Appendix 2: Indicators and Data Methods

Supplementary information for the State of Natural Capital Report for England 2024

October 2024

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NATURAL ENGLAND

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Catalogue code: NERR137 Appendix 2

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Keywords

Natural capital, ecosystem services, ecosystem assets, indicators, ecosystem benefits, state of ecosystem assets

Acknowledgements

We would like to express our thanks to all those who have contributed during the development of this work.

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Environment Agency

Jo Bayes, Vicky Beaumont-Brown, Susan Burton, Chris Cooper, Rachel Gibson, Catriona Hare, Alice Hiley, Owen Lewis, Glenn Maas, Jenny Marshall-Reed, Jonathan Ponting, Toni Scarr, Joanna Spink, Mike Summers, Nicola Terrett and Jenny Yarr.

Forest Research

Elena Vanguelova.

Joint Nature Conservation Committee (JNCC)

Roma Banga.

UKCEH

Lindsay Maskell, Lisa Norton, Ed Rowe, Kasia Sawicka and David Vowles.

With special thanks to

Alice Lord.

The team also acknowledges the contributions made by the following external contractors: Environment Systems and Natural Capital Solutions.

Citation

This appendix should be cited as:

Bell, F., Craven, J., 2024. State of Natural Capital Report for England 2024 Appendix 2: Indicators and Data Methods. NERR137 Appendix 2. Natural England.

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1 Introduction

Natural England's State of Natural Capital report for England 2024 (SONC) (Lusardi and others, 2024b) describes the state of England's ecosystem assets using indicators from the *Natural Capital Indicators: for defining and measuring change in natural capital* report (Lusardi and others, 2018) and the best public, national data currently available.

This appendix sets out the methods used for the indicators presented in the State of Assets Technical Report (Lusardi and others, 2024a), which underpins the SONC Report (Lusardi and others, 2024b). Details of the indicators and data used can be found in Appendix 1: Indicators and Data (Craven, Bell & Dobson, 2024).

The SONC Report assesses the state of eight ecosystem assets, aligning with the UK National Ecosystem Assessment (2011). The SONC Report considers marine and coastal margins together as they function as a system driven by natural processes.

SONC Report ecosystem assets:

- Marine and coastal margins
- Freshwaters and wetlands
- Woodlands
- Mountains, moorlands and heaths
- Semi-natural grasslands
- Enclosed farmland
- Urban (including other ecosystems present within urban built-up areas)

Box 1 Definitions of terms, as used in this appendix:

Natural capital: In a natural capital framework, nature is treated as a stock of assets that provides benefits to people. These benefits are wide-ranging and essential for a thriving society and economy. When we talk about England's natural capital, we mean the stock of nature that provides these essential benefits.

Indicator: a non-quantitative measure of a key environmental characteristic that tells us about the state of the ecosystem assets and their ability to provide benefits to people. Indicators should be transparent, relevant, meaningful, knowable, actionable, and scalable.

Metric: a quantitative measure of an indicator, including the units used.

Ecosystem assets: Natural capital assets are the parts of nature we want to protect and grow. In this report we focus on ecosystems as our assets because this is where the living and non-living parts of nature interact as a system. In order for natural capital to provide the benefits society depends on, ecosystems need to be in good working order.

Benefits: Our stock of assets, in good condition, provide multiple benefits to society and individuals. They are essential and include things such as food, clean air and water, the reduction of flood risk and our mental and physical health.

Box 2 Acronyms used in this appendix:

SONC	State of Natural Capital [report]
NCEA	Natural Capital and Ecosystem Assessment – a programme set up to collect data on the extent, condition and change in ecosystems
EES	England Ecosystem Survey – a programme of survey under the NCEA programme
ONS	Office for National Statistics
PRoW	Public Rights of Way
SSSI	Site of Special Scientific Interest
GIS	Geographic Information Software
CICES	Common International Classification of Ecosystem Services
UKNEA	UK National Ecosystem Assessment

2 Selecting indicators, data and metrics

2.1 Selecting indicators

Indicators for the quantity, quality and location of ecosystem assets were selected from the *Natural Capital Indicators: for defining and measuring change in natural capital* report (Lusardi and others, 2018). As the focus of the SONC Report is on the state of the assets, indicators for ecosystem service flows were omitted. Only indicators that could be reported for specific ecosystem assets were included. Consequently, those that are not ecosystem-specific, such as the condition of geological features and sites, were excluded.

Indicators were selected that were likely to show change within 5-10 years, would be meaningful and actionable for strategic-level decision-making, and where data were either already available or likely to become available in the near future.

Development of the Outcome Indicator Framework, which describes environmental change that relates to the 10 goals in the Government's *A Green Future: Our Plan to Improve the Environment* (Defra, 2018) has been progressing at the same time as development of the SONC Report. Wherever appropriate we have aligned with these indicators as they reflect best current evidence. However, many are still in development and so may change in the future.

