

inscription therefore help operationalise the concept of inscription for our context. The scoping review and interviews also clarified the documents for analysis, namely, the latest concluded Round in England (Round 4 in 2023), and the latest concluded ecological tender for the Netherlands (Hollandse Kust West in 2023) at the start of this research. Third, a deductive document analysis was undertaken to supplement and contextualise interview findings. Sources included European legislation (e.g. Birds and Habitats Directive, Restoration Law), national level EIA and key national policy documents such as the England's Information Memorandum for (tendering) Round 4 and 5 and Dutch site and tender criteria (i.e. Hollandse Kust West and Nederwiek 1-A). Round 5 and Nederwiek 1-A tender documents were used to illustrate a temporal element to the changing assumptions and priorities, highlighting that later tenders may adapt assumptions and priorities.

4. Comparing tendering processes

4.1. England

English offshore wind development involves three key stages, with various state and non-state actors responsible for executing and facilitating each (see Fig. 2). The first stage is the tendering process for seabed leasing from the Crown Estate, a for-profit public body that generates profit for Treasury [79,84]. The second stage involves granting a Development Consent Order for the wind park from the Planning Inspectorate, Secretary of State for Business and Energy and Industrial Strategy. Here developers also get input on their project plans from key stakeholder groups, such as the Marine Management Organisation and interested parties (i.e. Royal Society for the Protection of Birds) [10,91]. The third stage involves an additional tendering procedure for grid connection. We limit our analysis to the biodiversity requirements in the first two stages.

The English tender process uses a decentralised approach where Government uses marine spatial planning methods to plan each leasing round, while developers conduct surveys and environmental assessments to determine suitable locations [54,92]. However, the degree of flexibility afforded to developers has changed over time. In the first two tender rounds (launched 2000 and 2003), developers were allowed to select project areas ([61]; TOW-E, 05/12/24). In Round 3 (2007) the Crown Estate identified zones of interest for offshore wind parks [11]. In Round 4 (2019), the Crown Estate reverted to larger regions that delineate development zones based on marine plan boundaries, and technical feasibility, with further refinements made through consultation with statutory bodies, such as Marine Management Organisation and Natural England, non-statutory bodies and market stakeholders [78,79].

Biodiversity is assessed as a tendering criterion but remains a regulatory requirement under the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 [86] and the Conservation of Habitats and Species Regulations 2017 [85]. In the leasing stage, applicants with the highest bid secure a seabed lease with the Crown Estate [77]. Developers must then seek a Development Consent Order based on a submission of an EIA identifying expected environmental impacts at the site level and a Habitats Regulations Assessment (HRA) detailing expected impacts on the national network of protected habitats and species [60,80]. Where necessary, developers propose mitigation or compensation measures ([60]; ORS-E, 11/03/25). Since ecological criteria extend only to regulatory requirements, site-specific impacts can be negotiated, mitigated and compensated (SME-E, 26/02/25). Consequently, no sites are excluded a priori from development – including marine protected areas – and biodiversity enhancements only occur when compensation is deemed necessary [62,65].

In summary, the regulatory approach to the English tendering process sets out obligations underpinned by precautionarity through ex ante biodiversity assessments. These assessments lead to decision making that prioritises mitigating and compensating impacts. Decisions over tenders are nevertheless based on price-criteria, meaning that biodiversity impacts, and the design of mitigation and compensation remains pre-competitive.

4.2. The Netherlands

The Dutch approach to offshore wind park tendering is centralised within the state [92]. The Dutch government is responsible for defining leasing areas, site surveying, environmental and habitat assessments, site decisions, tendering schedules, consenting procedures, and offshore grid connections [67,68]. The government also sets price and non-price criteria including both technical design and biodiversity enhancement ambitions used to evaluate bids based on a scoring system. Interviewees described this approach as a "one-stop-shop" ([93]; OWEP-NL, 06/12/24; RS-ENL, 13/02/25; MENR-NL, 16/01/25) whereby the site permit, the plan-level and project-level EIAs, consenting, and offshore grid connections are coupled into a package that goes out to tender (see Fig. 3). Developers with successful bids are expected to then fulfil non-price criteria related to biodiversity in the construction and ongoing management of their wind parks.

