Marine Indicators in Context

Adam Smith[1], Adam Britton[1], Liam Matear[1], and Cristina Vina-Herbon[1]

May 2021

For further information please contact:
Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough PE1 1JY
https://jncc.gov.uk/
Communications@jncc.gov.uk

This report was produced by JNCC for Defra through the International Climate Finance Evidence Project.

This document should be cited as:
Smith, A.[1], Britton, A.[1], Matear, L.[1] and Vina-Herbon, C. May 2021. Focus on Marine Indicators in Context – International Climate Finance Evidence Project. JNCC, Peterborough https://hub.jncc.gov.uk/assets/376d989f-0563-4e7f-b034-c79108f63758#marine-indicators-context.pdf

Evidence Quality Assurance:
This document is compliant with JNCC's Evidence Quality Assurance Policy https://jncc.gov.uk/about-jncc/corporate-information/evidence-quality-assurance/

Summary

In recent years, a greater focus has been placed on the global biodiversity crisis and methods to tackle this challenge at genetic, species and ecosystem levels. International Climate Finance (ICF) aims to address and mitigate biodiversity loss through a 'triple-win' mechanism, whereby climate and societal goals are delivered with biodiversity benefits, through nature-based solution interventions. Key aims and objectives include the reversal of historic biodiversity loss, and net gains in biodiversity, achieved through intervention activities. Measuring biodiversity improvements and attributing change to intervention activities, or funding can be complex, requiring specific tools to enable understanding and assessment. Biodiversity indicators are key examples of tools available to policy and decision makers to evaluate the progress of environmental improvements of investments and nature-based solutions by measuring the state of biodiversity, identifying spatiotemporal trends and changes in environmental condition.

To assist in the delivery of ICF aims and objectives, and the wider review of biodiversity indicators, this report provides a summary of marine biodiversity indicators and recommendations that could be considered for application with the portfolio of ICF programmes relating to NbS activities in the marine environment. Indicators were critically reviewed in accordance with key themes (habitat extent, condition and species and pressures), identified as having particular relevance to biodiversity, and application to ICF funded projects. Potential indicators and key considerations are presented for each theme in this study.

This study highlights the complexity surrounding the use of indicators as an all-encompassing approach in the marine environment as certain approaches can have specific applications, which may not be relevant to all projects. Indicator selection is required to be informed by project design, relevant to project-specific aims and objectives, and scientifically robust. Where applicable, suggestions were made on potential indicator use and key messages highlighted for each of the indicator themes in a marine context:

- Habitat extent – Methodologies could consider a direct measure of change from project inception or an established baseline.
- Habitat condition – The use of diversity indices, or the direct monitoring of select keystone species, could be used as proxies for habitat condition, providing these are understood in the context of natural variability. Alternatively, the 'Hectares of ecological restoration as a result of funding' indicator could address both habitat condition and habitat extent themes.
- Species – The 'Improvement in status of threatened species as a result of funding' Indicator based on the International Union for the Conservation of Nature (IUCN) Species Threat Abatement and Restoration (STAR) metric, could be used in the future but is not applicable to marine species at present. Methods surrounding the 'Changes in Mean Trends of Species Abundance' indicator, could be considered in the meantime.
- Pressures – Where pressure-receptor links are known, evaluating pressures from human activities on the marine environments and associated impacts on sensitive receptors, such as benthic habitats could be considered as a proxy for condition in situations where direct measures of environmental improvements are not possible.

Key challenges and relevant alternative methods relating to the four indicator themes have also been discussed within this study. The recommendations put forward in this document can be used to inform indicator selection by the ICF portfolio of programmes, enabling the complexities relating to marine indicator assessments to be considered from project outset.

