GINGR White Paper

Road Map for Biodiversity Net Gain in the Offshore Renewables Sector

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GINGR
Global Initiative for Nature, Grids and Renewables

THE BIODIVERSITY CONSULTANCY

An introduction to GINGR

The Global Initiative for Nature, Grids and Renewables (GINGR) aims to support a just and sustainable energy transition by providing practical assessment tools that quantify contributions to Nature- and People-Positive goals. At a time of rapid expansion of renewable energy and electricity grids, GINGR is positioning the GINGR Framework as a trusted, science-based point of reference for outcomes that benefit ecosystems and communities alongside climate targets.

At GINGR, we are developing a comprehensive Framework that enables actors across the energy system to plan, monitor and report on progress towards biodiversity gains and co-created community benefits in the deployment of wind, solar and electricity grids. The GINGR Framework will support governments, regulators, the renewable energy industry and the financial sector to translate high-level commitments into clear requirements for tenders, permitting, project design, monitoring and investment decisions.

Through several Technical Working Groups with active participation from industry, NGOs, communities, academia and finance, we are co-developing robust and legitimate guidance and tools that work across different geographies and governance systems. Recognising the significant challenges of implementation, GINGR is also preparing a technical assistance function and a growing repository of pilots, case studies and lessons learnt.

GINGR is a collaborative initiative of the International Union for Conservation of Nature (IUCN) and the Renewables Grid Initiative (RGI).

Find out more at gingr.org.

Executive Summary

The rapid expansion of offshore renewable energy is critical to achieving global decarbonisation goals. However, this growth must be aligned with efforts to halt and reverse biodiversity loss. This whitepaper presents a comprehensive roadmap for delivering **Biodiversity Net Gain (BNG)** in the offshore renewables sector, supporting the ambitions of the Kunming-Montreal Global Biodiversity Framework (KMGBF) and the Sustainable Development Goals.

We begin by clarifying key concepts—*No Net Loss*, *Net Gain*, *Nature-Positive*, and the *Mitigation Hierarchy*—and emphasizing the importance of consistent terminology to avoid misapplication and confusion. We outline the unique challenges of implementing BNG in marine environments, including limited baseline data, monitoring difficulties, restoration feasibility, and regulatory complexity. Despite these challenges, the marine realm offers significant opportunities for biodiversity enhancement, particularly in degraded ecosystems.

We propose a structured roadmap detailing the steps required to achieve BNG:

- Prioritisation of biodiversity values
- Selection of appropriate metrics and indicators
- Establishment of baselines and targets
- Monitoring and adaptive management
- Transparent reporting and disclosure

We provide practical examples of Net Gain actions—such as shellfish restoration, eco-friendly scour protection, and marine litter removal—and link these to measurable indicators. We also highlight the importance of aligning monitoring with existing regulatory requirements to ensure cost-effectiveness and consistency.

Achieving BNG will require collaboration across developers, regulators, NGOs, academia, investors, and technology providers. Ambitious yet realistic targets, supported by robust monitoring and transparent data sharing, are needed in order to build trust and avoid accusations of greenwashing.

In conclusion, while offshore renewables are not the primary driver of marine biodiversity loss, their projected expansion presents both risks and unprecedented opportunities. By adopting the principles and practices outlined in this roadmap, the sector can play a pivotal role in restoring marine ecosystems and delivering Nature-Positive outcomes.

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1 Introduction

Anthropogenic activity has had a profound impact on marine biodiversity (McCauley *et al.* 2015). In addition to existing activities, there is a growing recognition that meeting global decarbonisation targets will require a rapid and significant increase in renewable energy generation in both the terrestrial and marine environment (Spillias *et al.* 2020). Consequently, there is a desire to ensure that these efforts to mitigate the impact of climate change do not exacerbate the existing negative trends seen in marine biodiversity (O'Hara *et al.* 2021). This contributes to a focus on ensuring that offshore renewable energy projects deliver not just No Net Loss of, but a Net Gain for biodiversity (Edwards-Jones *et al.* 2024), in line with the goals of the KMGBF to ensure human-induced extinction risk is halted and that ecosystems are maintained, enhanced and restored as appropriate.

At present, in line with national permitting requirements and standard Environmental Impact Assessment (EIA) practice, much of the language and assessments in relation to offshore wind farms is framed in relation to No Net Loss, and ensuring impacts at a project and cumulative scale are not considered to be unacceptable (e.g. European Union 2012). Moving towards a framing in relation to biodiversity gain is not trivial as the two principles reflect different underlying conservation philosophies (Bull & Brownlie 2017). Furthermore, substantial uncertainties in assessed impacts make it difficult to determine where the threshold between No Net Loss and biodiversity gain lies (Cook *et al.* 2025).

Case Study: *The Netherlands' approach to offshore wind farm planning*

In the Netherlands, offshore wind farms may only be built in areas designated by the government as part of the North Sea Programme (Figure 1). Having identified these areas, the Dutch Government conducts site surveys within them with a view to providing developers the information needed to develop a preliminary plan for the offshore wind farm, including the results of an EIA. The national government initiates a permitting procedure (tender), with developers invited to submit a proposal to develop the wind farm.

Non-price criteria, for example related to the enhancement of biodiversity within a site, are a common feature of this approach. Whilst developers do not necessarily need to demonstrate No Net Loss of biodiversity, they secure points for measures taken to protect and enhance biodiversity within a site. This can encourage developers to seek innovative and effective approaches to protect and enhance nature within the site, with a view to maximising the points they secure as part of the tender assessment process. Once the tender winner has been announced, they secure permission to develop the site and must implement the measures proposed as part of their bid, including in relation to biodiversity. This approach highlights how measures to deliver Net Gain of biodiversity can be embedded in decision-making in relation to offshore wind farms through the inclusion of non-price criteria.

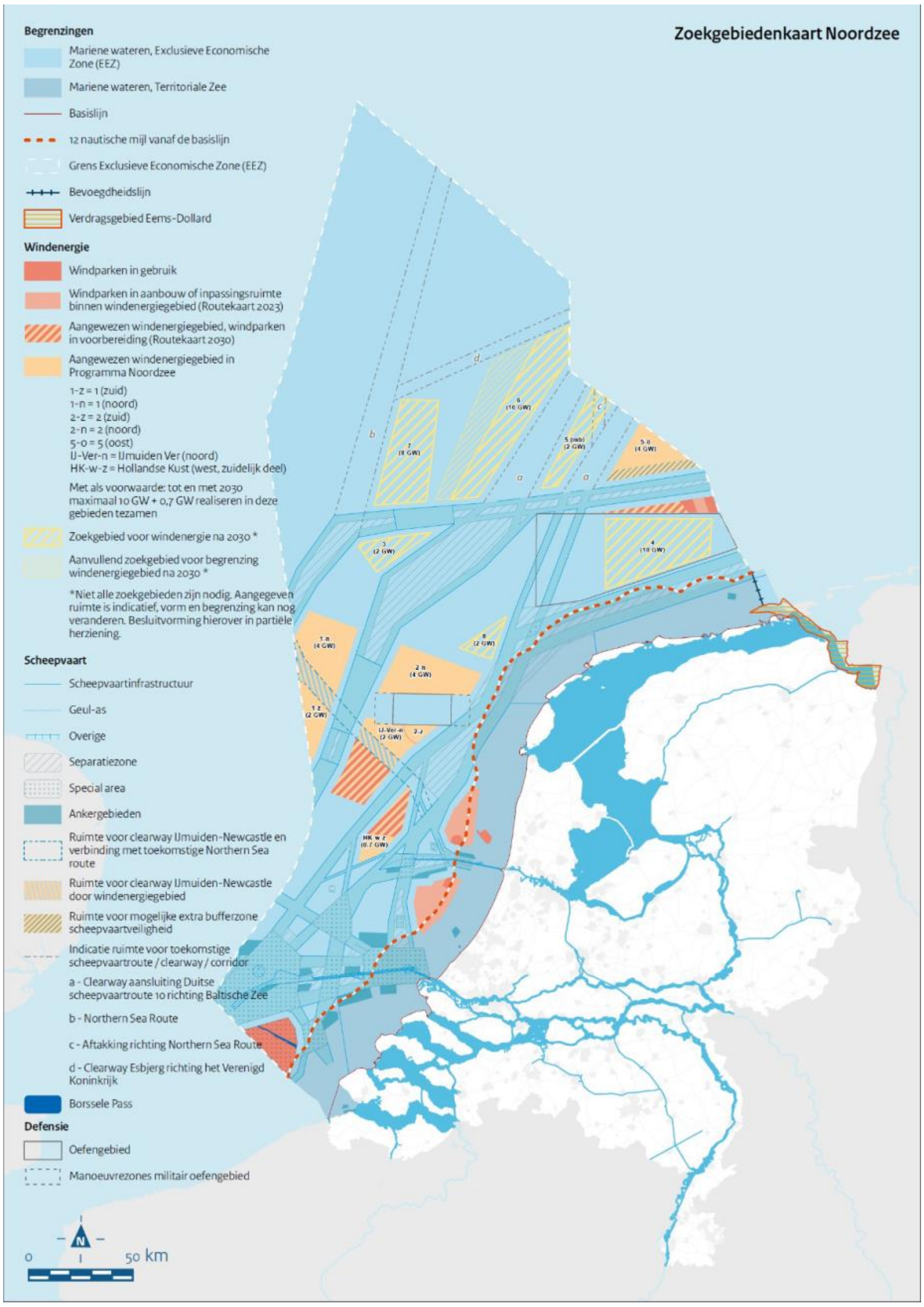

Figure 1: Offshore wind farm search zones in the Dutch North Sea (noordzeeloket.nl 2026).

Much of the focus of policies relating to biodiversity Net Gain has been in the terrestrial realm (e.g. zu Ermgassen *et al.* 2021), but as marine ecosystems tend to be highly degraded (e.g. Plumeridge & Roberts 2017), they may offer substantial opportunities for Net Gain (Weissgerber *et al.* 2019). However, the challenges of working in the marine environment mean that there are important differences between approaches to delivering Net Gain in the marine and terrestrial environments (Shumway *et al.* 2018).

The greater flow of water, organisms and other material (e.g. marine litter) in the marine environment makes predicting the outcome of restoration actions more challenging (Geist & Hawkins 2016; Shumway *et al.* 2018). This is exacerbated by the challenges of monitoring in the marine environment, which leads to a paucity of data at appropriate temporal and spatial scales (e.g. Costello *et al.* 2010), making it difficult to set a baseline and set targets for restoration. Finally, there are differences in social and governance structures, which can make it difficult to obtain, and maintain, permission to implement, monitor and continue measures aimed at achieving a biodiversity gain (Shumway *et al.* 2018). These are likely to contribute to increased costs in relation to both implementing and monitoring actions to achieve Net Gain in the marine environment. Costs may be inflated further by the scale of offshore renewable energy projects, many of which are substantially larger than onshore projects (Enevoldsen & Valentine 2016).