Published metrics have been used wherever possible if they were sufficiently well-aligned to the original Natural Capital Indicators (Lusardi and others, 2018) and reflected best available evidence. This was to avoid the duplication of analysis; defaulting to partners' analysis of their own data and utilising metrics that have been quality-assured wherever possible.

Bird and butterfly indices are published in a number of places. For the SONC Report we used figures from the Outcome Indicator Framework for the 25 Year Environment Plan (Defra, 2018) where they were available, then drew on the England biodiversity indicators - GOV.UK (www.gov.uk) for additional indices, and the Wild Bird indicators | BTO - British Trust for Ornithology for Upland Bird Indices.

2.2 Selecting data and metrics

The Natural Capital and Ecosystem Assessment (NCEA) programme has been set up to collect data on the extent, condition and change over time of England's ecosystems and natural capital. The expectation is that this data will be used for many of the indicators in future SONC reports. This first SONC Report uses Living England data (a satellite-derived habitat map, developed through funding from Defra ELM (Environmental Land Management) and the NCEA programme, led by Natural England) to report the quantity of assets. Field survey data are being collected through the England Ecosystem Survey (NCEA programme), but this is not yet available. In its absence we have used Countryside Survey data (predominantly from 2007 but with some more recent data analysis) and aligned metrics as closely as possible to what we expect to come from the England Ecosystem Survey.

Workshops were held with Natural England habitat specialists to identify data sets and specific metrics for the proposed indicators. The outputs were then reviewed with partners and data owners.

2.3 Data analysis for SONC indicators

For extent indicators and for certain quality indicators, where published metrics did not already exist, we undertook data analysis for the SONC Report (for more details on methodologies see Sections 4 and 5):

- Extents by ecosystem asset (using Living England, Marine Habitats and Species Open Data and ONS built-up areas data)
- Public Rights of Way density for each ecosystem asset (using Living England, ONS built-up areas and Public Rights of Way data)
- Scheduled Monuments and Protected Wrecks on the Heritage at Risk Register by ecosystem asset (using Living England, Marine Habitats and Species Open Data, Office for National Statistics (ONS) built-up areas, Scheduled Monuments and Heritage at Risk data)

We also undertook simple analysis of existing data sets or published figures for the following indicators (see Section 5):

- Visits to ecosystems (People and Nature Survey data)
- Area of Local Nature Reserves per 1000 people (Local Sites and ONS Census data)
- Sites of Scientific Interest (SSSI) feature condition (Designated Sites data)
- Woodland condition (National Forest Inventory data)
- Saltmarsh zonation (Saltmarsh Extent and Zonation data)

In other cases, partners either shared analysis of their data that they had previously undertaken for other purposes, or conducted bespoke analysis to produce metrics for the SONC Report (see Section 5):

- Analysis of soil invertebrates, pond condition and *Sphagna* moss coverage from Countryside Survey data (UK Centre for Ecology and Hydrology)
- Analysis for interim Outcome Indicator Framework D1 indicator (UK Centre for Ecology and Hydrology)
- Analysis of BioSoils data for woodland soils (Forest Research)
- Modification status and reasons for not achieving good ecological/chemical status by waterbody type (Environment Agency)

2.4 Linking indicators to benefits

The SONC Report links the state of assets (as described by the asset indicators) to the provision of benefits to people. The significance of asset indicators for particular benefits from nature are based on the links between the indicators and the benefits ('ecosystem services') established in the Natural Capital Indicators (Lusardi and others, 2018). These have been updated based on the expert judgment of Natural England's specialists. They reflect the specific indicators and metrics used in the SONC Report and are categorised as primary/major (P), secondary/minor (S) or negative (N) (detrimental to condition) to reflect the importance of each as an indicator for the benefits provided.

The benefit categories are based on the Common International Classification of Ecosystem Services (CICES v. 5.2), to ensure consistency with Office for National Statistics, Scotland's Natural Capital Asset Index and international approaches. The key benefits from nature on which to focus, were based on those identified for ecosystems in the UK National Ecosystem Assessment (2011). (See Section 8 for further information on the alignment of benefit categories with CICES.)

The links between the indicators and the benefits provided by nature are presented in the 'Asset indicators' tab of the Indicators and Data Appendix.

3 Presentation of indicators, metrics and data sources

The indicators, metrics, values, data sources and associated information for all indicators in the SONC Report can be found within the Indicators and Data Appendix. Indicator numbers refer to the numbering (Indicator ID) in the Indicators and Data Appendix.

3.1 Indicators

Indicators, metrics and values are presented in the ‘Asset indicators’ tab of the Indicators and Data Appendix.

Each indicator has an associated ‘source’ and ‘dataset ID’ listed. The source refers to the report, framework or publication that the value was cited from (e.g. the Outcome Indicator Framework for the 25 Year Environment Plan (Defra, 2018)), or bespoke analysis where this had been undertaken. The dataset ID refers to identifying number(s) of the underlying data groupings, a key for which can be found in the Datasets tab.