Contents

Acronyms

BEIS – Department for Business, Energy and Industrial Strategy

Defra – Department for Environment, Food and Rural Affairs

FCDO - Foreign, Commonwealth & Development Office

ICF – International Climate Finance

IUCN – International Union for the Conservation of Nature

KPI – Key Performance Indicator

MEA – Multilateral Environmental Agreement

NbS – Nature-based Solutions

ODA – Official Development Assistance

SER – Society for Ecological Restoration

1. Introduction

Biodiversity has been pushed to the forefront of global conservation efforts through mechanisms such as the ratification of Multilateral Environmental Agreements (MEAs) in attempts to combat the global biodiversity decline. In response to the increased focus on biodiversity, International Climate Finance (ICF) has developed the aim of a 'triple-win' scenario, where biodiversity benefits, climate and societal goals are achieved through the implementation of nature-based solutions (NbS). ICF is a ring-fenced funding avenue of the UK Official Development Assistance (ODA), which is delivered by the UK government Foreign, Commonwealth & Development Office (FCDO), Department for Business, Energy and Industrial Strategy (BEIS) and Department for Environment, Food and Rural Affairs (Defra). As part of the ICF's 'triple-win' structure, funded programmes seek to deliver significant biodiversity gains, in addition to restoring historic biodiversity loss.

Measuring biodiversity improvements towards objective 'states' can be complex, highlighting the imperative for assessment mechanisms, founded in sound science to enable accurate understanding of natural environments. Biodiversity indicators are examples of tools available to policy and decision makers to evaluate the progress of environmental improvements of investments and NbS by measuring the state of biodiversity, identifying spatiotemporal trends and changes in environmental condition. Indicators can be diverse, often with varied applications, ranging from project-level tools for localised reporting, to portfolio and international assessments of variables, such as biodiversity (JNCC, 2021b). Biodiversity indicators can have application across different spatial and temporal scales and can be used to identify, monitor and communicate complex trends to a variety of audiences. Indicator assessments can enable the measurement of progress towards specific (in the case of this study, biodiversity) goals and objectives and can be applied to highlight when objectives have been achieved.

To assist in the delivery of ICF aims and objectives relating to biodiversity, a review was undertaken to assess the applicability and relevance of existing biodiversity frameworks (JNCC, 2021a) and associated biodiversity indicators (JNCC, 2021b) to ICF funded projects. Information identified in the review was used to develop a series of thematic summaries, focussing on habitat extent and condition and both species and pressures indicators; themes were selected based on their relevance and contribution to impacts on biodiversity. This report presents a series of marine-focused considerations and recommendations for biodiversity indicators relevant to each indicator theme. Recommendations are presented below and relevance to ICF funded programmes highlighted.

2. Marine-focused Considerations

2.1 Habitat Extent

Marine habitat indicators recommended at a project level are those considered particularly relevant for NbS or activities that bring measurable benefits for the restoration or recovery of habitats, and species within those habitats, or the reduction of habitat loss. The foci of marine habitat extent indicators reviewed within the current project predominantly related to coastal habitats, such as coral reefs, seagrass meadows and saltmarshes as these seem to be the main focus of NbS funded projects by ICF programmes. Coastal habitat extent assessments may be more achievable than in wider marine areas due to accessibility for in-situ sampling efforts and data collection, and suitability of secondary data use (e.g. Earth Observation), which can provide cost-efficient snapshots of habitat extent. Therefore, methods relating to coastal indicators could provide ODA-funded projects with a cost-effective means for data collection and assessments in comparison with more complex survey methods associated with offshore assessments. Additionally, improved accessibility could facilitate understanding of the links between coastal habitats and NbS more easily than for wider marine areas. For example, many studies have been published on how coastal habitats can provide diverse ecosystem services, such as natural coastal defences, climate regulation via carbon sequestration, and provision of food security. Identifiable links between coastal habitats and benefits obtained from the outcomes of ODA receiving projects can therefore be integrated into project design, attributed to the actions of the project, and communicated from a project to a portfolio level.

For marine habitats, state (e.g. habitat extent) and response (e.g. restoration or recovery of habitats) indicators that measure trend changes in habitat extent over time could be viable options for projects, drawing on established methods, such as those used by Coral reef extent or Global seagrass extent indicators and/or other methods developed as part of the UK or regional marine indicators, which could be adapted for ODA use. If the use of extent indicators in marine environments is a priority for ICF ODA funded projects, a historic baseline, or a point of project inception, from which change could be measured from should be established. Assessments of ‘natural’ extent can be challenging to define in marine environments, and therefore, difficult to use as a starting point for direct measurements of change. To define a habitat extent as ‘natural’, understanding of the composition, structure, and function of the habitat in the complete absence of human pressures would be required, which can be time and data intensive. However, projects could assess known distribution for a given habitat through techniques such as habitat suitability modelling to assist in predicting ‘natural’ habitat extent.