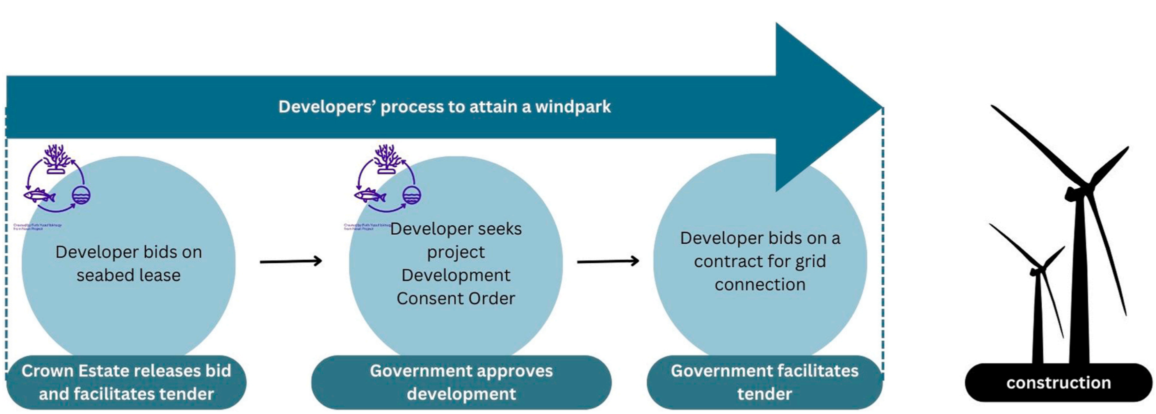

Fig. 2. English offshore wind development process.

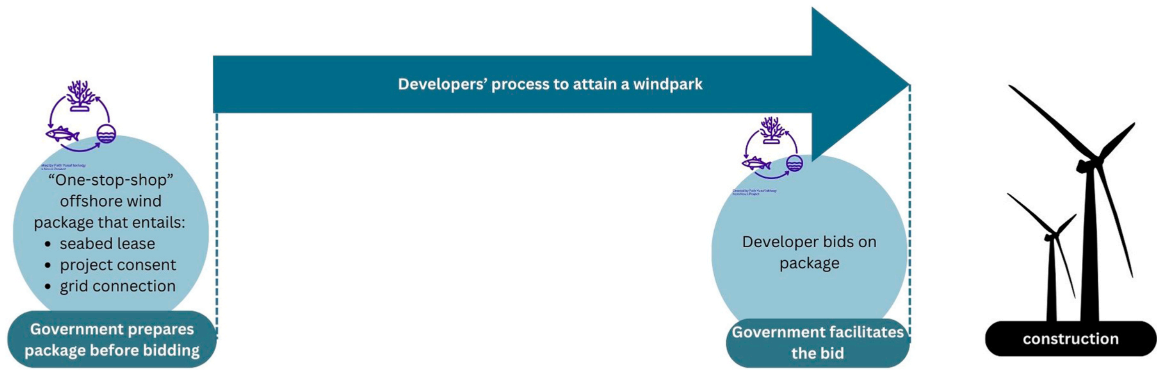

Fig. 3. Dutch offshore wind development process.

The government's overall planning is organised and communicated through the 'Offshore Wind Energy Roadmap', which details the location and sequence of site development, expected installed generation capacity and the expected dates for tenders to open [67]. Doing so the government aims to 'de-risk' offshore wind energy park development, whereby permits, site decision and grid connection are simultaneously provided to the winning bid ([67]; RS-ENL, 13/02/25). Furthermore, the Government pre-assesses sites through an EIA, Appropriate Assessment (AA) and a Cumulative Effects Assessment (KEC). These assessments identify and assess potential biodiversity impacts of current and future offshore wind parks on protected habitats and species [64,67]. Based on these assessments, solutions to biodiversity impacts are identified which directly inform the conditions for site development [64,67]. In doing so, biodiversity incentives and demands are embedded from the start within the tender process.

Tenders are 'opened' with a Ministerial Order outlining rules for the offshore wind sites. For each tender round, the Offshore Wind Energy Act provides four procedures for granting permits for plots: auctioning, a comparative test with a financial bid, a comparative test without a financial bid and granting permits linked to a subsidy [26]. While price criteria remain central to the tendering process, biodiversity enhancement has emerged as a key non-price criteria to select the winning bid that permits developers to construct, operate and remove an offshore wind park [68]. Proposals for biodiversity enhancement are evaluated based on a point system, whereby higher scores are given to more innovative or more 'exceptional' bids. Non-price criteria related to biodiversity enhancement are then added to developers' permit obligations.

In summary, while the English approach focuses on the development of an ad hoc biodiversity impact mitigation and compensation strategy, the Dutch tendering process requires an ex-ante biodiversity restoration and/or enhancement strategy embedded within the design of wind parks. The following details the ways in which biodiversity is inscribed in and through these two tendering processes and how both processes inscribe present day assumptions and priorities in wind park requirements that have consequences for future marine biodiversities.