Despite the challenges associated with delivering Net Gain in relation to marine renewable energy, it offers a substantial opportunity. Global assessments of ocean health highlight an ecosystem under pressure, with little improvement over time (Halpern *et al.* 2015, 2017). By 2050, the marine renewable energy industry is forecast to cover a total of 200,000 km^2, offering a substantial opportunity to support marine conservation if this expansion is aligned with the Global Biodiversity Framework (GBF) and the Sustainable Development Goals (in particular SDG 14[1]).

To understand the role of Net Gain in contributing to the development of an offshore renewable energy industry that supports the goals of the GBF, we can consider a Drivers-Pressures-State-Impact-Response (DPSIR) framework (Figure 2) (Patrício *et al.* 2016a). Anthropogenic pressures in the marine environment are increasing, with few ecosystems free from impact (O'Hara *et al.* 2024). The extent of planned marine renewable energy development means that policies to achieve a Net Gain of biodiversity in relation to these projects can act as a driver to reduce these pressures, assuming that any significant residual impacts associated with these projects have been addressed first.

Addressing these pressures could lead to measurable improvements in the state of key biodiversity features. For example, reduced fisheries pressure within the wind farm and its immediate surroundings (Fitkov-Norris *et al*., 2025) may help reverse marine biodiversity loss and support marine food webs. Successfully demonstrating these impacts could help lead to increased support for further measures to restore marine biodiversity, for example through meeting the goals of the KMGBF and the SDGs.

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[1] https://sdgs.un.org/goals/goal14

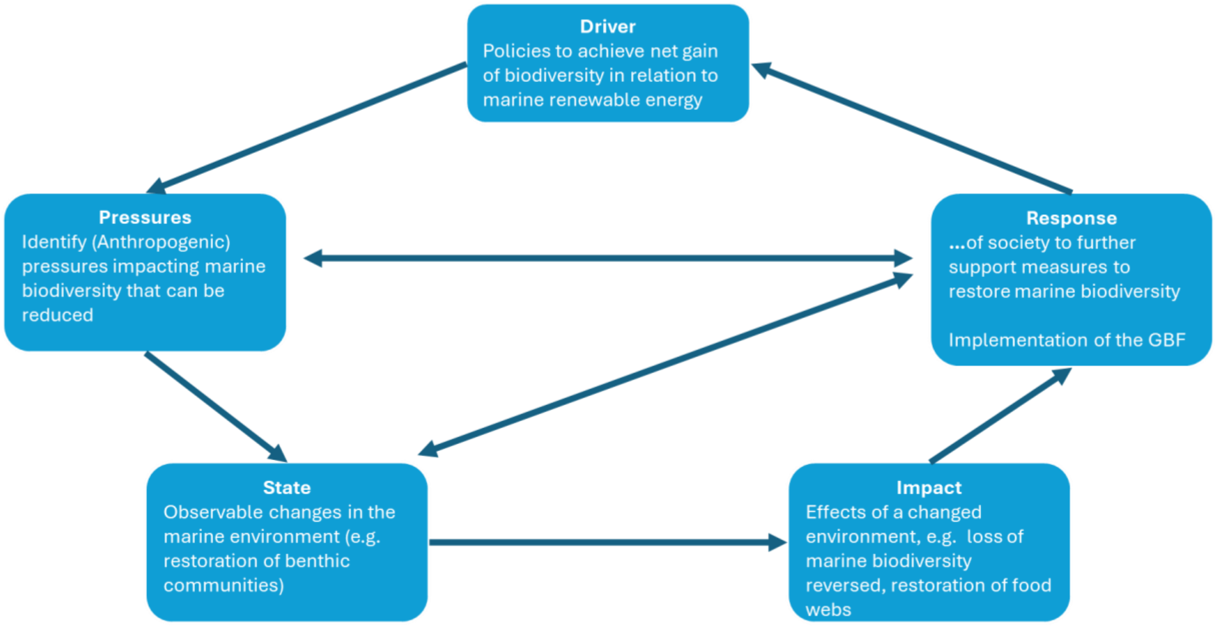

Figure 2: A DPSIR framework with Net Gain *policies considered as a driver.*

In light of the growing policy focus on delivering Net Gains in relation to the offshore wind industry, there is a strong consensus on the need for common guidelines and a framework for achieving this (Pardo *et al.* 2025a). This paper is intended as a narrative discussion about the current thinking about *Net Gain* in relation to the offshore wind industry. It will be accompanied by a framework setting out the metrics and quantitative approaches to assessing Net Gain actions. As part of this narrative, we discuss the role Net Gain targets and other conservation actions can play in supporting the contributions of the marine renewable energy to the Nature-Positive goals outlined by the KMGBF. We highlight the challenges and opportunities associated with delivering *Net Gain* in the marine environment and set out the roles that different stakeholders must play in order to overcome these challenges and deliver the potential opportunities.

2 Definitions and key concepts

Previous stakeholder engagement (Edwards-Jones *et al.* 2024) has highlighted inconsistencies in the way in which terms and concepts relating to Net Gain in the marine environment have been applied. When concepts are not clearly explained or understood, it can lead to a delay in action or selection of inappropriate management options (Masden *et al.* 2015). Consequently, it is important to ensure a common understanding of these definitions when determining whether the biodiversity management actions undertaken by a project have successfully achieved a Net Gain position.

2.1 Net Gain

As an approach to development, Net Gain, and the synonymous term "Net Positive Impact", aims to ensure that the environment is left in a better state post-development than it was prior to development (DEFRA 2018). The approach goes beyond any efforts taken in relation to the mitigation hierarchy to offset residual impacts that cannot be avoided or minimised. Consequently, Net Gain can be defined as the point at which adverse project-related impacts on biodiversity are outweighed by the measurable outcomes from actions taken in accordance with the mitigation hierarchy (see Section 2.3 and Figure 3) (Moilanen & Kotiaho 2021; Simmonds *et al.* 2022). Equivalency is a key concept in addressing residual impacts associated with a project (Maron *et al.* 2025), meaning that measures must be targeted at the species, ecosystem or other biodiversity component impacted by a project. Given that this negates the possibility of trading impacts between different biodiversity components, logically, an overall Net Gain for a project cannot be achieved unless, and until, a project has addressed their significant residual impacts and achieved No Net Loss of biodiversity (see Section 2.4; Moilanen & Kotiaho 2021; Simmonds *et al.* 2022). Equivalency is a key concept in addressing residual impacts associated with a project (Maron *et al.* 2025), meaning that measures must be targeted at the species, ecosystem or other biodiversity component impacted by a project. Given that this negates the possibility of trading impacts between different biodiversity components, logically, an overall Net Gain for a project cannot be achieved unless, and until, a project has addressed their significant residual impacts and achieved No Net Loss of biodiversity (see section 2.4).

Net Gain can be considered in relation to biodiversity in general (Biodiversity Net Gain), the marine environment (Marine Net Gain), or the environment in general (Environmental Net Gain) (DEFRA 2018, 2022).

2.1.1 Biodiversity Net Gain

Biodiversity Net Gain aims to halt biodiversity loss through development and restore habitat and biodiversity features such that they are in a better state than prior to development (DEFRA 2018). Biodiversity Net Gain is relevant in both the marine and terrestrial environments.

2.1.2 Environmental Net Gain

Environmental Net Gain goes beyond the concept of Biodiversity Net Gain and aims to deliver an improvement to all aspects of environmental quality. This includes improving the ability of impacted biodiversity to deliver ecosystem services (DEFRA 2018), and cannot be achieved unless, and until, requirements relating to Biodiversity Net Gain have been achieved.

2.1.3 Marine Net Gain

Marine Net Gain relates to the application of the Net Gain principle to the marine environment. As with Environmental Net Gain, it should extend the concept of Biodiversity Net Gain to cover the social, environmental and economic values of marine natural assets that are underpinned by biodiversity (DEFRA 2022). For the purposes of this whitepaper, we will focus on Biodiversity Net Gain in the marine environment and not extend this to cover the broader concept of Marine Net Gain.

2.2 Nature-Positive

The Nature-Positive concept has emerged in recent years as an inclusive and ambitious ‘rallying call’ that aligns with the GBF (Booth *et al.* 2024). 'Nature’ is often used as shorthand for biodiversity, but it is a broader concept that also encompasses non-living components, such as climate, air, soil and water. Conservation and business forums are increasingly converging on the Nature-Positive concept (zu Ermgassen *et al.* 2022) to achieve the 2030 and 2050 goals of the GBF and to drive transformative change in the relationship between business and nature. There is no single agreed definition for the term, and several are in use. In line with the GBF, the Nature Positive Initiative[2] defines it as ‘halt and reverse nature loss by 2030 on a 2020 baseline and achieve full recovery by 2050.’ The UK Council for Sustainable Business says “a Nature-Positive approach puts nature and biodiversity gain at the heart of decision-making and design. It goes beyond reducing and mitigating negative impacts on nature as it is a proactive and restorative approach focused on conservation, regeneration, and growth” (zu Ermgassen *et al.* 2022, p3).

Debate continues on what Nature-Positive means for business (Milner-Gulland 2022; zu Ermgassen *et al.* 2022), but it is generally viewed as a broad societal goal to which businesses and civil society can contribute, rather than a specific project or organisational-level objective (Booth *et al.* 2024). As a broad, societal objective, Nature-Positive applies to an organisation’s full value chain and interactions with broader stakeholders and actors, whilst Net Gain typically only applies to the level of the project and its direct operations. For these reasons, it is important that Nature-Positive is seen as being distinct from terms such as Net Gain Net Positive Impacts.

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[2] https://www.naturepositive.org/

2.3 The Mitigation Hierarchy

Application of the mitigation hierarchy (Figure 3) is central to a Nature-Positive approach (Maron *et al.* 2023; White *et al.* 2024). This means strongly prioritising impact avoidance and minimisation, whether at project, seascape or systems levels. The mitigation hierarchy sets out the sequence of actions to anticipate and avoid impacts on biodiversity and ecosystem services. It follows an iterative process of feedback and adaptive management across four steps: 1) avoidance and 2) minimisation measures to prevent or reduce impacts, 3) restoration, and 4) offsetting measures to remediate residual impacts and impacts that have already happened. The remediative step of offsetting is often referred to as compensation or compensatory mitigation (Allison *et al.* 2017; Croll *et al.* 2022). However, uncertainty associated with the efficacy of potential offsetting actions, these must be designed to over-deliver relative to the residual impacts (Moilanen *et al.* 2009). Delivery of Net Gain in relation to offshore wind farms is predicated on the assumption that the mitigation hierarchy has been followed, and that residual impacts have been addressed.