It is important to note that an increase in habitat extent doesn't necessarily denote habitat in good condition; where feasible, it is recommended that projects understand and identify the relationships between extent and condition of assessed marine habitats, as it is possible to have a large extent of a given habitat that is in poor condition. For example, if habitats become fragmented or patchy, they may no longer provide the same ecosystem functions, such as provision of protection from predation or sediment retention. Additionally, habitat fragmentation may result in increased sensitivity to physical marine pressures, such as erosion or wave action, due to increased exposed habitat surface area. Understanding of condition for habitats that may be impacted by fragmentation could be achieved through assessments of area coverage, rather than extent, or by incorporating habitat-specific factors such as seagrass blade density to improve understanding of condition.

Understanding of condition is relevant from a marine perspective as habitats are heavily influenced by the species composition and substrate type. Full condition assessments can be challenging to measure and interpret, requiring habitat-specific knowledge, and data at appropriate spatial and temporal resolutions. Alternatively, simple extent-based assessments, with some quality metrics such as the presence of key species, could be more easily achieved as a starting point, for example using observational surveys, and/or remote sensing techniques, potentially with a view to develop condition assessments later. It is also recommended that projects consider the continuity of an assessed marine habitat and potential for fragmentation. For example, it is possible that marine habitats, such as biogenic reefs can cover a wide spatial extent but be severely fragmented. Therefore, area calculations may be more suitable than assessments of extent for habitats where fragmentation could lead to reductions in total habitat area.

In the absence of direct habitat measurements, extent could be modelled using variables incorporated from pressure indicators (where pressure-receptor links are known), such as the Potential Physical Loss of Predicted Seafloor Habitats (Strong, et al., 2018), to indirectly assess habitat distribution based on the presence and intensity of a given pressure. However, pressure-receptor interactions are complex and the use of pressure indicators as a proxy for habitat presence is recommended to be informed by project-specific information, such as the spatial and application of the project. Projects should consider assessing relevant pressures, known to impact the habitat of interest, such as bottom-contacting fishing practice impacts to seagrass beds. Additionally, changes in habitat extent, as a result of impact or pressure reduction should be clearly identifiable, and changes should be distinguishable from wider ambient drivers of change.

In summary, marine extent indicators are considered most easily measured as direct changes for coastal habitats from established baselines or project inception, rather than known 'natural' extent. Therefore, it is recommended that ODA funded projects account for these considerations when informing project design. Key knowledge gaps for NbS in marine areas outside coastal habitats should be noted, and further investigation is required to explore best approaches if funding for NbS activities aims to target marine areas beyond the coast, or in order to evaluate wider marine environmental benefits.

2.2 Habitat Condition

In marine environments, the selection of indicators will depend on the location, habitat type or ecosystems included under the project, whether existing data and evidence of the environmental conditions of the area are available, and the capacity and expertise of those involved in the ODA project team. This will determine if and to what extent improvements in ecosystem health or condition in terms of improvement in community structure (e.g. increased diversity in the area) or ecosystem function (e.g. increased biomass of a habitat type overtime) can be measured. The selection of suitable indicators or metrics will depend also on the scale and focus of the funded ODA projects.

Potential options to be considered further are:

- **Diversity indices**: In the simplest form, ODA funded projects could consider the use of biodiversity indices in marine environments (e.g. Simpson's Diversity Index) particularly if there are habitat data limitations, to provide a quantifiable measurement of species composition and diversity within a given location. Dependent on the factors contributing to observed change, increases in diversity may be indicative of improvements in ecosystem health or condition. To maximise understanding of the impacts a given ODA funded project has on marine ecosystem quality or condition, it is recommended that assessments using biodiversity indices consider historic or projected trends and expected species composition for the area of interest to contextualise observed changes against natural variability. If considered relevant, the use of biodiversity indices may provide ODA funded projects with relatively simple and easily interpretable methods of assessing condition. Biodiversity indices can be understood with relatively limited need for specialist expertise, enabling findings to be communicated more easily than more complex alternative indicators or methods.
- **Diversity index plus phylogenetic diversity**: It should be noted that assessments of species diversity may not be representative of other characteristics, such as phylogenetic diversity within a given marine environment. For example, an ecosystem containing many different classes, orders, families, genera and species, could produce similar measures of diversity to ecosystems containing only a few genera, but many species. The conservation of phylogenetic diversity can enable a wide range of traits exhibited by different taxonomic groups to remain within an ecosystem, supporting the overall unique biological functions provided by organisms in an ecosystem (e.g. habitat provision, nutrient cycling, predator/prey control and primary productivity). Therefore, it is recommended that when considering diversity indices, projects account for taxonomic distinctness to ascertain whether diversity is considered from closely related species (e.g. at a genera level) or less taxonomically related species (e.g. family or order level). Taxonomic distinctness can be defined as the "path" distance between all sets of distinct species through the taxonomic hierarchy.
- **Keystone species and/or habitat sensitivity**: Monitoring of keystone species or the presence and abundance of sensitive[1] species in marine environments could be proposed to understand wider ecosystem condition. Keystone species, such as corals and/or other calcareous benthic species play integral roles in influencing overall biodiversity and the structure, function, and condition of marine ecosystems. Therefore, where data are available, ODA funded projects could indirectly assess condition by focussing on a relevant subset of keystone species; measurements could be compared with non-impacted reference/control sites as counterfactuals to understand the impact of project action. Coral reefs and other habitat forming species, such as seagrass, are highly sensitive and provide essential habitats and nursery grounds for a diversity of marine species, therefore, assessments via indicators such as 'Live Coral Cover' could be considered to understand the extent of reef in a condition which can support other marine life. Additional variable, such as biomass or density of reefs could also be included. In addition, if assessing habitat forming species such as corals, it is recommended that species morphology is accounted for, as this can influence habitat heterogeneity, a factor indicative of the overall variety of unique habitats for other species to inhabit within a given area.
- **Indirect measures of impact indicators**: In cases where they are data limitations, or difficulties with direct data collection, projects could consider both state and

[1] Sensitivity in this context is defined as the combination of resistance (likelihood of damage to pressures) and resilience (rate of recovery) of habitats or ecosystems

pressure indicators to inform condition assessments. ODA funded projects could explore methods similar to the ones used in OSPAR Regional Sea Convention measuring Potential Physical Loss of Predicted Seafloor Habitats (Strong, et al., 2018), or the Extent of Physical Damage to Predominant and Special Habitats indicators (OSPAR, 2016) to understand habitat extent and condition in response to the presence and intensity of damaging human activities.

- An indicator considered under the habitat condition theme, with specific links to the habitat extent theme, was the 'Hectares of ecological restoration as a result of funding' indicator. This indicator is used for coastal marine habitats, and draws on the Society for Ecological Restoration (SER) definitions and five-star assessment scale for levels of habitat restoration (Gann, et al., 2019). The number of hectares restored against the five-star scale are measured and counted where restoration is valued at five stars (four, if five is unattainable). The indicator primarily focusses on habitats that are to be restored as part of ICF funded projects. In the marine environment this indicator would only be applicable to a small number of coastal habitat types, with coral reefs perhaps being the best example, and therefore, may not be representative of non-coastal, wider marine ecosystems.

The rate at which condition changes in marine environment may not align with the duration of an ODA funded project, therefore, it is recommended that factors for assessment are selected based on what is achievable within project timeframes to improve the likelihood of detecting change as a direct result of project impact. For example, this may be particularly important when assessing species composition, as mobility and distribution can change throughout life stages of development (e.g. sessile benthic species with meroplankton larval stages), and natural and anthropogenic impacts may have varied effects on organisms dependent on development.