5. Inscribing biodiversity through tendering

In the following sections, we detail the seven moments of inscription under the three dimensions described within the inscription framework (see Table 3). In doing so, we compare how England and the Netherlands fair in each dimension through examples based on moments of inscription identified from the analysis. Table 3 can be used as guidance to read through this section.

5.1. Assumptions and priorities

Comparing assumptions and priorities between the English and Dutch tendering processes demonstrates differences in how risks to biodiversity are perceived and framed. The comparison also demonstrates that these perceptions and frames fundamentally influence how future biodiversities are inscribed through the development of offshore wind energy, making them moments of inscription.

First, assumptions and priorities in the two countries reveal how they differ not only in how they perceive biodiversity, but also in the types of biodiversity they prioritise in offshore environments.

In England, the concept of 'marine net gain' is currently proposed as a new mandatory framework for wind energy projects [22], aiming to "leave the *natural* environment in a measurably better state than beforehand" ([16], p. 3). This framework, expected to become mandatory in offshore wind energy development, prioritises the existing natural environment over the introduction of "potentially positive incidental impacts whose benefits are subject to significant uncertainty" ([15], p. 13). Consequently, passive impacts from offshore wind parks are seen as a negative because the substructures of turbines enable "the creation of new habitats and ecosystems" that attract both endemic and non-native species ([15], p. 13). As such, passive impacts are not considered positive environmental outcomes and are excluded from the conceptualisation of marine net gain [16]. However, the characterisation of native vs. non-native species is highly dependent on a subjective definition of baselines (e.g. 2025 or 1900) used to assess biodiversity in the UK [33]. As implied by one specialist, the choice of baselines thus shapes

Table 3
Summary of results comparing the English and Dutch inscription process.

Inscription process	Moments of inscription	England	The Netherlands
Assumptions and priorities	1. Perceiving biodiversity	Preservationist	Interventionist
	2. Framing biodiversity	Impact and mitigation perspective	Impact, mitigation and enhancement perspective
	3. Managing uncertainty and risk	Precautionary and minimal biodiversity management	Adaptive biodiversity management
Ways of knowing	4. Assessing biodiversity	Static ex-ante biodiversity assessment	Continuous centralised biodiversity assessment
	5. Prescribing biodiversity	Compliant, negotiable and ad-hoc compensatory biodiversity requirements	Innovative and experimental biodiversity requirements
Future biodiversities	6. Emerging biodiversity frameworks	Strategic and natural marine net gain	Localised and innovative biodiversity enhancement
	7. Adapting future offshore wind tenders	Early biodiversity requirements	Stricter, targeted and more ambitious biodiversity requirements

what is regarded as (un)natural and, by extension, what is deemed worthy of restoration or enhancement (MSP-E, 19/05/2025).

In the Netherlands, the concept of 'biodiversity enhancement' is used in wind park tendering to describe "the process of assisting a general increase in the number of species or species richness", referring to both species richness and improved ecosystem functioning ([9], p. 8). At the same time, the Dutch approach is comparatively flexible, recognising passive benefits such as those artificial substrates or nature inclusive design [26], and allowing experimentation with enhancement within wind parks. This is illustrated, for instance, by Ecowende Wind Park's 'Tree Reef' pilot using discarded fruit trees to create habitat for benthic and fish species [20]. Unlike the notion of net gain in England, there is limited consideration of natural vs. unnatural in terms of what biodiversity is being enhanced.

Second, assumptions of what is perceived to be natural and artificial shape how tenders prioritise and frame mitigation or enhancement interventions. Whereas England stresses evidence-based assessment of biodiversity impacts prior to wind park development, the Netherlands encourages developers to experiment with and propose different biodiversity enhancement interventions.

To illustrate, in both countries, regulatory mechanisms such as the EIA and other environmental assessments (i.e. HRA, AA and KEC) determine which aspects of biodiversity are prioritised – such as protected species or habitats [85,86]. For instance, in England, species protection is based on the designation of Special Areas of Conservation and Special Protection Areas [80], while in the Netherlands, Natura 2000 sites (protected under the EU Birds and Habitats Directives) are prioritised [63]. Both countries, as such, operate primarily from an impact mitigation perspective that translates into prescribed assessments and tendering criteria. In England, EIA and HRA are used to assess and guide impact mitigation, with the ambition to "maximise avoiding and reducing impact" on the mitigation hierarchy (MSP-E, 19/05/25), while in the Netherlands, impact avoidance and reduction are embedded in EIA, AA and KEC assessments under the Offshore Wind Energy Act (MENR-NL, 16/01/25). Subsequently, in the Netherlands non-price ecological criteria in tenders then serve to prioritise enhancement opportunities within the mitigation hierarchy, anticipating cumulative environmental impact (SPM-NL & MEN-NL, 09/12/24).