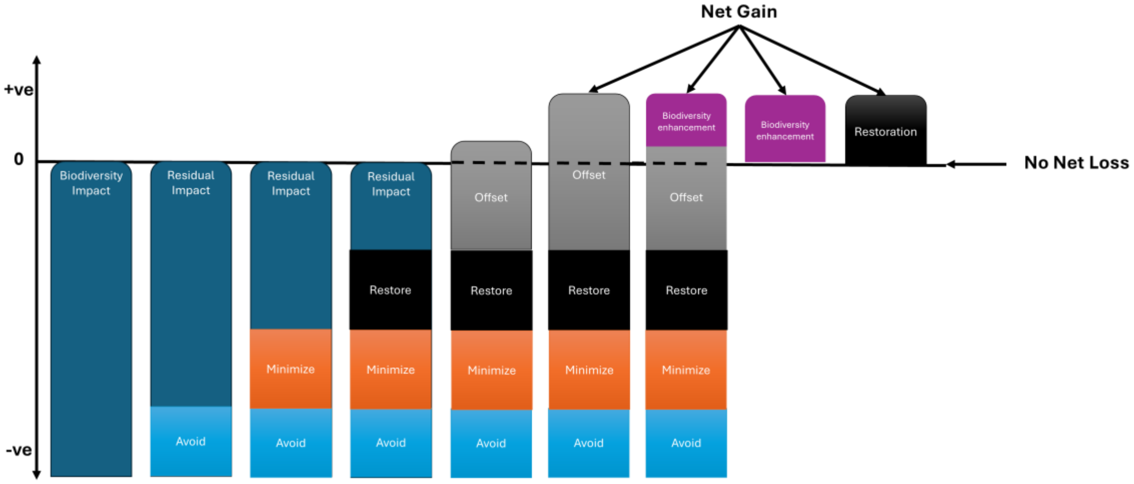

Figure 3: The Mitigation hierarchy, No Net Loss, and Net Gain.

Case Study: *The Mitigation Hierarchy and Net Gain*

Aligning with the GBF and Nature-Positive goals to achieve an overall Net Gain of biodiversity requires going beyond the requirements of the mitigation hierarchy. There are several potential mechanisms for this. Firstly, the level of offsetting delivered could be designed to exceed that required to achieve No Net Loss (IPIECA 2025), noting existing requirements to over-deliver relative to residual impacts. Secondly, actions can be taken to enhance or restore biodiversity linked to the project. This could include measures such as the use of eco-friendly scour protection (Lengkeek et al. 2017) or the restoration of native shellfish populations (Rendle et al. 2023). Whilst these measures can target components of biodiversity negatively impacted by the project, assuming residual impacts relating to these components have been addressed, they do not necessarily have to do so. However, they must be targeted at the project site and/or linked to the species interacting with the project. They must also be delivered in addition to the mitigation hierarchy (Maron et al. 2023; Jobson et al. 2024; White et al. 2024; Pardo et al. 2025b).

2.4 No Net Loss

No Net Loss can be defined as the point at which adverse project-related impacts on biodiversity are balanced by measures taken through the application of the mitigation hierarchy (see Section 2.3). Achieving No Net Loss necessitates that any losses associated with a project have been quantified, and that any negative impacts have been fully compensated for by commensurate gains (Bull *et al.* 2016). Consequently, where projects have delivered No Net Loss, biodiversity will be no worse – but also no better – after project mitigation actions are taken into account, noting the potential for temporal lags between actions associated with a project and their observed impacts on biodiversity (Gonzalez *et al.* 2016), and the uncertainty associated with predictions of project and cumulative level impact (Masden *et al.* 2015). No Net Loss can be defined as the point at which adverse project-related impacts on biodiversity are balanced by measures taken through the application of the mitigation hierarchy (See Section 2.3). Achieving No Net Loss necessitates that any losses associated with a project have been quantified, and that any negative impacts have been fully compensated for by commensurate gains (Bull *et al.* 2016). Consequently, where projects have delivered No Net Loss, biodiversity will be no worse – but also no better – after project mitigation actions are taken into account, noting the potential for temporal lags between actions associated with a project and their observed impacts on biodiversity (Gonzalez *et al.* 2016), and the uncertainty associated with predictions of project and cumulative level impact (Masden *et al.* 2015).

2.5 Metrics and indicators

Whilst the terms indicator and metric are used frequently within the science-policy interface, these are often poorly defined (Heink & Kowarik 2010a). We consider that indicators provide insights or meaning to metrics. For example, species' Red List categories are a measure (metric) of the risk of species extinction; however, the Red List Index[3] is an indicator demonstrating the trend in species extinction risk over time. In the context of the offshore renewables industry, metrics such as the density of birds within a proposed offshore wind farm (Johnston *et al.* 2015) may be used to define the baseline condition of the marine ecosystem. The change in density of birds through time could then be used as an indicator (Mercker *et al.* 2021) to track the impact of the project over time. In relation to Net Gain, indicators are required which can be used to quantify changes in the environment throughout the project lifecycle, ideally using a consistent methodology during baseline, construction, operation and decommissioning phases.

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[3] https://www.iucnredlist.org/assessment/red-list-index

3 Aligning offshore renewable energy with global biodiversity goals

Efforts to align offshore renewable energy with global biodiversity goals do not exist in a policy vacuum. Alongside legislation and policies at a national level, many companies have introduced commitments to biodiversity at a corporate level. Examples of these policies and commitments include:

- The EIA Directive of the European Union (European Union 2012), which legislates for requirements to apply the mitigation hierarchy by setting out requirements for projects to set out details or measures taken to avoid, minimise and, where possible, offset adverse environmental effects;
- The International Finance Corporation Performance Standard 6 (IFC 2019), which introduces requirements for projects receiving development finance to achieve *No Net Loss*, and to deliver a Net Gain where they overlap with *Critical Habitat*;
- The inclusion of non-price criteria in offshore wind leasing and auction rounds, for example, the recent Offshore Wind Leasing Round 5 in the UK, which introduces requirements for bidders to demonstrate the environmental value of their projects (The Crown Estate 2023), and the Nederwiek 1-A tender in the Netherlands, which includes criteria relating to increasing the area of habitat suitable for species native to the North Sea (Netherlands Enterprise Agency 2025); and
- Public commitments by companies such as Ørsted[4], SSE[5] and RWE[6] to deliver biodiversity gains in relation to their projects.

Efforts to track progress towards these goals has led to developers exploring the application of standardised approaches for tracking progress towards their targets, such as Ørsted's Biodiversity Measurement Framework[7].

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[4] https://orsted.com/en/who-we-are/sustainability/nature/net-positive-biodiversity-impact

[5] https://www.sserenewables.com/media/vgsdoav3/sser-biodiversity-net-gain-report-nov-2022-final.pdf

[6] https://www.rwe.com/-/media/RWE/documents/09-verantwortung-nachhaltigkeit/rwe-biodiversity-policy.pdf

[7] https://orsted.com/en/who-we-are/sustainability/nature/net-positive-biodiversity-impact/biodiversity-measurement-framework

4 A roadmap for Net Gain in relation to offshore renewable energy projects

The lack of consistently agreed-upon metrics, frameworks, or regulatory schemes presents a fundamental challenge for integrating biodiversity goals, such as Net Gain, into new offshore wind projects (Jedele *et al.* 2023). Whilst international standards, such as IFC performance Standard 6, bring in requirements for Net Gain to involve "*measurable, additional conservation actions*" (IFC 2019), there is less guidance on how this should be implemented, particularly within the marine environment. At a corporate level, commitments to Net Gain are often viewed with scepticism by stakeholders (Bull & Brownlie 2017), which may be exacerbated if claimed gains cannot be quantified and assessed in relation to baseline conditions. In such situations, these actions may be viewed as symbolic rather than substantive, leading to accusations of "green-washing" (Walker & Wan 2012). Consequently, commitments to achieving Net Gain must be accompanied by a process to measure progress towards this target. With this in mind, and building on Maron *et al.* (2023), efforts to deliver Net Gain in relation to the marine renewable energy projects should adhere to the following principles:

- **Net outcomes are necessary:** In determining a biodiversity gain, it is necessary to consider the net outcome of a project, combining both gains and losses due to projected impacts. This means that the mitigation hierarchy must have been correctly applied, and that, logically, a biodiversity gain cannot be achieved unless, or until, all significant residual impacts have been accounted for.
- **Recognise limits:** In the context of biodiversity gain, it is necessary to distinguish between the concepts of no loss and *No Net Loss*. In some cases, the biodiversity values associated with a site may be irreplaceable, for example, where sites qualify as *Key Biodiversity Areas*[8]. In such circumstances, any loss of biodiversity values would be unacceptable, even if biodiversity gains were achieved elsewhere. In other contexts, however, a *No Net Loss* approach—whereby biodiversity losses in one location are offset by equivalent gains elsewhere—may be considered acceptable. This distinction is necessary, as it will determine whether a biodiversity gain is possible in relation to an impacted biodiversity value.
- **Set a goal state for Net Gain:** As noted by Bull & Brownlie (2017), without further clarification, the concept of biodiversity gain is open to many interpretations, including a negligible improvement in baseline conditions. Consequently, at a site or project level, as part of a robust framework, it will be necessary to set a goal in relation to biodiversity gain. This could be linked to the recovery of biodiversity values relative to baseline conditions or the probability of species persistence.
- **Clarify timeline:** Linked to the above, it will be necessary to set a timeline over which biodiversity gains will be assessed. Given the prevalence of shifting

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[8] https://www.keybiodiversityareas.org/

baseline syndrome (Soga & Gaston 2018), this will include clearly defining the baseline conditions against which gains will be assessed, and identifying appropriate temporal scales over which to consider changes, noting the potential for lagged responses (Cook *et al.* 2014; Bull & Brownlie 2017).

- **Capture key biodiversity:** It is important to clearly define the values for which biodiversity gains will be sought (see prioritisation of biodiversity values below). This should relate to the ecological value of a site, rather than the economic benefits it provides humans (Cuckston 2019). As noted in (Jobson *et al.* 2024), where there is the opportunity for biodiversity enhancement, measures do not necessarily have to target values that are impacted by a development, but should target biodiversity values present.
- **Ambitious, not merely adequate:** Projected cumulative impacts from renewable energy projects are approaching levels whereby action to mitigate climate change is challenging efforts to reverse biodiversity loss (Cook *et al.* 2025). Whilst the renewable energy industry is not a primary driver of biodiversity loss, the scale of planned development, particularly in the marine environment, offers substantial opportunities for biodiversity gain at both the project and portfolio level (Jobson *et al.* 2024), where ambitious but achievable goals are set.