When assessing changes in the condition, it is recommended that projects aim to define a project-specific ecosystem reference state, from which change can be measured. Where possible, the use of counterfactuals, or non-impacted reference zones with similar characteristics to the area of focus should be considered to enable comparison with locations that are not directly impacted by project action. It should be noted that assessments from project inception should only be considered as the starting point, and not as a reference state as it is expected habitats will be on a degraded condition. Therefore, it is recommended this is accounted for in project design and where possible, projects aim to identify what could be defined as 'good' condition to ensure measured changes are truly representative of improvements in ecosystem health.

In summary, condition in the marine environment is highly nuanced and influenced by a variety of different factors including habitat extent, fragmentation, the influence of ambient pressures and wider ecological drivers such as the interactions between benthic and pelagic systems. Additionally, not all parameters indicative of condition will be relevant to all ODA funded projects. Therefore, assessed parameters should be identified on a project-specific basis and incorporated into project design where feasible and relevant. Due to the complexity of assessing condition directly, measurements using diversity indices, or monitoring of select keystone species could be considered as proxies in the short-term. To improve understanding of direct project impact, assessments could be compared with counterfactuals or non-impacted reference states. However, project design needs to be informed by accurate scientific understanding to ensure that assessed changes are representative of changes in condition and linked to the outcomes of an ODA funded project.

2.3 Species

The review of marine species indicators identified certain examples as having methodological elements that could potentially be recommended or adapted for use in ODA funded projects that assess marine species. Primarily, an indicator which assesses trends in mean species abundance could be proposed due to simplicity and potential achievability for ODA receiving projects. Examples of established indicators which focus on species abundance comprise ‘Abundance of Selected Key Species’ (United Nations, 2007), a state indicator similar to the ‘Population Abundance of Selected Species’ indicators (Specially Protected Areas Regional Activity Centre, 2017) used by the Mediterranean Regional Sea Programme and the ‘Abundance and Biomass of Key Reef Fish Taxa’ indicator (GCRMN, 2016), recommended by the International Coral Reef Initiative to the Convention on Biological Diversity. These methods involve selecting key species (e.g. keystone, rare or endemic, or threatened species) that are of relevance to the project, that can be used as a proxy for biodiversity, and whose abundance can be measured or quantified. If a representative species can be successfully identified at a project level, advantages of this approach include being less resource intensive than monitoring all species relevant to the project. Additionally, as abundance is an established metric, it can be easily understood and communicated, and may require less resource to statistically analyse, when compared with more complex diversity indices.

However, the quality of marine abundance assessments can be dictated and/or constrained by data availability. As abundance is a direct measurement, a baseline or point of inception for analyses would be required and robust data collection needed to accurately detect and monitor change. If projects intend on identifying ‘indicator species’, it may be challenging to select species that are truly representative of project diversity, or species that could be easily monitored for change throughout project duration. In addition, indicator species may be representative of a specific project or location, hindering potential for data aggregation from a project to portfolio level. It is also possible that trends in abundance are difficult to measure over project timescales, due to behavioural and morphological changes throughout varied stages of species development (e.g. sessile organisms with mobile planktonic juvenile stages). Species distribution may also fluctuate, dependent on seasonal or annual cycles (e.g. migratory species). Particular challenges can occur when assessing highly mobile species, or those who move across different habitats or areas throughout the day, for example due to feeding behaviour. Therefore, it is recommended that any species considered for assessments are selected and informed by sound scientific understanding of both the species and the nature and application of the project.

It should be noted that abundance assessments may not be directly applicable to all species in marine environments (e.g., sponges or encrusting corals), therefore, indicators may need to be adapted to assess species with specific traits (e.g. assessments of percentage cover, rather than absolute count). The review also highlighted that measurements of abundance may not be indicative of the drivers of change affecting an organism, making it challenging to attribute change to the direct impacts of a given NbS project. Abundance in marine environments can vary due to a diversity of natural and anthropogenic factors outside of the scope of an NbS project. Furthermore, the interactions between pressures and drivers may be nuanced and complex, therefore, extensive analyses may be required to correctly understand observed changes in abundance.