Third, England and the Netherlands differ in their assumptions about how biodiversity-related uncertainties should be addressed, based largely on the perceived success of mitigation, compensation and enhancement interventions.

The English tendering process reflects a precautionary stance: when outcomes are uncertain, specific designs or locations for wind energy are to be avoided wherever possible. This is illustrated by the emphasis on like-for-like compensation for identified impact, as outlined in compensation plans negotiated in stage two of the tendering process [82,83]. One interviewee shared that when not deemed necessary by assessments, any experimental restoration or enhancement interventions within the wind park require additional permits and licenses that demand evidence for biodiversity net gain impacts (BS-E, 21/03/25). However, pilot testing innovations within wind parks is challenging because of the difficulty of determining their success (BS-E, 21/03/25). According to another interviewee, the English approach risks stalling progress and innovation as it focuses on "doing less harm rather than actively doing something different that does good" (SBI-ENL, 12/02/25).

In contrast, the Dutch tendering process emphasises experimentation, described by one industry expert as a 'try now and see what happens later' approach (SBI-ENL, 12/02/25). This approach rests on the assumption that the status of biodiversity is already poor, reflected in the North Sea Programme 2022–2027 statement that "the current ecological status of the North Sea is worrying" ([30], p.30). Ecological restoration and enhancement are, as such, deemed desirable because they are "expected to influence the overall status of the North Sea in a positive way" ([30], p. 109). Yet ex ante proposals for enhancement remain uncertain. For instance, enhancement measures from successful tenders have been incorporated into subsequent tenders before their effectiveness is known (MEI-NL, 14/02/25). A policymaker characterised such initiatives as "no regret measures" – i.e. low-cost measures that may or may not enhance biodiversity but are expected to minimise biodiversity losses (MNP-NL, 14/02/25). However, other experts cautioned that without adequate feedback, such replication creates the risk of doing more harm than good (SBI-ENL, 12/02/25; SPM-NL & MEN-NL, 09/12/24).

5.2. Ways of knowing

The results also show that England and the Netherlands have adopted different approaches to biodiversity assessments within the tender process. In England, assessment occurs only during the consenting phase, while in the Netherlands, it is carried out continuously throughout the tender process.

In England, biodiversity is assessed through the EIA and HRA conducted at both the national plan level and on project sites. Leasing agreements are based on plan-level EIAs and HRAs conducted by either developers or the Crown Estate (TOW-E, 05/12/24). Once the lease is granted by the Crown Estate, developers submit an Environmental Statement detailing initial impact and plans. During the consenting stage with government authorities, developers conduct a project-level EIA [60,80] and an HRA to evaluate project impacts on designated nature conservation sites under the Birds and Habitats Directive, and identify measures to avoid adverse effects [80]. Together, the EIA and HRA determine which biodiversity impacts must be compensated and subsequently monitored, allowing offshore wind projects to proceed once compensation measures are agreed during the consenting phase. This flexibility enables site allocation (even within marine protected areas) on a case-by-case basis. At the same time, reliance on ex-ante assessment limits opportunities for alternative responses such as biodiversity enhancement (SBI-ENL, 12/02/25). Nevertheless, as outlined above, the potential introduction of 'net gain' in the marine environment suggest a potential shift toward more proactive and ambitious biodiversity outcomes.

In contrast, the Netherlands adopts a centralised approach to biodiversity knowledge generation, using EIAs and Appropriate Assessment to identify potential impacts and embed biodiversity enhancement in the tender process. Both assessments are commissioned by the Government – and conducted by a third party – prior to a site going out to tender [68]. Like in England, these assessments prioritise the protection or enhancement of species and habitats within the tender. However, the Netherlands embeds biodiversity into site requirements through non-price ecological criteria, thereby legislating the protection and enhancement of biodiversity. These assessments then form an ongoing framework to guide developers on what and how they should monitor biodiversity against the enhancement strategies they propose in their tenders. This effectively shifts responsibility to developers for designing monitoring of enhancement again with the intention of encouraging innovation in biodiversity management.

In addition, prescriptions of biodiversity within English and Dutch tendering processes highlight the different ways that biodiversity is known. These policy requirements shape what knowledge is considered necessary, which criteria are deemed relevant and for whom they carry significance.