The dataset ID relates to the datasets in the ‘Datasets’ tab; where possible datasets have been disaggregated to underlying indicator metrics. Where metrics use a combination of datasets they are linked to multiple dataset IDs.

The ‘source’ and ‘datasets’ are listed separately for transparency to allow readers to find the metric values where published and explore the underlying data as needed.

Indicator-specific comments or caveats are presented in the ‘Indicator comment(s)’ column of the Asset indicators tab.

The links between the indicators and the benefits provided by the ecosystem assets are shown in the Asset indicators tab, along with the level of risk to the benefits and relevant policy targets (see the SONC Report and the Natural Capital Risk Register (the Risk Register) (Morgan & Lusardi, 2024) for more information).

Any additional supporting information is captured in the ‘Supporting information’ tab of the Indicators and Data Appendix.

3.2 Datasets

All datasets which form the basis for the indicator values in the 'Asset Indicators' tab are listed in the 'Datasets' tab of the Indicators and Data Appendix. Each dataset has the following metadata (Table 1) recorded within the datasets tab:

Table 1 – Dataset metadata categories

Publisher	The organisation hosting/publishing this data
Latest Update	When the dataset was last uploaded/shared
Latest Data	When the most recent data were collected
Frequency of Updates	How often the data are updated
Link	Where users can view the data (if available online)
Description	A brief summary of the dataset and what it reports on
Methodology	A description of what data are collected and with what techniques
Caveats	Context and further information on the data (and associated metrics) including relevant limitations

All data were accessed between October 2022 and March 2024.

3.3 Trends and targets

Where possible, indicators were linked to targets from existing policies and strategies, and an assessment of whether these targets were being met was undertaken. Targets were drawn from sources including the Environmental Improvement Plan, UK Marine Strategy, and 25 Year Environment Plan (Defra, 2018). Table 2 outlines the categories and criteria used for the target assessment, adapted from the risk register scoring matrix in Mace and others (2015).

Table 2 - Categories and criteria used for the target assessment

Performance category	Criteria for assignment
Met/Exceeded	Assigned if the metric value meets the target value exactly or is above it
Below	Misses the target by up to 50%
Substantially below	Misses the target by over 50%
No applicable target	No relevant policy or target could be found

Trends were assessed to understand changes to the extent and condition of ecosystems since the UKNEA was published in 2011. However, not all the indicator data identified went back this far. In other cases, due to the nature of the indicator (e.g., a long-term indicator) or the need to use more data points for a robust assessment of change, trends were assessed over longer periods of time. Table 3 provides the criteria for the trend assessment; the most recent values were assessed against benchmark values. The date ranges over which trends were assessed are included in the Indicators and Data Appendix of the SONC Report.

Table 3 - Trend assessment criteria

Performance category	Criteria for assignment
Significantly positive	Assigned if the metric value is >50% of the benchmark value
Positive	Up to 50% over the benchmark value
No change	The value for the metric is the same as benchmark value
Negative	Up to 50% under the benchmark value
Significantly negative	>50% under the benchmark value
No trend ascertained	No trend could be assessed because historical data are not available

It was not possible to link all indicators used in the SONC Report to existing policy targets, and some indicators did not have enough previous data points to allow trend assessments. For the list of indicators that did have target or trend information, and additional detail (e.g., on identified policy targets, and time ranges used for trend assessments) see the Indicators and Data Appendix of the SONC Report.

4 Quantity/extent indicators developed for the SONC Report

Analysis was required to produce metrics of habitat extent across England. These were then aggregated to report extent figures for the SONC Report ecosystem assets. We undertook analysis using Living England Habitat Map (Phase IV) – data.gov.uk and Marine Habitats and Species Open Data – data.gov.uk, combined with a number of other data sets. The outputs of these analyses were then also used to report some quality indicators by ecosystem asset (see Sections 5.1 – 5.2).

In Geographic Information Software (GIS), PostGIS, and R, Living England data and the Marine Habitats and Species Open Data were combined to create a single spatial 'habitat' layer across England with no overlaps. (Where overlaps occurred, Living England data took priority – see Section 4.3). This habitat layer was then overlaid by the 2021 Built Up Areas Boundary spatial layer from the 2021 Census. Any areas within the boundary of built-up areas were categorised as being part of the 'Urban' ecosystem, while retaining their original habitat classification. This enabled reporting of ecosystems contained within the urban environment (such as Urban woodlands, and Urban freshwaters and wetlands), as distinct from all other ecosystem assets outside of urban areas (such as Mountains, moorlands and heaths, and Woodlands).

A number of other datasets were then combined with this single habitat layer in GIS to produce quality indicators for each ecosystem asset. This single data layer, which had combined terrestrial and marine habitat data, historic landmark, and public access data, was then converted into a non-spatial table from which queries could be made in PostGRES software.