Where direct species assessments are not possible, response-based indicators could be considered, such as ‘Translocation Activities Undertaken for Priority Species’ and ‘Uptake of Invasive Species Monitoring and Management Protocols’. Both response proposals have similarities with indicators used in various Regional Sea Conventions and could contribute to ODA funded projects where a species translocation or biocontrol has been identified as part of the nature-based solution. Benefits of response-based measures for ODA receiving projects could include ease of measurement due to less complex methodologies and analyses than those requiring direct biological monitoring. Furthermore, it may be possible to measure these indicators over projects with short durations, as they measure project actions or milestones.

Although response indicators may be more easily assessed than abundance measurements, they do not necessarily measure direct changes in biodiversity, therefore, impacts of ICF/ODA funding on biodiversity may not be fully represented if these methods are applied. It is recommended that projects consider a range of methods based on what is feasible at a project level to ensure coverage of potential knowledge gaps. Protected area response measures were also considered in the review, should projects clearly relate to protection measures. However, links between NbS projects and protected areas were found to be limited, the time taken for formal designation of protected areas may exceed project duration, and the concepts underpinning definitions of important biodiversity areas which merit protection may be subjective. Other indicators considered for the species theme from a included the Species Habitat Index and the IUCN Species Threat Abatement and Restoration (STAR) metric; both of which were not considered currently applicable to marine ecosystems. There may be potential for IUCN STAR to align with marine assessments in the future, should species on the IUCN Red List Index be expanded and become more representative of marine species. If so, the '[Improvement in status of threatened species as a result of funding'](#) indicator could be used to assess the contribution of ICF funding towards improving the conservation status of threatened species. However, further review would be required to understand its applicability to marine species assessments.

In summary, given the difficulties of identifying an indicator species and the aforementioned limitations, a possible recommendation could be to consider methods associated with 'Changes in Mean Trends of Species Abundance'. This approach would be similar to 'Abundance of Indicator Species'. However, an indicator species would not have to be identified, potentially enabling aggregation at a programme or portfolio level. Indirect assessments via pressure or response-based indicators could also be suitable for ODA funded projects, although, application should be informed by project-level information to ensure that selected indicators are representative of their use.

2.4 Pressures

Where pressure-receptor links are known, evaluating pressures from human activities on the marine environments and associated impacts on sensitive receptors, such as benthic habitats could be considered as a proxy for condition in situations where direct measures of environmental improvements are not possible. This could include metrics on the extent and distribution of human activities on wider areas such as fisheries activities, or the footprint at a specific location, such as coastal developments. For example, methods such as the 'Extent of Physical Damage to Predominant and Special Habitats' indicator (OSPAR, 2016), which combines sensitivity and pressure data through modelling could be employed to assess the spatial extent and level of fisheries activities on marine seafloor habitats. However, due to the complexity of pressure-receptor interactions, the applicability of indirect indicators to a given project should be assessed and informed by project-specific information to ensure representivity.

It should be noted that certain marine pressures are likely to only have relevance to specific projects, for example if a project is looking at improvements in water quality, project impacts may not necessarily be directly comparable with other locations or circumstances, even when the assessed pressures and receptors are the same. Therefore, assessments of NbS and marine pressure reduction undertaken by ODA funded projects should be informed by project-level information to ensure that the types of pressures and indicators which are selected are representative of the scope and application of the project. If assessing pressures in marine environments is a priority for a given project, then project design should be based on pressure-relevant data at appropriate spatiotemporal scales and resolutions. Information that supports marine pressure assessments can comprise pressure sources, such as fishing activity, pressure-receptors links (e.g. known impacts on fish populations), and the nature of impacts on a given receptor (e.g. organism sensitivity to a pressure).

Examples of marine NbS related indicators that assess pressure could include the Marine Trophic Index, which measures mean trophic level of fisheries landings as an indication of whether large-bodied fish are being overexploited, or sustainably managed. Such pressure indicators can facilitate and improve understanding of how anthropogenic impacts can adversely affect marine ecosystems.

Marine environmental change (e.g. fluctuations in trophic dynamics) can be influenced by a diverse range of natural and anthropogenic factors, highlighting the imperative for assessing pressures with a holistic approach, to understand influences from other drivers of change and their relationships with pressures that are being assessed. For example, pressures caused by maritime activities, including fishing may be exacerbated when coupled with large-scale environmental perturbations, such as an increase in the number and intensity of storms in low-lying coastlines driven by climate change. Therefore, differentiating between change arising from the direct impacts of an ICF ODA funded project and variation caused by ambient marine environmental conditions can be challenging, and it is recommended that such interactions are considered carefully throughout project design.