Implicit in these principles is the requirement for data with which to establish a baseline and derive metrics with which to assess progress from this baseline towards Net Gain targets. However, although the situation is improving, in comparison to terrestrial biomes, the availability of these data are still much more limited in marine biomes (Gagné *et al.* 2020), often with a pronounced bias towards charismatic species (Canonico *et al.* 2019) and lacking in key attributes, such as locational accuracy (Moudrý & Devillers 2020). This largely reflects the economic and logistical challenges of working in the marine environment, and means that where data are collected, a lack of standardisation makes drawing robust conclusions difficult (Eger *et al.* 2022).

A key exception to this is the data collected as part of EIAs for offshore wind farms, which are often subject to prescriptive requirements set out by regulators (e.g. Bundesamt für Seeschifffahrt und Hydrographie (BSH) 2013). As a consequence, a number of approaches are routinely used for data collection in the marine environment (e.g. Table 1), facilitating this standardisation and enabling more straightforward assessment and comparison of approaches to deliver Net Gain in relation to offshore wind farms.

Table 1: Monitoring approaches used in pre- and post-construction monitoring adapted from (Watson et al. *2025).*

Method	**Description**	**Taxa**	**Project Phase**
Vessel-based surveys	Transect-based counts	Birds, marine mammals, turtles	All
(Digital) Aerial surveys	Transect-based counts	Birds, marine mammals, turtles	All
SCUBA Diver Surveys	Visual inspection of turbine foundations and surrounding area	Benthic habitats	Operation
Underwater video	Either following a defined route mounted on remotely operated vehicles, or fixed at stations either baited, or unbaited	Benthic fauna and habitats	All
Passive acoustic monitoring	Hydrophones to record underwater soundscapes	Cetaceans, fish, underwater noise	All
Echosounders	Sonar pulses from single or multibeam echosounders	Seabird habitats, fish aggregations	All
Grab samples	Sampling of the sediment within the project area using box corers with a view to identifying the benthic species present	Benthic species	All
Trawl surveys	Trawls to collect species for identification, often paired with echosounders	Fish	All
Satellite remote sensing	High resolution imagery from satellites	Large fauna (e.g., cetaceans, seals), environmental proxies (e.g., chlorophyll)	All

Method	Description	Taxa	Project Phase
Telemetry	Radio, satellite, or GPS transmitters attached to species to track movements	Birds, bats, marine mammals, fish	Operation
Radar	Deployed on turbine transition pieces and used to assess the horizontal, vertical, or three-dimensional location of birds.	Birds	Operation
Cameras/impact sensors	Mounted on turbines to detect collisions	Birds, bats	Operation
Autonomous/Uncrewed vehicles – underwater, surface or aerial	Equipped with sensors to collect environmental and ecological data – e.g., cameras, sonar, infrared imagery, hydrophones	All	All

As efforts to deliver Net Gain in the marine environment gather pace, we set out a roadmap for measuring progress towards Net Gain (Figure 4). We discuss each step below and then highlight some of the key challenges associated with delivering Net Gain in relation to marine renewable energy.

Figure 4: A roadmap for developing and executing biodiversity Net Gain for offshore renewables projects.

4.1 Prioritisation of biodiversity values

The number of species potentially interacting with offshore renewable energy projects is substantial. For example, Causon *et al.* (2022) recorded at least 62 species of marine invertebrate during pre-construction grab surveys at Greater

Gabbard Offshore Wind Farm. In addition to these, many other taxonomic groups are likely to be present at the site, including fishes, marine mammals and seabirds. Consequently, screening to identify those Priority Biodiversity Values (PBVs) most likely to be negatively impacted by offshore wind farms is a key step of the assessment process (Fox *et al.* 2006).

However, a wider range of PBVs can and should be considered when identifying options for delivering Net Gain. For example, the restoration of species such as the European flat oyster *Ostrea edulis* is a widely promoted measure for enhancing biodiversity within offshore wind farms (Jobson *et al.* 2024). The degraded nature of the habitat within some planned offshore wind farms means that the species may not be present prior to construction (e.g. Rendle *et al.* 2023) and would therefore not be considered as part of assessments. Processes for identifying PBVs with which to target measures to deliver Net Gain within offshore wind farms need to be able to account for opportunities such as this. Criteria for identifying measures with which to deliver Net Gain may include:

- Biodiversity values most likely to be sensitive and susceptible[9] to impacts of renewable energy;
- Globally, regionally, or nationally threatened species;
- Legally Protected Areas and other areas of biodiversity importance;
- Natural/semi-natural habitats (most marine areas);
- Species or habitats that play a key role in the structure and functioning of the ecosystem;
- Biodiversity values of concern to stakeholders;
- Biodiversity values required to be considered under relevant regulatory requirements; and
- Biodiversity values identified under other criteria e.g., Critical Habitat qualifying species based on IFC PS6.

4.2 Confirm Net Gain actions

Having identified the PBVs for which actions to deliver Net Gain will be targeted, the next step is to confirm the actions that will be used. IFC Performance Standard 6 suggests that measures to achieve Net Gain "*must involve measurable, additional conservation outcomes. Such gains must be demonstrated on an appropriate geographic scale (e.g., local, landscape-level, national, regional) as determined by external experts. In instances where a biodiversity offset is not part of the client's mitigation strategy (i.e., there are no significant residual impacts), Net Gains may be obtained by supporting additional opportunities to conserve the critical habitat values in question.*" (IFC 2019).

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[9] Note that sensitivity (e.g., conservation threat status) is not necessarily the same as susceptibility to impact (e.g., behaviour, life history, activity or morphology that predisposes a species to renewable energy-related risks).

There are a range of well-established measures that can be implemented to deliver Net Gain for the priority biodiversity values associated with marine renewable energy (Croxall et al. 2012; Nelms et al. 2021; Danovaro et al. 2025; see Table 2 for examples). As the projected scale of cumulative impacts associated with offshore wind farm projects reaches levels where there is a regulatory requirement to provide compensation in order to offset these impacts (Brabant et al. 2015; Busch & Garthe 2018; Cook et al. 2025), there has been a focus on measures to deliver this (e.g. McGregor *et al.* 2022; NIRAS 2024, 2025; Tapia-Harris & Evans 2024). Whilst it is important to re-iterate that compensation should not be seen as equivalent to delivery of a Net Gain (see Section 2.3), in situations where residual impacts have been addressed, measures proposed in relation to compensation may also contribute to the delivery of Net Gain. Typically, compensatory measures for offshore wind farms are arrived at following extensive stakeholder consultation, often involving governmental advisers and regulators and environmental NGOs.

Consequently, precedent may mean that these measures benefit from existing support by regulators and other key stakeholders. There are a range of well-established measures that can be implemented to deliver Net Gain for the priority biodiversity values associated with marine renewable energy (Croxall et al. 2012; Nelms et al. 2021; Danovaro et al. 2025; see Table 2 for examples). As the projected scale of cumulative impacts associated with offshore wind farm projects reaches levels where there is a regulatory requirement to provide compensation in order to offset these impacts (Brabant et al. 2015; Busch & Garthe 2018; Cook et al. 2025), there has been a focus on measures to deliver this (e.g. McGregor *et al.* 2022; NIRAS 2024, 2025; Tapia-Harris & Evans 2024).

Whilst it is important to re-iterate that compensation should not be seen as equivalent to delivery of a Net Gain (see section 2.3), in situations where residual impacts have been addressed, measures proposed in relation to compensation may also contribute to the delivery of Net Gain. Typically, compensatory measures for offshore wind farms are arrived at following extensive stakeholder consultation, often involving governmental advisers and regulators and environmental NGOs. Consequently, precedent may mean that these measures benefit from existing support by regulators and other key stakeholders.

Many potential measures are focused on restoration or enhancement within the wind farm footprint (Table 2), and there is widespread support for incentivizing these measures (Edwards-Jones *et al.* 2024). However, it is essential to consider the ecology of the priority biodiversity values concerned. Whilst some may be highly restricted in range and/or movements, much broader spatial scales may be relevant for others (O'Hanlon *et al.* 2023). When targeting values for which broader spatial scales are relevant, more strategic approaches, often decoupled from the project footprint may be appropriate (Table 2), and there is broad stakeholder support for this (Edwards-Jones *et al.* 2024; Secor *et al.* 2024).

Case Study: *UK Marine Recovery Fund*

A marine recovery fund is being established in the UK with a view to providing industry-funded, strategic measures to compensate for the adverse effects of offshore wind farms. Figure 5 illustrates the process for purchasing compensation from the Marine Recovery Fund.

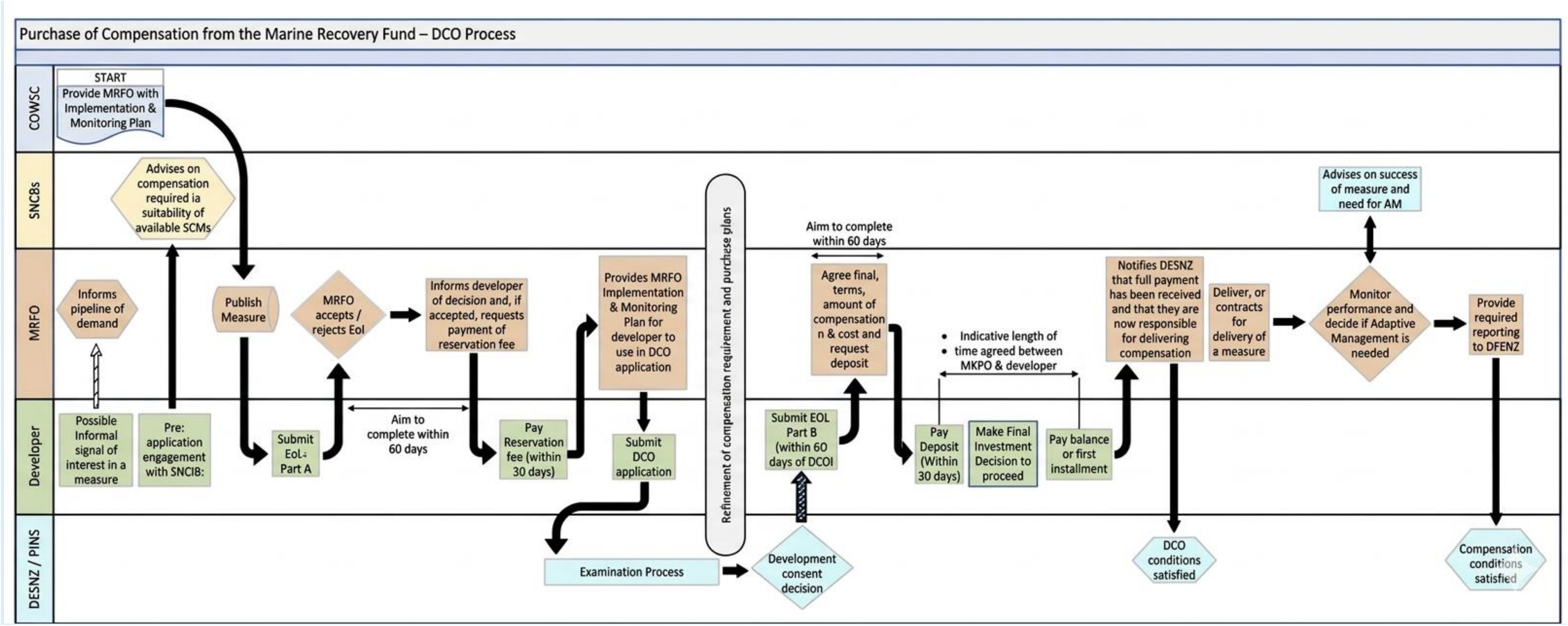

Figure 5: Process for purchasing compensation (Marine Recovery Fund 2026).