A series of queries were then made of this data table, which allowed reporting of ecosystem asset extents to produce quantity indicators (see Sections 4.1 - 4.3) and reporting of a subset of quality indicators by ecosystem asset (see Sections 5.1 - 5.2).

All extent values are presented in the 'Extents' tab of the Indicators and Data Appendix, as well as in the 'Asset indicators' tab where relevant to specific indicators.

4.1 Terrestrial extents

For terrestrial ecosystem asset quantity indicators, the NCEA programme's Living England Phase 4 map (2022) was used as this was the data release available at the time of analysis. It provides an evidence-based prediction of the likely habitat in any given location based on satellite data combined with other existing datasets. This represents the first release of Living England data and there are some recognised limitations (see 'Datasets' tab of Indicators and Data Appendix, and Living England: Technical User Guide (Kilcoyne and others, 2022)). An updated release of data is expected in 2024 which will be a significant change to the methods and training data; this will be the baseline going forward and the methods from this point will be unchanged, to enable comparisons of habitat

change on the ground. This means that extent values in this first SONC Report will not be comparable with those in future SONC reports.

Living England habitat classifications were aligned with SONC Report ecosystem assets using expert judgement and checked with Natural England's habitat specialists (Table 4). For each polygon, the habitat class with the highest likelihood was selected to report on extents and for analysis of indicators of quality. Living England has an 'Unclassified' class where cloud cover has precluded data predictions; this will have an impact on extent statistics.

The 'Urban' ecosystem in the SONC Report encompassed the Living England habitat class of 'Built Up Areas and Gardens', and all areas within the ONS Built Up Areas, regardless of LE habitat class. This means the 'Urban' ecosystem asset comprises a mixture of built environment, amenity spaces and semi-natural habitats in close proximity to urban populations. The other ecosystem asset extents exclude these urban areas.

Table 4 – Living England habitat classes aligned to SONC Report ecosystem assets.

SONC Report Ecosystem Asset	Living England Habitat Classes
Coastal margins	Coastal Saltmarsh
Coastal margins	Coastal Sand Dunes
Freshwater	Water
Freshwater	Fen, marsh and swamp
Woodlands	Broadleaved, mixed and yew woodland
Woodlands	Coniferous woodland
Woodlands	Scrub
Mountains, moorlands and heath	Dwarf shrub heath
Mountains, moorlands and heath	Bracken
Mountains, moorlands and heath	Bog (NB: Including lowland and upland bogs)
Semi-natural grassland	Acid, calcareous, neutral grassland
Enclosed farmland	Improved grassland
Enclosed farmland	Arable and Horticultural
Urban	Built-up areas and gardens
Urban	Improved grassland
Urban	Arable and Horticultural
Urban	Bare Ground
Urban	Bare Sand
Urban	Broadleaved, mixed and yew woodland
Urban	Coniferous woodland
Urban	Scrub
Urban	Acid, calcareous, neutral grassland
Urban	Dwarf shrub heath
Urban	Bracken
Urban	Bog
Urban	Water
Urban	Fen, marsh and swamp
Urban	Coastal Saltmarsh
Urban	Coastal Sand Dunes
Other	Unclassified
Other	Bare Sand (outside Urban areas)
Other	Bare Ground (outside Urban areas)

4.2 Marine extents

For the marine ecosystem asset, the Marine Habitats and Species Open Data was used for indicators of asset quantity. This is a collation of marine habitat and species data collected by a range of organisations at different times.

Extent values were based on habitat sub-feature categorisations, which were aligned with SONC ecosystem asset categories using the expert judgement of Natural England's habitat specialists (Table 5).

There are known limitations for the Marine Habitats and Species Open Data datasets. For further information, please refer to the 'Datasets' tab of the Indicators and Data Appendix.

Unlike the Living England data, the Marine Habitats and Species Open Data does not have full coverage around the English coast, and our analyses and extent figures will therefore include these gaps. In the future these gaps will be filled as more data become available through the Marine Habitats and Species Open Data.

Table 5 – Marine Habitats and Species Open Data sub-feature categories aligned to SONC Report ecosystem assets

SONC Report Ecosystem Assets	Marine Habitats and Species Open Data Sub-feature Categories
Marine: Intertidal	Intertidal rock
Marine: Intertidal	Intertidal mud
Marine: Intertidal	Intertidal sand and muddy sand
Marine: Intertidal	Intertidal coarse sediment
Marine: Intertidal	Intertidal mixed sediments
Marine: Subtidal	Subtidal mud
Marine: Subtidal	Subtidal sand
Marine: Subtidal	Subtidal coarse sediment
Marine: Subtidal	Infralittoral rock
Marine: Intertidal	Intertidal biogenic reef: mussel beds
Marine: Intertidal	Intertidal biogenic reef: *Sabellaria* species
Marine: Intertidal	Intertidal seagrass beds
Marine: Subtidal	Maerl beds
Marine: Subtidal	Subtidal biogenic reefs: mussel beds
Marine: Subtidal	Subtidal biogenic reefs: *Sabellaria* species
Marine: Subtidal	Subtidal mixed sediments
Marine: Subtidal	Subtidal seagrass beds
Marine: Subtidal	Circalittoral rock
Unclassified	Unknown marine