In summary, it is not possible to have a one-size-fits-all approach for ODA funded projects relating to pressure assessments and NbS in a marine context. It is recommended that assessed pressures and relevant indicators which are used are selected based on what is relevant and considered feasible at a project level.

3. Conclusion

In conclusion, to assist in the delivery of ICF aims and objectives relating to the marine environment, key recommendations and considerations have been outlined for marine indicators, grouped according to thematic areas, selected based on their relevance and contribution to impacting marine biodiversity and ecosystems. Relevant indicators and prospective proposals have been identified, which could potentially complement existing KPIs for the ICF programme portfolio. Commonality was identified throughout the indicator themes, including knowledge gaps potentially limiting indicator application and key recommendations, such as ensuring indicator selection is informed by what is relevant at a project level, or achievable within project scope. In summary, concluding remarks for each indicator theme are outlined below:

- Habitat extent indicators are likely to be particularly relevant to NbS that are predominantly focussed on coastal habitats. Where direct measurements of extent are not possible, extent could also be predicted through habitat modelling incorporating variables, such as pressure information, or variables indicative of habitat suitability.
- Habitat condition is likely to be location and ecosystem-specific, could potentially be assessed via measurements including, but not limited to, diversity indices (including phylogenetic diversity), the presence and abundance of keystone species, or habitat fragmentation or 'patchiness'. Hectares Under Ecological Restoration as a Result of Funding could be considered by projects focussing on coastal ecosystems such as coral reefs and seagrass beds to understand changes in both habitat condition and extent.
- Species-themed indicators could be applied as direct assessments, such as easily understood and communicated metrics including 'Changes in Mean Trends of Species Abundance'. Indirect assessments could be considered where relevant, such as response-based measures where direct benefits to species are identified. The Improvement in status of threatened species indicator is not currently applicable to marine species, but may have future application should the IUCN Red List be

expanded to be more representative of marine species; further assessment would be required to determine suitability for application in marine environments.

- Pressure indicators can be highly nuanced and locally specific and can be very useful where direct measurements of environmental improvements are not considered possible. Improvements or environmental change could be assessed through proxies for impacts, and they could include metrics on the extent and distribution of human activities on wider areas such as fisheries activities.

References

Gann, G. et al., 2019. International principles and standards for the practice of ecological resoration.. *Restoration Ecology,* Volume 27, pp. S1-S46.

GCRMN, 2016. *GCRMN-Caribbean Guidelines for Coral Reef Biophysical Monitoring.* [Online]
Available at: https://www.car-spaw-rac.org/IMG/pdf/gcrmn-caribbean_guidelines.unep_depi_car_wg38.inf17-en.pdf
[Accessed 26 May 2021].

JNCC, 2021a. *Biodiversity Indicator Frameworks Review Interim Report - International Climate Finance Evidence Project.,* Peterborough: JNCC.

JNCC, 2021b. *Biodiveristy Indicators Review - International Climate Finance Evidence Project.,* Peterborough: JNCC.

OSPAR, 2016. *Intermediate Assessment 2017 Resources - Extent of Physical Damage to Predominant and Special Habitats.* [Online]
Available at: https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/habitats/extent-physical-damage-predominant-and-special-habitats/
[Accessed 26 May 2021].

Specially Protected Areas Regional Activity Centre, 2017. *2017 Mediterranean Quality Status Report.* [Online]
Available at: https://www.medqsr.org/biodiversity-and-ecosystems
[Accessed 26 May 2021].

Strong, J. et al., 2018. *Potential physical loss of predicted seafloor habitats, UK Marine Online Assessment Tool.* [Online]
Available at: https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/benthic-habitats/physical-loss/
[Accessed 26 May 2021].

United Nations, 2007. *Abundance of Selected Key Species.* [Online]
Available at:
https://www.un.org/esa/sustdev/natlinfo/indicators/methodology_sheets/biodiversity/abundance_key_species.pdf
[Accessed 26 May 2021].