The marine recovery fund was established in order to speed up decision-making within the planning and consenting process for offshore wind, and to deliver more effective and strategic measures to compensate for the adverse environmental impacts of offshore wind farms on protected sites.

The fund develops a Library of Strategic Compensation Measures (LoSCM), which currently contains three measures:

1. MPA designation and/or extension for adverse effects on the seabed (benthic habitats)
2. offshore artificial nesting structures for adverse effects on kittiwakes
3. predator reduction for adverse effects on seabirds

Where adverse environmental effects are expected, developers are encouraged to engage with the Statutory Nature Conservation Bodies in order to determine whether one of the approaches identified in the LoSCM can be used to compensate for the impacts associated with the project. Where this is the case, the developer will make a contribution to the fund proportionate to the magnitude of the projected impact. Where it is not the case, the developer cannot use the fund until a suitable measure is added to the LoCSM. In these instances, the developer would be required to identify alternative sources of compensation, though they may retain the right to make use of the fund if a suitable measure is added.

Whilst developed with compensation in mind, the Marine Recovery Fund offers an example of a more strategic approach that could be applied to the delivery of positive contributions to biodiversity, drawing from a list of agreed measures, with standardised costs. Such an approach would provide greater certainty to developers in relation to the approaches used to deliver a positive contribution to biodiversity.

Table 2: Example of measures that could be applied to contribute to Net Gain in relation to offshore renewable energy projects, and the indicators that could be used to assess progress towards targets.

Net gain action	Justification and examples	Priority Biodiversity Value (PBV)	Potential Indicator(s)	Data requirements
Designation or extension of Marine Protected Areas (MPAs)	The potential to establish new or extend existing MPAs has been acknowledged as a potential compensation option in the UK as part of the Marine Recovery Fund (DEFRA 2025). As part of compensation for impacts to benthic habitats in relation to Norfolk Vanguard and Boreas Offshore Wind Farms, Vattenfall proposed to extend the boundaries of the Haisborough, Hammond and Winterton SAC to provide additional protection to two Annex 1 habitats – *Sabellaria spinulosa* reefs, and sandbanks. Where sensitive species and/or habitats associated with an offshore wind farm project are noted on the edge of protected areas, a similar approach could be applied to contribute to a biodiversity Net Gain in relation to that project. This could be extended further through the development and implementation of management plans for those protected areas.	Primarily benthic habitats, communities and species, though may confer benefits to species in higher trophic levels.	Total area covered by protected areas; number of PBVs covered by Protected Areas; proportion of Protected Areas subject to management plans[10]; Margalef Diversity Index (van Loon *et al.* 2018).	Area covered by protected areas; number of protected areas subject to management plans; species richness; total abundance of marine organisms.

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[10] https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/marine-protected-areas/

Net gain action	**Justification and examples**	**Priority Biodiversity Value (PBV)**	**Potential Indicator(s)**	**Data requirements**
Restoration of native shellfish within offshore wind farms	The introduction of hard structures into the marine environment offers potential habitat on which the larvae of shellfish, such as the European flat oyster *Ostrea edulis* and blue mussels *Mytilus edulis*, may settle (Bridger *et al.* 2022; Hofstede *et al.* 2023). The potential of this as a restoration measure, that may contribute to a Net Gain of biodiversity in relation to offshore wind farms, is being actively explored, for example with the reintroduction of the European flat oyster to the area covered by the Hollandse Kust West offshore wind farm[11]. The potential for shellfish reintroduction to provide benefits for other species, such as the sea ducks which feed on them, is also being considered (NIRAS 2024).	Shellfish though may confer benefits to higher trophic levels, such as seals (Russell *et al.* 2014) and sea ducks (NIRAS 2024).	Size of shellfish patches (Christianen *et al.* 2017); % shellfish coverage of patches (Bridger *et al.* 2022); Spat settlement rates (ter Hofstede *et al.* 2024).	Species abundance estimated either using visual inspection by divers/ remotely operated vehicles (ROVs), or by removing material (e.g., ropes/rocks) shellfish settle on for closer inspection.
The use of eco-friendly scour protection	As a relatively low-cost, “no-regret” action, eco-friendly scour protection has been widely promoted as a means to enhance biodiversity within offshore wind farms (Jobson *et al.* 2024). Conventional scour protection is formed from a bottom, filter layer of coarse gravel, topped with an armour layer or larger rocks. Using a wider variety of material, in terms of size, shape and	Benthic communities.	Species richness; abundance; functional diversity (Kingma *et al.* 2024).	Species identification through ROVs and removal of samples of scour protection.

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[11] https://ecowende.nl/en/our-innovations/fish-and-benthic-habitats/offshore-oyster-network-stimulation/

Net gain action	Justification and examples	Priority Biodiversity Value (PBV)	Potential Indicator(s)	Data requirements
	substrate, in scour protection, it is possible to more closely mimic natural habitats, introducing more nooks and crannies which act as protection and settlement points for a variety of species (Kingma *et al.* 2024).			
Restoration of seagrass meadows	Seagrass meadows support a number of ecosystem services including fisheries, carbon sequestration, and coastal protection. However, the extent of these ecosystems has declined dramatically in response to pressures including disease, coastal development and deteriorated water quality (de los Santos *et al.* 2019). Given the range of species supported by seagrass meadows, they make a strong candidate for restoration as a measure to provide compensation and/or Net Gain in relation to offshore wind farms (Tapia-Harris & Evans 2024). Reflecting the importance of this ecosystem, Ørsted have committed to restoring an area of seagrass within the Humber Estuary in the UK as part of their commitment for renewable energy assets to have a net positive impact on biodiversity[12].	Habitat, likely to confer benefits for higher trophic levels.	Shoot density; leaf surface per shoot; leaf area index (Soissons *et al.* 2014); Area; depth limit; production; shoot mortality (Marbà *et al.* 2013).	Samples of seagrass collected using cores and/or mowing.

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[12] https://orsted.co.uk/media/newsroom/news/2023/04/wilder-humber-launch

Net gain action	**Justification and examples**	**Priority Biodiversity Value (PBV)**	**Potential Indicator(s)**	**Data requirements**
Removal of marine litter, debris and disused infrastructure	Marine litter and debris has the potential to negatively impact all PBVs, with effects ranging from entanglement to ingestion by marine organisms with potentially lethal and sub-lethal consequences (Galgani *et al.* 2019). As a consequence, there is a growing interest in both reducing the quantity of litter in the marine environment and preventing it from entering the environment in the first place. Reflecting this interest, the removal of marine litter is one of the measures that has been agreed upon in relation to compensation for offshore wind farms[13].	All PBVs.	Macro-plastic on sea-surface; macro-plastic on seafloor; micro-plastic at sea surface; micro-plastic on shorelines; ingestion of plastic by marine species; entanglement rates of marine species (Galgani *et al.* 2013).	Visual surveys using ships, aircraft, ROVs or divers, trawling and water filtration, necropsy and observations of mortality of key species.
Reduction of predation pressure at seabird colonies	The potential for impacts of offshore wind farms on seabird populations has received considerable attention (e.g. Garthe & Hüppop 2004; Furness *et al.* 2013; Kelsey *et al.* 2018; Croll *et al.* 2022), and as a group undergoing extensive declines (Paleczny *et al.* 2015), they would be a key candidate for measures to deliver Net Gain. However, their highly mobile nature makes identifying actions that may deliver a direct benefit within the footprint of an offshore wind farm challenging. Instead, many of the actions proposed are	Seabirds.	Seabird abundance at breeding colonies; seabird breeding success (Cook *et al.* 2014).	Counts of seabirds at their breeding colonies, targeted monitoring of seabird breeding success.

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[13] https://www.legislation.gov.uk/uksi/2022/138/schedule/17/paragraph/29/made?view=plain

Net gain action	**Justification and examples**	**Priority Biodiversity Value (PBV)**	**Potential Indicator(s)**	**Data requirements**
	focused on the breeding colonies of species and populations that are likely to interact with projects (McGregor *et al.* 2022; Tapia-Harris & Evans 2024). These include measures to reduce predation pressure at colonies, either through the use of anti-predator fencing, or the eradication of rats, mice, and other mammalian predators from key breeding islands.			
Bycatch reduction	Bycatch reflects a substantial threat to many of the highly mobile species that may interact with offshore wind farms (Reeves *et al.* 2013; Lewison *et al.* 2014; Ramírez *et al.* 2024). A number of effective measures to reduce bycatch risk are available, and these have been proposed as a measure to compensate for impacts of offshore wind farms[14] [15]. A similar approach could be applied in relation to Net Gain.	Seabirds, marine mammals, marine turtles.	Bycatch rates[14] [16].	Derived from onboard observers, camera recording, self-reporting and/or interviews with fishers.

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[14] https://nsip-documents.planninginspectorate.gov.uk/published-documents/EN010098-001693-Hornsea%20Project%20Four%20-%20Other-%20G5.13%20Bycatch%20Reduction%20Technology%20Selection%20Phase%20Summary.pdf

[15] https://marine.gov.scot/sites/default/files/derogation_case_-_appendix_2_-_compensation_plan_0.pdf

[16] https://oap.ospar.org/en/ospar-monitoring-programmes/cemp/cemp-appendices/theme-b-biodiversity-and-ecosystems/theme-b-bdc/bb28/

4.3 Review appropriate metrics for offshore

In the absence of a quantifiable target, the concept of Net Gain has many possible interpretations, including a negligible improvement on "No Net Loss" (Bull & Brownlie 2017). Consequently, a target and measures to assess progress towards that target are essential (Maron *et al.* 2021). At present, there are over 600 indicators and metrics with which to assess the status of the marine environment (Teixeira *et al.* 2016), often developed for policy objectives, for example to monitor progress towards achieving "Good Environmental Status" in relation to the EU Marine Strategy Framework Directive (e.g. Cook *et al.* 2014; McQuatters-Gollop *et al.* 2022). However, a lack of coherence in how these indicators have been applied may limit their applicability across the region (Hummel *et al.* 2015; Uusitalo *et al.* 2016).