4.3 Coastal margins extents

For the coastal margins ecosystem asset, a combination of Living England and Marine Habitats and Species Open Data was used for quantity indicators. There were spatial overlaps between these data at the intertidal range of England. Although more detailed

rule-based prioritisations were considered, it was decided that Living England habitat classifications would be prioritised in these areas of overlap for transparency and clarity.

Living England extends to the Mean High Water mark, beyond which all habitat classifications were taken from the Marine Habitats and Species Open Data at the sub-feature level.

Gaps remained at the intertidal range where there were no Living England data or Marine Habitats and Species Open Data available, which are reflected in the extent values in the SONC Report. These data gaps will be filled for future reports as more data are collected. The next iteration of Living England will again map up to the Mean High Water mark but will go beyond this where saltmarsh extends into the wider intertidal zone.

5 Quality indicators developed for the SONC Report

For a subset of indicators where a suitable metric for England was not already published, or easily simplified to produce a suitable metric, Natural England and other data owners undertook analyses of openly available datasets to produce values. The methodologies used for these indicators are described in more detail below. Several metrics were publicly available but presented in a format, or level of detail, not suitable for this report. For these indicators, the presentation of the publicly available metrics was modified.

Indicator numbers refer to the numbering in the SONC Indicators and Data Appendix.

5.1 Public Rights of Way density

For the SONC Report, Natural England calculated Public Rights of Way (PRoW) length and density for each ecosystem asset (Indicators 35, 165, 335, 426, 488).

Public Rights of Way linear access data were combined in GIS with the habitat extent layer produced by Natural England (see Section 4 for further detail). This process included splitting intersecting polygons into new, smaller polygons to remove any overlaps and ‘flatten’ the data layer. This data layer was then converted into a non-spatial data table, which could be used to report the Public Rights of Way data by ecosystem asset.

PRoW density was produced by taking the total length of routes across England within each ecosystem asset (from Living England), and dividing by the total area of that respective ecosystem asset.

There are known data gaps from a number of Highway Authorities, resulting in an absence of any PRoW data in those areas, which could result in underestimates of PRoW density. Please refer to the ‘Datasets’ tab in the SONC Indicators and Data Appendix for further information.

To understand the scale of the missing data, we estimated the percentage of England's area where there is not yet data available using the Green Infrastructure Public Rights of Way (PRoW) density map (Green Infrastructure Map (naturalengland.org.uk)). The total area of gaps in the PRoW density map was estimated using GIS, and this value was divided by the total area of PRoW density coverage. Approximately 2.5% of England is lacking data on PRoW. However, this indicator is only used for non-urban areas; the gaps only represent approximately 1.5% of the area when the Urban ecosystem areas are excluded.

5.2 Scheduled Monuments and Protected Wrecks on the Heritage at Risk Register

For the SONC Report, Natural England calculated the percentage area of Scheduled Monuments and Protected Wrecks on the Heritage at Risk Register (Indicators 36, 166, 279, 338, 430, 489) for each ecosystem asset.

Scheduled Monuments and Protected Wrecks areas, and Heritage at Risk areas were then combined in GIS with the habitat extent layer produced by Natural England (see Section 4 for further detail). This process included splitting intersecting polygons into new, smaller polygons to remove any overlaps and 'flatten' the data layer. This data layer was then converted into a non-spatial data table, which could be used to report the Scheduled Monuments, Protected Wrecks and Heritage at Risk data by ecosystem asset.

The total area of Scheduled Monuments and Protected Wrecks was produced by summing the area of polygons from the Scheduled Monuments and Protected Wrecks datasets within each ecosystem asset according to the habitat extent layer (see Section 4).

The area of Scheduled Monuments and Protected Wrecks on the Heritage at Risk register was produced by totalling the area of Scheduled Monument and Protected Wrecks polygons which were also within Heritage at Risk polygons, within each ecosystem asset.

The percentage of Scheduled Monuments and Protected Wrecks on the Heritage at Risk register was calculated by summing the area of Scheduled Monuments and Protected Wrecks also on the Heritage at Risk Register within each ecosystem asset, and dividing by the total area of Scheduled Monuments and Protected Wrecks in the respective ecosystem assets.

At the time of this analysis, bare sand was included within the Marine and Coastal Margins ecosystem asset. It subsequently became clear that much of Living England's bare sand category is not coastal. For this report we have therefore not reported the percentage of Scheduled Monuments and Protected Wrecks on the Heritage at Risk register as the values were inaccurate. Consequently, for future SONC reports bare sand will not be included within the Marine and Coastal Margins ecosystem asset.