As outlined above, the compensatory approach to biodiversity in England's tender process is negotiated after impact assessments are completed. This leaves the inclusion of biodiversity impacts in leasing agreements open to negotiation over what and where compensation should take place. To illustrate, like-for-like compensation measures are often not possible where species or habitats in one location cannot be reproduced elsewhere. As one interviewee explained, "if it's a reef, you can build an artificial reef but how do you generate a new sandbank? The North Sea is all sand, right?" (TOW-E, 05/12/24). Such considerations are weighed and negotiated by the Steering Group of each tender round using DEFRA's compensation hierarchy detailing different levels of compensatory measures of each tender round until 'reasonable outcomes' can be agreed upon [14,83]. To illustrate, Level 1 requires compensation at the same location, related to direct compensation of losses to habitat or biodiversity; Level 2 refers to the same ecological function and different location; Level 3 sets comparable ecological function at the same location of impact; and Level 4 obliges comparable ecological function at a different location. For some respondents these negotiations are limited to only 'significant impacts' rather than providing a comprehensive set of biodiversity requirements (SME-E, 26/02/25; ORS-E, 11/03/25; BS-E, 21/03/25). And where 'significant impacts' are considered, compensation is oriented to losses rather than gains, making it difficult to assess enhancement effects (BS-E, 21/03/25).

In contrast to England, the Netherlands adopts a relatively more innovative and experimental approach to biodiversity with site requirements prescribed and embedded throughout the tender process. For instance, the site decision - a legal document that provides the bidding framework for developers - includes explicit measures to protect harbour porpoises, seals, fish, birds and bats and nature-inclusive design requirements [26]. In doing so, the site decision prescribes which kinds of biodiversity should be prioritised and, to some extent, the ways in which they should be enhanced (OWEP-NL, 06/12/24). Voluntary non-price ecological criteria provide additional opportunities for developers to innovate beyond these prescribed measures. As one respondent argued, the site decision includes what is already known and assumed to be a priority, while the non-price criteria – making up 50 % of tender assessment - provide room for exploring new innovations [27]. For instance, the design of ecological solutions such as using nature-inclusive bird sensor systems or colouring turbine blades [21]. Together these site decisions and non-price ecological criteria generate knowledge on biodiversity interventions, create opportunities to address knowledge gaps across stakeholders, and promote innovation that extends beyond the scope of conventional EIA and HRA.

5.3. Future biodiversities

Finally, the results demonstrate how current biodiversity ambitions through these assessments and requirements are enacting assumptions, priorities and ways of knowing about imagined future biodiversities.

First, the two tendering processes show the different ways that England and the Netherlands anticipate and imagine valuable and desirable future biodiversities through concepts of 'marine net gain' and 'biodiversity enhancement' at different scales.

In England, imagined futures includes a notion of 'natural' biodiversity strategically restored and compensated through the 'marine net gain' framework. However, it is questionable whether 'marine net gain' offers a means of restoring or improving biodiversity given its emphasis on enhancing the 'natural' environment. In the words of one expert, the North Sea is characterised by sandy substrates, "so addition of any kind of rock is seen as putting a different type of habitat in. Even if it is colonised, it is not seen as improving the natural environment, it is basically seen as an impact" (BS-E, 21/03/25). The requirement to only enhance 'natural' biodiversity around offshore wind parks has been increasingly challenging due to offshore wind demands and the difficulties with localised like-for-like compensation. Therefore, future 'marine net gain' initiatives will encourage strategic, ecosystem-based compensation through initiatives such as an industry-funded Marine Recovery Fund, appearing less ad hoc than current approaches, and allowing for more intentional biodiversity interventions [17,18].

The Dutch tendering process, by contrast, envisions 'biodiversity enhancement' as localised and actively fostered by innovative interventions. Current tenders typically target a few key species – for instance, migratory bird species, marine mammals (i.e. harbour porpoise), reef/habitat building species (i.e. tube worms, oysters and mussels) and cod [40]. As a result, artificial reefs are being trialled in offshore wind parks, aiming to enhance specific species or habitats. Because biodiversity enhancement is embedded in the design of wind parks through the tender process, initiatives remain localised and linked to offshore infrastructure to meet permit requirements (MNP-NL, 14/02/25). Freedom given to developers to monitor their biodiversity interventions creates challenges regarding their vs. the government's responsibilities to monitor wider scale effects to biodiversity based on localised intervention (MNP-NL, 14/02/25). Thus, unlike England's anticipation of 'natural', mitigated and strategic biodiversity, Dutch project-level designs risk resulting in fragmented experimental projects that enhance biodiversity but provide a limited picture of how future biodiversities are being enhanced or restored.