Indicators may be, more or less, complex (Buckland *et al.* 2005), and the level of complexity associated with any indicator can bring challenges when interpreting values and trends. For example, species interactions are often complex, and the data collected using standard monitoring approaches may be insufficient to adequately describe them, meaning that indicators based on ecosystem models may be uninformative in relation to describing changes in state. In contrast, more simplistic approaches, based on metrics, such as species richness or diversity, can be misleading. For example, if loss of habitat leads to an influx of generalist species, this can lead to an increase in estimates of species richness or diversity (Buckland *et al.* 2005). Reflecting these challenges, Heink & Kowarik (2010b) set out nine criteria against which indicators should be assessed:

- **Knowledge:** It is important that we have a good understanding of the taxa underpinning biodiversity indicators in order to derive informed hypotheses, for example the sensitivity and likely response to offshore wind farm development.
- **Portability:** The indicators should be repeatable and reproducible; this is particularly important if they are to be applied across multiple sites and noting that not all indicators will be suitable for all sites.
- **Suitability for statistical analysis:** Typically, indicators should be based on large samples, or the taxa underpinning them should be subject to low levels of random variation, to be able to detect changes in state with confidence.
- **Reference values:** There should be a robust baseline against which changes in state can be assessed, for example, as defined using pre-construction baseline characterisation surveys within and potentially beyond the project.
- **Feasibility of data collection:** For ease of monitoring, the data required to update indicator values should be straightforward to collect.
- **Universality:** To facilitate comparisons at a broader spatial scale (e.g., at an industry or company portfolio level), ideally indicators should be based on a

taxonomically diverse range of species with a broad geographic range, representing multiple habitats.

- **Parsimony:** To minimise effort in data collection and analysis, the number of indicators and/or taxa covered should be consolidated where appropriate (considering universality) whilst ensuring minimal loss of information.
- **Precision of correlation:** There should be a clear correlation between the indicator and the desired end point, for example, an increase in the indicator value should correlate with an increase in the biodiversity value of a site.
- **Construct validity:** There should be evidence and theory to support the interpretation of the result. For example, a loss of habitat may be correlated with an increase in species richness as a result of ingress by generalist species. Such a situation would not reflect a Net Gain, highlighting the importance of clearly defining goals and identifying indicators to track progress towards these.
- **Aggregation of ecological information:** Recognising that assessing Net Gain is a multi-dimensional problem, covering multiple parts of the ecosystem, ideally indicators should be capable of distilling multiple, complex sources of information into single, easy to interpret indices.

It is important to note that there will be trade-offs between these criteria, for example, between scientific robustness and ease of application (McVittie & Faccioli 2020), and an optimal balance between these should be sought. In the context of assessing Net Gain at a site level, some features may be more important than others, and this should be accounted for when assessing these trade-offs. For example, whilst universality and portability may be most relevant for comparing and assessing measures at a portfolio level, ensuring indicators are based on sound ecological knowledge, robust baseline values are available and further data collection is feasible, is essential regardless of the scale at which metrics are considered.

Whilst metrics and indicators are yet to be defined in relation to Net Gain, considerable effort has been expended in developing approaches to quantifying offsetting (Marshall *et al.* 2020). Typically, most of these efforts have been targeted at habitat level (Marshall *et al.* 2020), for example, the DEFRA Biodiversity Metric, which combines habitat extent, condition and distinctiveness (DEFRA & Natural England 2023). However, stakeholders involved in the offshore wind industry have highlighted the importance of ensuring that indicators used account for both habitats and species, including considering the potential for offsite impacts in relation to highly mobile species such as birds and marine mammals (Edwards-Jones *et al.* 2024). It is important to identify metrics and indicators that are relevant to these PBVs, and for which the necessary data can be collected in relation to the project concerned (e.g. Table 2). Once these have been identified, they can be incorporated within tools, such as biodiversity accountancy calculators to assess progress towards Net Gain (e.g. Carreras Gamarra *et al.* 2018; Cuckston 2019).

4.4 Establishing biodiversity baselines and set targets

Having established the actions that will be implemented to deliver Net Gain, it is essential to define targets for achieving Net Gain and establish the baseline conditions against which these targets will be assessed. A Net Gain must relate to the pre-development condition of a site (IFC 2019). Hence, the baseline conditions for the priority biodiversity values and metrics considered must be defined prior to any development. Targets for achieving Net Gain should be set in relation to this baseline. In setting targets, careful consideration should be given to the timescales over which any actions to achieve a Net Gain are likely to act; target gains should be achievable within the lifetime of a project. For example, the efficacy of measures targeting populations of long-lived species like seabirds and marine mammals may not become apparent for several years until animals enter the breeding population (Cook *et al.* 2014). In contrast, the efficacy of shellfish restoration may become apparent much more quickly (Arnaldi *et al.* 2018). These timescales may influence the scale of ambition for any actions proposed to deliver Net Gain. Whilst it is important that proposed targets are achievable, given the highly degraded status of marine ecosystems, it is important that they are also ambitious (Plumeridge & Roberts 2017). However, the scale of any ambition should take factors into consideration, such as the generation time of the priority biodiversity values concerned.

4.5 Monitoring

Robust monitoring is central to strategies for achieving Net Gains (Thomas *et al.* 2024). As part of this, it is important to understand the totality of impacts, both positive and negative. A key first step in this process is defining a baseline condition against which all impacts, both positive and negative, will be assessed. This baseline data, and subsequent post-construction monitoring data, is collected using a wide range of different approaches (Table 1; Watson *et al.* 2025), often mandated by regulators (e.g. Bundesamt für Seeschifffahrt und Hydrographie (BSH) 2013).

Having established baseline conditions and set targets in relation to Net Gain, it is essential that a monitoring plan is put in place prior to both the development of the project and implementation of any actions to deliver Net Gain. This will ensure that progress towards Net Gain is tracked in relation to the previously defined baseline conditions and not, for example, in relation to an environment which has been depleted following construction activities. As highlighted above (Section 4.3), two of the key criteria for identifying useful indicators are the availability of reference values and the feasibility of data collection. Given the cost and challenges of data collection in the marine environment, ideally the data used to define baseline conditions and assess progress towards Net Gain should align with, or possible derive from, the data that is collected as part of mandated pre- and post-construction monitoring.

The methods selected should be based on both the metrics being measured, and the questions being asked, with investment in capacity and further development of methodologies as required (Stephenson 2024, Figure 6). To ensure consistency in data, ideally the monitoring should be designed to enable a common approach to be applied across all phases of development (i.e. pre-construction, construction, operation and decommissioning). At present, much monitoring within the marine environment focuses on surveillance to detect spatial and temporal trends in biodiversity (Patrício *et al.* 2016b). Whilst it is important to ensure adequate temporal and spatial coverage appropriate to the ecosystem components under consideration, it is likely that a greater focus on condition monitoring will be required when assessing progress towards Net Gain in order to ensure a more holistic understanding of ecosystem health in general (Elliott 2011). This issue is likely to get greater attention in the coming years as we gain a greater understanding of the wider ecosystem effects associated with offshore wind farms (Isaksson *et al.* 2023). New technology to facilitate this monitoring, for example, cameras (Bicknell *et al.* 2016), eDNA (Gold *et al.* 2021), remote sensing (Kachelriess *et al.* 2014) and sensors mounted on autonomous vehicles, (Ventura *et al.* 2023) is developing rapidly. However, the implementation of these technologies lags their potential (King & Halpern 2025).

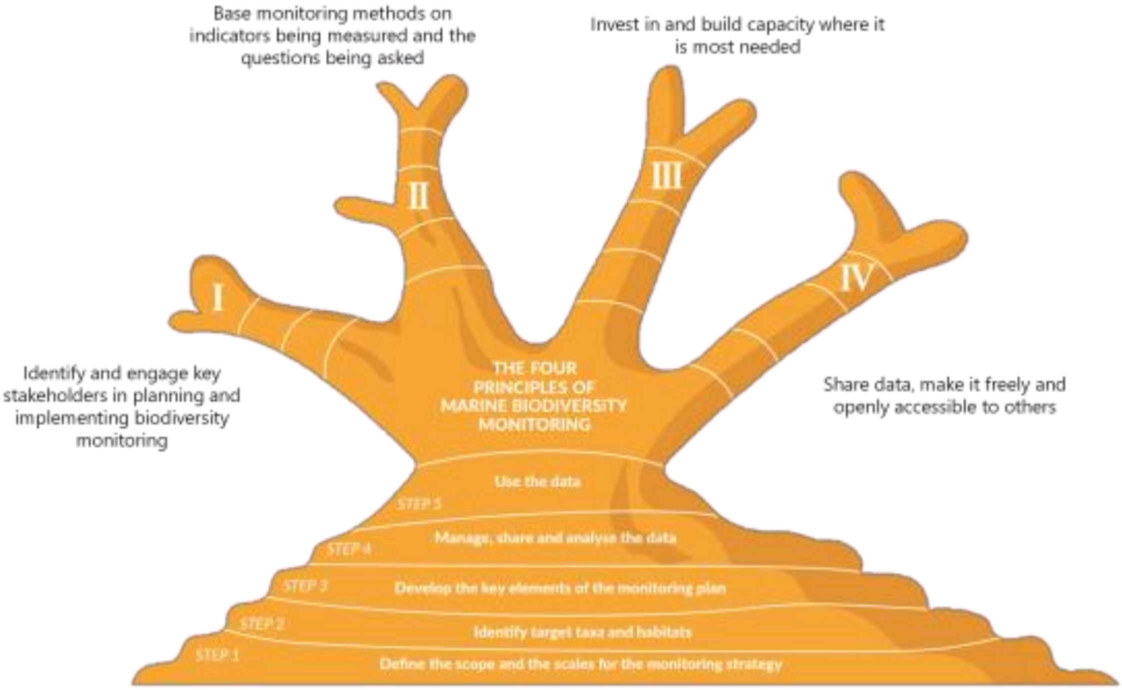

Figure 6: Key steps and principles for marine biodiversity monitoring for offshore wind development (adapted from The Global Initiative for Nature, Grids and Renewables 2024).