5.3 Countryside Survey metrics

Future SONC reports will draw on data from the NCEA programme's ongoing England Ecosystem Survey for many of the quality indicators. However, as the five-year baseline data are currently being collected and therefore not available for inclusion in this first SONC Report, interim metrics have drawn from analogous Countryside Survey data, predominantly from the 2007 survey.

Most indicator metrics drawing on Countryside Survey data were taken from open reports published in 2007 (UK Centre for Ecology & Hydrology, 2007a; UK Centre for Ecology & Hydrology, 2007b), while a subset were produced through unpublished analysis conducted by the UK Centre for Ecology and Hydrology and Natural England. These indicators and metrics are as follows:

5.3.1 Topsoil invertebrates

Values for topsoil invertebrates (mean no. taxa/sample - Indicators 308.1 and 463.1) were produced by the UK Centre for Ecology and Hydrology for the Enclosed farmland and Semi-natural grasslands ecosystem assets. They are the mean average of the number of taxa recorded per soil sample collected in the field from areas of acid grassland and neutral grassland (for Semi-natural grasslands), and improved grassland and arable and horticulture (for Enclosed farmland).

5.3.2 *Sphagna* moss coverage in bog

The value for *Sphagna* moss coverage in bog (mean % - Indicator 148.1) was produced by the UK Centre for Ecology and Hydrology for the Mountains, moorlands and heaths ecosystem asset. It is the mean average of the percentage cover of *Sphagna* moss species per vegetation sample surveyed in the field in areas of bog.

5.3.3 Pond ecological quality

For pond ecological quality (% good - Indicator 394.1) the UK Centre for Ecology and Hydrology provided the raw Predictive System for Multimetrics (PSYM) scores from the ponds surveyed in the 2007 Freshwater Pond Survey. The number of ponds in each condition category were then converted to a percentage of the total number of ponds surveyed.

5.4 Woodland soil metrics

Quality indicators on soil carbon density and bulk density within woodlands (Indicators 10.1 and 12.1) were produced by Forest Research, derived from BioSoils data. Soil samples were taken from randomly selected plots between 2005 and 2009 within woodlands across England, and the values reported in this SONC Report reflect topsoil

measurements (0-15cm depths), and are grouped by three main soil types; mineral, organic and organo-mineral.

5.5 Hydrology metrics for Freshwaters and Coastal margins

The Environment Agency provided figures for the number of waterbodies at each modification status (Natural/Heavily modified/artificial – Indicators 384.1 and 385.1) and impacted by physical modifications (Indicators 557.1 and 558.1), broken down into waterbody type which Natural England then converted to a percentage.

5.6 Local Nature Reserve provision

The Local Nature Reserve provision (ha per 1000 people – Indicator 84.1) was calculated by Natural England using the area of Local Nature Reserves in England (43067 ha from Natural England's Designated Sites View (naturalengland.org.uk) and the population of England (56,490,048) from the Population and household estimates, England and Wales: Census 2021 (Office for National Statistics, 2022).

5.7 Saltmarsh zonation

Saltmarsh zone extent (ha and % - Indicator 247.1) was calculated by Natural England using the Environment Agency's Saltmarsh Extent and Zonation dataset (Saltmarsh Extent & Zonation - data.gov.uk). An R script was created to import the saltmarsh zonation shapefile and calculate the area and percentage of each zone ('Pioneer', 'Spartina', 'Mid-low', 'Upper Marsh', 'Reedbeds' and 'Unclassified').

The saltmarsh zonation shapefile reports two columns: 'classif' (hereafter 'main classification') which reports the description of the saltmarsh zone, and 'alt_class' ('alternative classification') which reports the alternative zone (if present). For the metric reported in Indicator 247.1, the main classification was used for clarity, but we found that the main and alternative classifications differed for a total of 4485 ha, or approximately 13% of the total saltmarsh area within the dataset.

5.8 Interim indicators from Outcome Indicator Framework D1

In the SONC Report we have included a suite of metrics which are currently under development by UK Centre for Ecology and Hydrology and Natural England for the Outcome Indicator Framework D1 indicator: Quantity, quality and connectivity of habitats (Outcome Indicator Framework for the 25 Year Environment Plan (defra.gov.uk)). As such, these metrics are subject to further change as analysis and data collation progresses. It should also be noted that the figures presented in the SONC Report have been calculated specifically for this report and only represent sub-components of the D1 indicator due to be released. The metrics are as follows:

5.8.1 Plant indicators

- Positive plant indicators (mean no. of species)
- Negative plant indicators (mean % cover)
- Non-native species (mean % cover)

The provisional D1 values are calculated from available datasets. Primarily data were obtained from Countryside Survey (1990-2022), however, not all habitats are sampled sufficiently by this survey so in some cases alternative sources of data have been used. For sand dunes, vegetation plot data from sand dune surveys collated by UK Centre for Ecology and Hydrology were used. Additional data on invasive species came from the Environment Agency's Sand Dune Habitat Map (Environment Agency, 2023). Results have been calculated from vegetation plots recorded in Countryside Survey and analysed using a linear mixed effects model to account for the hierarchical nesting of different plots within a 1km square, with year as an explanatory variable. Results for coastal sand dune habitats were created by calculating means and standard deviations from available plot data (amalgamating data from different time periods to create a current estimate).