Second, 'marine net gain' in England and 'biodiversity enhancement' in the Netherlands are already reshaping ambitions for governing biodiversity in the context of offshore wind energy, albeit in different ways.

In England, the Crown Estate is adapting regulatory assumptions and priorities to include biodiversity more prominently in the tendering process, as seen in the 2023 Floating Offshore Wind tender in Wales [81]. This tender included a criterion to "support the creation of social, economic and environmental value" ([81], p. 6), a political move to better enable applications to more directly align with national targets for habitat restoration, creation and enhancement. Developers were asked to demonstrate "how they will accelerate progress towards a net positive outcome for the environment and improved resilience of marine ecosystems" ([81], p. 33), reflecting The Crown Estate's new objective to take a "leading role in stewarding the UK's natural environment and biodiversity" ([81], p. 6). Yet, while biodiversity is increasingly demanded within the tendering process, it is not yet prioritised as an important requirement in determining winning bids (ES-E, 06/05/25). At the same time, there is growing hope that biodiversity will become more significant in the tendering process through strategic compensation and mandatory (financial) contributions to compensation initiatives, such as the Marine Recovery Fund (MSP-E, 19/05/25; [17]).

In the Netherlands, by contrast, biodiversity enhancement directly addresses concerns that cumulative biodiversity impacts will, in the words of one respondent, result in a "future of no offshore wind" (RS-ENL, 13/02/25). The non-price ecological criteria in the tender process aims to distribute responsibility for addressing ecological issues, knowledge gaps and uncertainties. In doing so it positions industry and market actors as efficient problem-solvers (OWEP-NL, 06/12/24). The concept was adopted to stimulate knowledge generation and compensate for biodiversity losses from cumulative environmental impacts. The perceived success of the first ecological tender (OWEP-NL, 06/12/24; RS-ENL, 13/02/25; MEI-NL & MNP-NL, 14/02/25; [94]) reinforced biodiversity's importance in subsequent rounds. For example, the current tender rounds mandate 40 % of scour protection be nature inclusive for biodiversity enhancement – 20 % above the previous rounds [39]. Ecological non-price criteria for species and enhancement measures have also become increasingly specific and targeted, informed by the results of earlier tenders. For example, in the 2025 Nederwiek I-A tender, target species such as gannets and herring gull are specified, with "shutdown on demand/local curtailment in the wind park on a representative number of wind turbines in the presence of the target species" proposed as a measure ([40], p. 14). Each tender thus operates as a learning cycle, incrementally improving how biodiversity is integrated.

6. Discussion

In this paper we identified seven moments in which biodiversity was inscribed in the offshore wind energy tendering processes of England and the Netherlands (see Table 3). These moments of inscription show the operationalisation of assumptions, priorities, ways of knowing and future biodiversities in offshore wind tenders (see Fig. 4). In England, biodiversity is inscribed as natural, mitigated and compliant while in the