4.6 Implementation and adaptive management

Once actions are confirmed, where possible, implementation should begin prior to project impacts occurring to ensure that gains are realised then. However, it appears that this may not be possible in all cases, for example, where actions to deliver Net Gain are linked to project infrastructure such as scour protection (Jobson *et al.* 2024). After measures are implemented, it is important to track and report on progress towards Net Gain targets (Thomas *et al.* 2024). Where monitoring indicates that progress towards Net Gain is slower than expected, noting the different timescales over which biodiversity values may respond to conservation actions, adaptive management can enable remediative action to be taken in order to get projects back on track to meet their Net Gain requirements (zu Ermgassen *et al.* 2021). Whilst these actions may result in additional costs to developers, the impact of these costs may be less substantial than the reputational risk of failing to meet publicised targets for Net Gain (Walker & Wan 2012). The risk of this can be minimised by identifying and selecting evidence-based conservation measures such as Net Gain actions, and ensuring that whilst targets may be ambitious, they are also realistic.

4.7 Reporting and disclosure

Transparency has been highlighted as being essential in relation to policies of No Net Loss (Bull *et al.* 2018), and this applies equally in relation to Net Gain. Once collected and processed, data should be made freely available (Figure 6). This will serve both to increase stakeholder confidence in relation to claims of Net Gain, and to ensure that future projects are able to take advantage of the lessons learned. To maximise the value of these results, outputs of both successful and unsuccessful projects should be made available through a centralised repository akin to the IUCN Contributions for Nature platform[17], or Conservation Evidence[18]. Claims made by projects in relation to Net Gain should be specific regarding whether they relate to a particular PBV or all PBVs that a project has identified. Corporate disclosure requirements may have more specific requirements related to how the organisation plans to ensure that their business model and strategy are compatible with relevant targets outlined in the GBF including e.g., how offsets are used and metrics and related tools used to measure progress[19].

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[17] https://iucn.org/resources/conservation-tool/contributions-nature-platform

[18] https://www.conservationevidence.com/content/page/82

[19] https://www.efrag.org/sites/default/files/sites/webpublishing/SiteAssets/11%20Draft%20ESRS%20E4%20Biodiversity%20and%20ecosystems%20November%202022.pdf

5 Challenges associated with delivering Net Gain in relation to offshore renewable energy projects

5.1 Target features

As stated above, the prioritisation of biodiversity values for marine Net Gain targets presents a challenge, especially below water where sufficient monitoring information is required to demonstrate that species are present reliably, predictably and in sufficient number, and that habitats are classified appropriately (e.g., with sufficiently granular habitat classification and information on extent and condition). However, with the rapidly improving monitoring approaches available (see below and Section 4.5), this information is becoming easier, faster and more cost effective to collect.

5.2 Challenges of marine restoration

Marine restoration is logistically challenging to implement and many instances of failure have been documented (Van Dover *et al.* 2014; Bayraktarov *et al.* 2016a). Success depends on the specific techniques implemented and varies across habitat and ecosystem types (Danovaro *et al.* 2025b). Success of marine restoration projects averages 64%, and, in the context of habitats of relevance to offshore wind, efforts to restore saltmarshes, habitat-forming species on hard bottoms, and algal forests are more successful than efforts to restore oyster beds and seagrass (Danovaro *et al.* 2025b).

Besides the ecosystem concerned, restoration can fail for a number of reasons including inappropriate restoration / offset site selection, stochastic events, changing environmental conditions, and anthropogenic and industrial impacts (Bayraktarov *et al.* 2016a). Given these challenges, it is important to look for opportunities to maximise the success of any restoration project. Well-designed methodologies, including effective spatial planning, are key to maximising the probability of success (Lester *et al.* 2020; Danovaro *et al.* 2025b). However, whilst a variety of approaches to support the spatial planning of marine restoration projects exist, these are rarely used (Lester *et al.* 2020).

Across reports and publications, there is consensus on the need for experimentation in relation to Nature-Positive approaches for offshore wind farms (Pardo *et al.* 2025a). Given the often limited evidence base with which to assess the likely effectiveness of marine conservation measures (Álvarez-Romero *et al.* 2018), and the often voluntary nature of measures to achieve Net Gain, there is value in developers applying untested but evidence-informed approaches. Assuming such studies are clearly and accurately reported, this may deliver greater benefits to biodiversity through advancing the understanding of what works than repeating interventions that have been widely implemented elsewhere. However, regardless of the approach taken in support of Net Gain in relation to offshore wind farms, reporting the long-term outcomes of these efforts is vital (Pardo *et al.* 2025a). Much of the published evidence is restricted to one to two years post-restoration action (Lester *et al.* 2020), making it difficult to assess the long-term efficacy and success of these measures.

5.3 Monitoring

Monitoring biodiversity in the marine environment is inherently more complex and logistically challenging than for terrestrial biodiversity. Besides the difficulty of recording data in a highly dynamic environment, there are often significant health and safety considerations associated with working at offshore wind farms. To overcome these challenges, an increasing range of approaches to biodiversity data collection in and around offshore wind farms are available (Watson *et al.* 2025). Both to reduce costs, and to limit exposure to health and safety risks, there is an increasing use of remote automated approaches to monitoring, for example, underwater monitoring at Hollandse Just Noord offshore wind farm[20]. However, a key challenge for developers is determining which survey methods are proportionate and relevant to the biodiversity values for which Net Gain targets apply. This is illustrated by the fact that there is a clear gap between the pace at which these approaches are developed, and the pace at which they are implemented in the marine environment (King & Halpern 2025).

5.4 Costs

It is important to acknowledge that offshore renewable energy projects operate in a sector characterised by tight financial constraints. Delivering measures to achieve Net Gain and collecting data to inform progress towards Net Gain targets can carry a substantial economic cost. The most cost-effective approach is to prioritise the Avoidance and Minimisation stages of the mitigation hierarchy during project planning, ensuring residual impacts are minimal and manageable, reducing the need for costly remediation or monitoring, and making it easier to achieve outcomes beyond No Net Loss, including Net Gain.

Restoration of marine ecosystems is known to be more expensive than for other ecosystems and can be 10-400 times higher than the maximum costs for restoration of terrestrial ecosystems (Jacob *et al.* 2018). As an example, costs for some marine conservation activities are provided in Table 3. However, to put these costs into context, an estimated US $6 trillion investment is needed to meet 2050 targets for the offshore wind industry (Van Sluis *et al.* 2025). Evidence from recent Dutch, Danish and British offshore wind tendering suggests that it is feasible to reserve 1-5% of project investments for nature restoration through a combination

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[20] https://www.fugro.com/news/business-news/2025/bewild-achieves-world-s-first-remote-ecology-survey-at-crosswind-offshore-wind-farm

of redistributing funds from financial bids, incorporating tendering criteria, channeling contributions via OWF leasing fees in centralised licensing processes, and incorporating nature-inclusive designs in projects (Van Sluis *et al.* 2025).

Table 3: Cost estimates for marine conservation activity examples

Activity	**Cost**
Seagrass restoration	US $106,782 per hectare (Bayraktarov *et al.* 2016b)
Saltmarsh restoration	US $67,128 per hectare (Bayraktarov *et al.* 2016b)
Oyster reef restoration	US $66,281 per hectare (Bayraktarov *et al.* 2016b)
Removal of floating marine litter by vessels	EUR €4-75 per kg (Andrés *et al.* 2021)
Beach cleaning	EUR €12,050 – 96,150 per km or up to €2.90 per kg (Cruz *et al.* 2020)
Supporting MPA designation	US $775 per km^2 per year (Balmford *et al.* 2004)
Invasive mammal eradication from islands	GBP £440 per hectare (Ratcliffe *et al.* 2009)

To further reduce costs across the industry, collaboration, transparency and data sharing will be important. Lessons learned through the application of measures to achieve Net Gain are key to delivering the maximum conservation gains from the available project budgets. Similarly, identifying opportunities for collaboration between developers across sites may offer an opportunity for more strategic approaches to be taken when delivering Net Gain, offering a greater potential overall benefit for biodiversity.

5.5 Decommissioning

As the first offshore wind projects reach the end of their operational lives, there is substantial debate around approaches to decommissioning. Whilst some advocate a renewables-to-reefs approach (Smyth *et al.* 2015), there is often a requirement that, where technically feasible, artificial structures in the marine environment are removed in their entirety (e.g. OSPAR Decision 98/3[21]).

Furthermore, operators may retain legal liability for any structures left *in situ* beyond their operational life and may be reluctant to incur this additional risk. These discussions are relevant in the context of Net Gain as many of the actions

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[21] https://www.ospar.org/documents?v=6875

concerned, for example, the use of scour that promotes the growth of benthic communities (Kingma *et al.* 2024), would, under strict application of these rules, require removal, meaning any gains would not be sustained beyond the lifetime of the project concerned. Given the highly degraded status of many marine ecosystems (Plumeridge & Roberts 2017), it would seem strange to remove any structures that have supported the restoration of marine life through strict adherence to these rules.

5.6 Climate change

The distributions of marine species are shifting rapidly in response to climate change (Pinsky *et al.* 2020). This is likely to present significant challenges in relation to identifying suitable actions for delivering Net Gain in relation to marine biodiversity values. It is acknowledged that rapidly shifting distributions mean that existing Marine Protected Area networks may no longer be suitable for the species and habitats for which they were designated (Fredston-Hermann *et al.* 2018). Where conservation actions are targeted with a view to delivering a Net Gain for a particular biodiversity value within a site, it is important to acknowledge that wider environmental conditions may mean that over time that site will become less suitable for the biodiversity value concerned, and that it may eventually be lost from the site. In such circumstances, there is a risk that targets for Net Gain will be missed due to wider environmental conditions, despite efforts from developers to deliver Net Gain for biodiversity. The potential for this phenomenon needs to be considered when developing strategies for delivering Net Gain in relation to marine renewable energy.