Positive and negative indicators were derived from Common Standards Monitoring guidance, collated by the Botanical Society of Britain & Ireland to create a list of plants indicative of habitats of high conservation value. UK Centre for Ecology and Hydrology then consulted with NE habitat specialists and updated the list to reflect updated understanding, to be tailored to England and to include habitats not covered by Common Standards Monitoring e.g. semi-improved and improved neutral grassland. Native status from PlantAtt (Hill, Preston & Roy, 2004) was used to derive the cover of non-native species.

Provisional benchmark thresholds were proposed based on a review of Common Standards Monitoring guidance, Biodiversity Net Gain and the wider scientific literature and then reviewed by Natural England's habitat specialists.

5.8.2 Pond number and density

- Pond density (number of ponds/km^2)
- Pond number (estimated total)

UK Centre for Ecology and Hydrology produced a national estimate of the number of ponds from data collected during the 2007 Countryside Survey.

5.9 SSSI Condition

From April 2023 Natural England has begun moving from unit scale assessment of SSSIs, to whole feature assessment: assessing condition at the scale of notified features. As the whole feature assessment approach is new there are still a significant number of feature assessments remaining to be done; the SONC Report includes only those whole feature

assessments done as of November 2023. Only features which clearly align to SONC Report ecosystem assets have been included (Table 6).

The values for SSSI feature condition have been obtained from the publicly available Designated Sites data (Designated Sites View (naturalengland.org.uk). A 'Feature group condition overall summary' report was generated in November 2023, which reported the number of features within each condition category. Features were aligned with SONC Report ecosystem assets, and the numbers of features in each condition category were converted into percentages for features and combined for ecosystem assets where applicable.

Table 6 – SSSI features aligned to SONC Report ecosystem assets

Feature List	SONC Report Categories
Bogs habitat	Mountains, moorlands and heaths
Lowland heathland habitat	Mountains, moorlands and heaths
Uplands habitat	Mountains, moorlands and heaths
Coastlands habitat	Marine and coastal margins
Marine Intertidal & Shallow Subtidal habitat	Marine and coastal margins
Saline lagoon habitat	Marine and coastal margins
Fens habitat	Freshwaters and wetlands
Freshwater fish	Freshwaters and wetlands
Freshwater habitat	Freshwaters and wetlands
Lowland grasslands habitat	Semi-natural grasslands
Woodlands habitat	Woodlands
Bryophytes	Excluded as not linked to specific ecosystem asset
Fungi (non-lichenised)	Excluded as not linked to specific ecosystem asset
Geological	Excluded as not linked to specific ecosystem asset
Invertebrates	Excluded as not linked to specific ecosystem asset
Lichens and associated mircofungi	Excluded as not linked to specific ecosystem asset
Mammals	Excluded as not linked to specific ecosystem asset
Reptiles and amphibians	Excluded as not linked to specific ecosystem asset
Vascular plants	Excluded as not linked to specific ecosystem asset

5.10 Visitors to [ecosystem asset] in the last month

These values were taken directly from the publicly available CSV (Comma Separated Values) file output from The People and Nature Surveys for England - GOV.UK (www.gov.uk) and are the mean values of monthly percentage of People and Nature Survey respondents who had visited a given habitat in the month prior, between 2020 and 2022. The People and Nature Survey categories were aligned with SONC Report ecosystem assets for reporting purposes (Table 7).

Table 7 – People and Nature Survey categories aligned to SONC Report ecosystem assets

People and Nature Survey categories	SONC Report ecosystem asset
Urban greenspace (such as a park, field or playground)	Urban
Grounds of a historic property or country park	Not reported as not assigned to an ecosystem asset
Allotment or community garden	Urban
Woodland or forest	Woodlands
River, lake or canal	Freshwaters and wetlands
Hill, mountain or moorland	Mountains, moorlands and heaths
Beach / other coastline / sea	Marine and coastal margins
Nature / wildlife reserve	Not reported as not assigned to an ecosystem asset
Fields / farmland / countryside	Enclosed farmland
Another green- and natural-space (specify)	Not reported as not linked to specific ecosystem asset
No visits in the last month	Not reported

5.11 Woodland condition metrics

The National Forest Inventory - Forest Research has published metrics for woodland condition in terms of veteran trees, age structure, regeneration potential, pests and diseases, and invasive species within a series of CSV (Comma Separated Values) documents online. From these CSV files, we extracted the areas of woodland in England split by nativeness category, and by the respective condition categories. We then converted the total areas into percentages for each indicator of woodland condition.