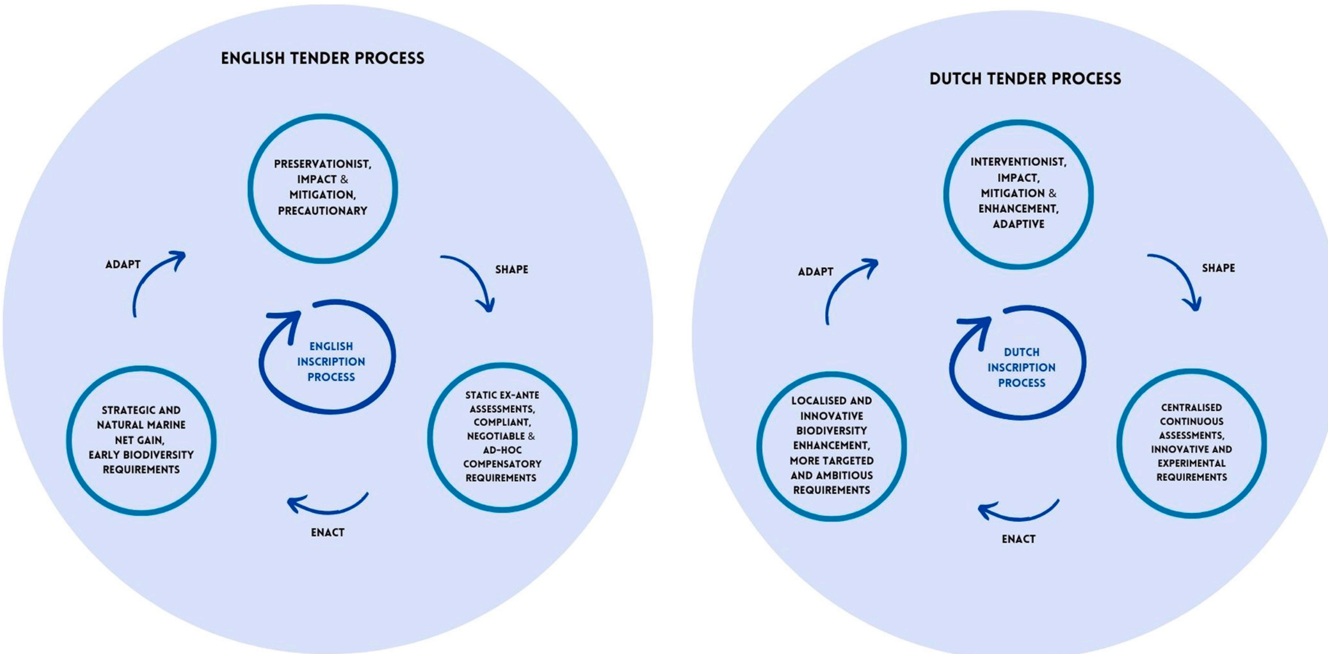

Fig. 4. Summary of English and Dutch inscription processes.

Netherlands, it is inscribed as interventionist, experimental and innovative. This comparison demonstrates how tendering processes, with distinct assumptions and priorities leading to specific ways of monitoring and mitigating biodiversity, shape how specific future biodiversities are anticipated, with the risk of unknowingly perpetuating one vision of biodiversity over others. Unpacking this process can shed light on and make room for deliberation on alternative future biodiversities. Here we further discuss how the identified moments of inscription shape tendering processes as a means of governing future biodiversity in offshore wind energy parks.

Our results show how assumptions and priorities in the tendering processes in England and the Netherlands – in line with Asdal [3] and Steuernagel et al. [74] – shape visions and ambitions for future biodiversities. As outlined in Table 3, these inscription processes have shaped tendering into a form of anticipatory governance that 're-makes' biodiversity through assessments and criteria [13]. For instance, the decision to include ecological criteria (or not) within offshore wind tenders influences which habitats and species are mitigated or enhanced, and thus which biodiversity futures are made possible. Tendering therefore inscribes what counts as desirable biodiversity in and around offshore wind parks and how that desirability is achieved [47,48,69]. Building on Turnhout et al. [88], it is not merely a policy instrument for allocating offshore wind parks but also a governance process that enacts socially constructed ideas of which future biodiversities are either reshaped or ignored.

Our results also show that moments of inscription embed assumptions and priorities that reify specific ways of assessing and knowing biodiversity. In both England and the Netherlands, values of nature tend to align with either preservationist or interventionist, as well as precautionary or adaptive approaches to biodiversity mitigation. These approaches, in turn, affected how impacts are assessed – for instance, through project level EIA and plan level HRA in England, and cumulative impacts in the Netherlands. Yet despite these differences between the two countries, there is also evidence that over time assumptions about nature, and approaches for assessing mitigation and enhancement in tendering processes are evolving. For instance, through strategic interventions by England or more prescribed criteria by the Netherlands. Following Esguerra [24], while tendering processes in both countries seem to reinforce particular, institutionalised ways of anticipating biodiversity (Fig. 1), shifting assumptions, priorities and ways of knowing also create opportunities for adaptation, enabling the anticipation of alternative future biodiversities.

We argue that the seven moments of inscription summarised in Table 3, can also be used to reflexively reshape the devices [46] used in tendering processes that govern future marine biodiversity. Two such inscription devices are particularly important in this regard: (1) biodiversity assessments and (2) biodiversity prescriptions. By reflecting on how these assessments and prescriptions enact biodiversity, it becomes possible to steer tendering processes as explicit instruments for governing future biodiversity.

First, while often seen as technical and objective devices, the results show how biodiversity assessments are inscribed with specific assumptions and priorities. Making these inscriptions explicit opens up space to deliberate on the role of biodiversity assessments and to make more reflexive decisions on their design. In England, for example, precautionary priorities influence how Environmental and Habitat Regulation Assessments guide mitigation and compensation strategies. Similarly, in the Netherlands interventionist priorities influence how Appropriate and Cumulative Effects Assessments guide biodiversity enhancement strategies. At the same time, our results show how the role of these assessments are open to scrutiny and change. In England, there is a political shift away from precautionarity to foster net gain, and in the Netherlands the risks of enhancement interventions are leading to political discussions over the need for greater precautionarity. These shifts point towards how wider political ambitions affect and adapt the ways that technical devices such as tenders inscribe biodiversity, indicating opportunities for change.