6 Opportunities in relation to delivering Net Gain for offshore renewable energy projects

Despite the challenges described above, there are a number of opportunities to align nature and climate goals through the delivery of Net Gain in relation to offshore renewable energy projects. These may include:

- **Contributing to broader ecosystem recovery.** Offshore renewable energy represents a relatively new marine sector, operating, in many parts of the world, in degraded marine environments. Offshore renewable energy, whilst needing to carefully manage impacts, can contribute meaningfully to the restoration and recovery of the marine environment (e.g., restoration of Flat Oyster *Ostrea edulis* reefs, seagrass meadows, seabird populations etc.), and through the exclusion of some activities known to be damaging to the marine environment (e.g. bottom-trawling) (Edwards-Jones *et al.* 2024; Bicknell *et al.* 2026). In some cases, depending on the particular features, the offshore renewables may even complement the management objectives of Marine Protected Areas (through reduced fishing effort, artificial reef effects and enhanced monitoring).
- **Addressing and overcoming stakeholder concerns about the offshore renewable energy industry.** At present, perceived environmental impacts associated with offshore renewable energy projects can lead to stakeholder concerns, contributing to “green-on-green” conflict. These concerns can contribute to substantial costs and delays to projects as a result of local opposition and legal challenges. By taking a pro-active approach to delivering Net Gain in relation to projects, it may be possible to minimise these challenges.
- **The identification of “no-regret” actions** that may deliver substantial biodiversity enhancement benefits for biodiversity at little or no additional cost to project developers. Examples of this include the nature-inclusive design of turbine scour protection and cable mattresses to promote benthic communities[22].
- **Building and contributing to an evidence base** for what works in marine conservation. By investing in Research and Development, trialling innovative approaches and collating information on the Net Gain measures that have been developed and applied, as well as the metrics used to assess the efficacy of these measures, it will be possible to develop a catalogue of conservation actions in different regions that can significantly contribute to Nature-Positive

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[22] For further examples see Jobson *et al.* (2024) and the Rich North Sea Nature Enhancements Toolbox

goals. This can be publicised using platforms, such as the IUCN Contributions for Nature Platform[23], to highlight conservation actions taking place globally.

- **Taking advantage of the increasing availability of biodiversity monitoring approaches.** Biodiversity monitoring offshore is now more readily available than ever before, including, for example, through the collection and analysis of Environmental DNA (eDNA), ROVs, hyperspectral / RGB imaging, and the use of Artificial Intelligence to classify biodiversity values. Compelling examples of biodiversity enhancement at offshore wind farms are already available, for example at the South Fork Wind Farm in USA[24]. However, to date, the usage of novel approaches to monitoring has not kept pace with the development of new methodologies (King & Halpern 2025).

Case Study *Ecowende***:**

Ecowende is a joint venture between Shell, Eneco and Chubu in the Dutch North Sea, which aims to make a positive contribution to biodiversity and be the most ecological wind farm yet. In addition to measures that minimise impacts on biodiversity (Figure 7) such as migration corridors to reduce seabird displacement rates, raised hub heights and coloured blades to reduce collision risk, and reduced noise during pile-driving to reduce impacts to harbour porpoises, a number of measures have been proposed to enhance biodiversity underwater (Figure 8). These include the use of eco-friendly scour protection, measures to encourage the formation of artificial reef habitats, and measures to restore populations of the native Flat Oyster *Ostrea edulis*. This work is underpinned by a commitment to share the knowledge gained as part of these projects, enabling others to learn from what has been effective and apply this at new sites.

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[23] https://www.iucncontributionsfornature.org/

[24] https://storymaps.arcgis.com/stories/43138bdb3826449bbc4ce2b3eba49bb0

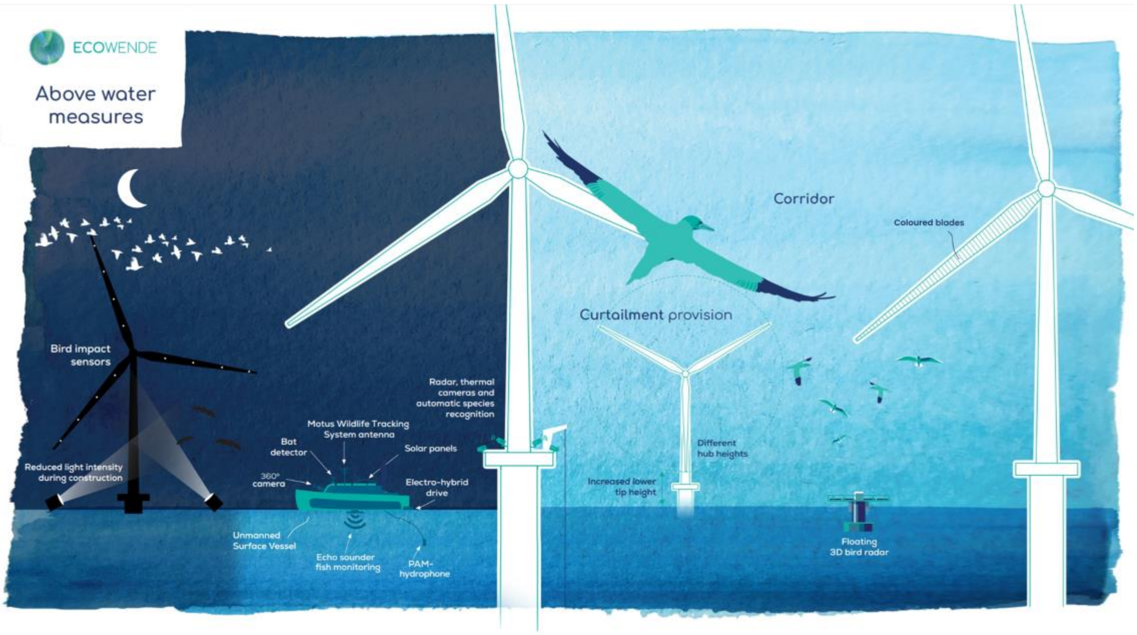

Figure 7: Above water measures at Ecowende wind farm (Ecowende.nl 2026).

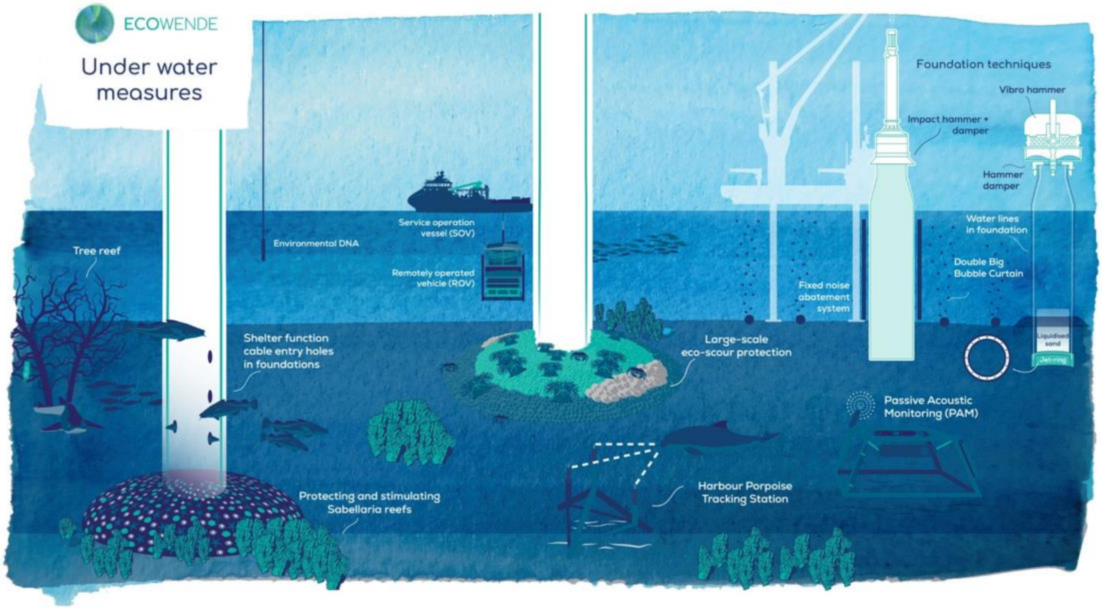

Figure 8: Under water measures at Ecowende wind farm (Ecowende.nl 2026).

7 The role for stakeholders in delivering Net Gain in relation to offshore renewable energy

Given the spatial and financial scale of offshore wind development in coming decades, there is the potential for the industry to play a significant role in making Nature-Positive contributions. However, there is a risk that through its efforts to be seen as a green industry, it is held to higher standards in relation to other industries, for example oil and gas. Consequently, it is important to ensure that, where appropriate, developers' efforts to deliver Net Gains in relation to their projects are recognised and supported. This will involve the constructive engagement with the industry by other stakeholders in marine environment.

Key stakeholders and the roles they play in supporting Net Gains in relation to offshore renewable energy are listed in Table 4. An open and collaborative environment will be required across these stakeholders to create the space for efforts to achieve Net Gain to succeed.

Table 4: Roles of influential stakeholders in delivering Biodiversity Net Gain for offshore renewables.

Stakeholder	Role
Developers	• Setting Net Gain targets and developing internal capacity for tracking and delivering biodiversity gains; and • Transparently reporting progress towards targets and sharing data for the wider benefit of the sector and biodiversity conservation.
Governments, regulators and permitting bodies	• Prioritising projects that take a proactive approach to delivering a Net Gain for biodiversity through giving greater consideration to non-price criteria in auctions and leasing rounds; • Developing statutory approaches for Net Gain in the marine realm; and • Overseeing the expansion of offshore renewables and managing the risks associated with cumulative and in combination impacts within and across jurisdictions.
Non-governmental Organisations	• Sharing expertise, knowledge and data about the current state of the marine environment and conservation actions that can be taken to deliver Net Gain; and • Influencing policy measures for the broader benefit of the marine environment.
Academia	• Developing and critiquing approaches for Net Gain in offshore renewables sectors; and

Stakeholder	Role
	• Delivering research to support the evidence base for Net Gain in the offshore renewables sectors.
Environmental consultancies	• Support in developing internal capacity, ambition and goals associated with biodiversity Net Gain; and • Support to design, deliver and analyse data collected as part of offshore renewables projects with a target to deliver Net Gain.
Financial institutions and other investors	• Financing projects that take proactive and innovative approaches to delivering Net Gain in relation to offshore renewable energy. Especially ensuring that in emerging markets, projects are incentivised to deliver Net Gain; and • Investing in developers with robust biodiversity management processes aligned with the GBF and holding them to account if commitments are unrealised.
Technology and monitoring service providers	• Enabling projects to monitor biodiversity values cost effectively, safely, and to be able to track progress over time towards Net Gain targets.

8 Conclusions

It is important to acknowledge that the marine renewable energy industry is not a primary driver of biodiversity loss in the marine environment. Indeed, mitigating the impacts of climate change by reducing carbon emissions will be a key step in minimising biodiversity loss. However, the projected scale of future expansion of offshore wind highlights the potential for substantial opportunities in relation to delivering Net Gain for marine biodiversity (Jung *et al.* 2024; Cook *et al.* 2025).

In order to avoid accusations of greenwashing, it is important to ensure that robust processes are set out to quantify and track progress towards Net Gain. This starts with identifying actions for delivering Net Gain and setting clear targets relative to a pre-impact baseline. Robust monitoring and transparent reporting of results is essential for building trust in the process and industry claims of success.

However, it is also important to acknowledge that the industry is operating under heightened technical and financial constraints. Consequently, support from a wider group of marine stakeholders will be essential in order to fulfil this opportunity to deliver Net Gains to marine biodiversity in relation to the marine renewable energy industry.

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