Second, although unintentional, we found that prescriptions of biodiversity in tender processes can affect the inclusion or exclusion of certain biodiversity futures. Unpacking the institutional arrangements and political objectives behind these prescriptions allows possible 'reverse engineering' of decisions made about what future biodiversities are included/excluded. For instance, the Dutch adopt a centralised approach to prescribing and steering desirable futures, by explicitly requiring biodiversity in the non-price ecological criteria and mentioning what target species are to be enhanced and through what measures, creating a specific kind of desirable future for marine biodiversity [38]. This notion of enhancement used by the Dutch can be attributed to historical utilisation of the land, whereby controlling nature has been part of the Dutch cultural identity (e.g. land reclamation, dikes) [52,76]. In contrast, the more decentralised approach in England does not prescribe any ecological criteria but works with developers to co-design future biodiversities through the EIA and HRA process. By understanding how these institutional differences in assumptions and priorities influence how and what biodiversity is prescribed, it is possible to better trace how criteria lead to the inclusion/exclusion of biodiversity and open up explicit deliberation on how tendering processes might otherwise govern future biodiversities.

In summary, offshore wind tendering is shaped by different biodiversity inscriptions, each carrying distinct implications for the enactment of future biodiversities. Our analysis shows how identifying moments and devices of inscription helps unpack the black box of tendering by revealing how assumptions, priorities and ways of knowing and governing biodiversity become embedded in the acceleration of marine infrastructure development [53]. Our comparative case studies also demonstrate that inscriptions are context-dependent, shaped by national approaches to human-nature relations that determine the scope and type of assumptions and priorities ascribed to biodiversity. These comparisons are nevertheless relative. For instance, while England appears less interventionist and more precautionary than the Netherlands, others argue that England (and the UK) takes a far more interventionist stance on nature than the United States [33]. Building on Kristensen et al. [70] work on inscription in the design of marine monitoring technologies, we have shown that beyond epistemic communities, inscription can also occur through wider historical, present, and emerging assumptions, priorities and ways of knowing embedded in institutional settings and practices. This underlines the value of the inscription framework for examining governance processes across different contexts, illuminating how different approaches steer future biodiversities, and identifying opportunities for change for offshore wind and other marine interventions.

7. Conclusion

Offshore wind tendering processes are shaping, enacting and adapting future North Sea biodiversities. Through a comparative case study between the English and Dutch tendering processes, we identified key moments of inscription that illustrate the different ways in which biodiversity is perceived, framed, managed, assessed and prescribed through the tender process. By unpacking the inscription process, we were able to trace how institutional assumptions, priorities and ways of knowing influence the way that future biodiversities are imagined and adapted through emerging biodiversity frameworks and offshore wind policies.

The tender process not only shapes, enacts and adapts current biodiversity ambitions, but also renders future biodiversity governable. By reflecting on and adapting the institutional assumptions, priorities and ways of knowing biodiversity, tendering processes can enable alternative visions of future biodiversity – e.g. marine net gain or biodiversity enhancement – that current inscriptions do not necessarily support. These findings, as such, invite policy makers engaged in tendering processes to reflect on how assumptions and priorities of the state may shape particular ways of knowing biodiversity through tenders, which in turn perpetuate certain kinds of biodiversity over others. This reflection can be done both internally in government Ministries and departments, or in conversation with science-policy and/or public-private consultation bodies. By reflecting and seeking advice from these bodies, the black box of inscription surrounding public offshore marine environments can be made more visible while also helping to pluralise how biodiversity is inscribed and ultimately enacted through novel infrastructures such as wind energy parks.

Future research could investigate different contextual and national inscriptions. For example, it would be valuable to explore other offshore tendering processes related to infrastructures and novel technologies such as offshore wind cabling and carbon capture storage. Attention could also be given to how biodiversity is inscribed in different aspects of offshore development, such as the decommissioning of oil and gas platforms, and how they may relate to political framing surrounding these discussions (i.e. Rigs-to-reef debate, see [58]). These questions become even more important as new infrastructures and interventions are influencing current approaches to marine governance. Greater reflection on how tendering processes increasingly constitute sites of anticipatory governance can inform how we make decisions on desirable futures for offshore marine environments.

CRediT authorship contribution statement

Simon R. Bush: Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Samantha G. Kristensen:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Conceptualization. **Annet P. Pauwelussen:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2025.106977.

Data Availability

The data that has been used is confidential.

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