6 Data gaps

We have recorded gaps in the 'Data gaps' tab of the Indicators and Data Appendix. These represent indicators from the Natural Capital Indicators (Lusardi and others, 2018) which we would have included in the SONC Report if data were available matching the requirements set out in Sections 2.1 and 2.2. Indicators where only partial elements could be represented are also included.

The relevance of these indicators to the provision of particular benefits is shown in the Indicator and Data Appendix, taken from the Natural Capital Indicators (Lusardi and others, 2018).

Future research and data capture/survey should aim to address these gaps to enable a more comprehensive picture of the state of our ecosystem assets.

For future SONC reports, England Ecosystem Survey data will be available to report indicators of quality relating to soil, woody linear features, ponds, and vegetation.

7 References

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8 Additional information – benefits from nature categories

Table 8 shows the SONC benefits from nature categories, the corresponding Common International Classification of Ecosystem Services (CICES v. 5.2 [draft]) classes (Haines-Young, 2023) and the Government 25 Year Environment Plan (YEP) ambitions (Defra, 2018). For further information, please refer to the *Natural Capital Indicators: for defining and measuring change in natural capital* report (Lusardi and others, 2018).

Table 8 - Benefits from nature aligned with CICES classes and the 25 YEP ambitions

SONC 2024 benefits from nature	CICES classes	Relevant 25 YEP ambition
Timber and other wood products	Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials)	Using resources from nature more sustainably and efficiently Mitigating and adapting to climate change
Produce from the sea	Wild animals (terrestrial and aquatic) used for nutritional purposes Wild plants (terrestrial and aquatic, including fungi, algae) used for nutrition	Using resources from nature more sustainably and efficiently
Aquaculture	Plants cultivated by in- situ aquaculture grown for nutritional purposes Plants cultivated for fibres and other materials by in-situ aquaculture for direct use or processing (excluding genetic materials) Plants cultivated by in- situ aquaculture grown as an energy source Animals reared by in-situ aquaculture for nutritional purposes Fibres and other materials from animals grown by in-situ aquaculture for direct use or processing (excluding genetic materials) Animals reared by in-situ aquaculture as an energy source	
Plant-based energy	Cultivated plants (including fungi, algae) grown as a source of energy	Mitigating and adapting to climate change
Cultivated crops	Cultivated terrestrial plants (including fungi, algae) grown for nutritional purposes	

SONC 2024 benefits from nature	CICES classes	Relevant 25 YEP ambition
Plentiful water	Surface water for drinking Surface water used as a material (non-drinking purposes) Ground (and subsurface) water for drinking Ground (and subsurface) water used as a material (non-drinking purposes) Freshwater surface water used as an energy source Coastal and marine water used as energy source Ground water (and subsurface) used as an energy source; regulation of heating and cooling	Clean and plentiful water
Reared animals (and outputs)	Animals reared for nutritional purposes	
Clean water	Regulation of the chemical condition of freshwaters by living processes Regulation of the chemical condition of salt waters by living processes Bio-remediation by micro-organisms, algae, plants, and animals Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals Dilution or transport of wastes by freshwater and marine ecosystems	Clean and plentiful water
Clean air	Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	Clean air
Noise regulation	Noise attenuation	A reduced risk of harm from environmental hazards such as flooding and drought
Urban cooling	Regulation of temperature and humidity, including ventilation and transpiration at local scales	A reduced risk of harm from environmental hazards such as flooding and drought Mitigating and adapting to climate change

SONC 2024 benefits from nature	CICES classes	Relevant 25 YEP ambition
Erosion control	Buffering and attenuation of mass movement Control of water erosion rates Control of wind erosion rates	A reduced risk of harm from environmental hazards such as flooding and drought
Flood protection	Regulation runoff and base flows Regulation of peak flows Flood and storm surge mitigation	A reduced risk of harm from environmental hazards such as flooding and drought
Pollination	Pollination (or 'gamete' dispersal in a marine context)	Thriving plants and wildlife
Thriving plants and wildlife	Maintaining or regulating nursery populations and habitats or breeding grounds (Includes gene pool protection) Maintaining or regulating refuge habitats Maintaining or regulating feeding grounds	Thriving plants and wildlife
Pest and disease control	Pest control (including invasive species) Disease control	Enhancing Biosecurity
Climate regulation	Regulation of chemical composition of atmosphere and oceans, including maintaining rainfall patterns through evapotranspiration at the sub-continental scale	Mitigating and adapting to climate change
Cultural benefits	All services within the Cultural (Biotic) section of CICES v5.2	Enhanced beauty, heritage and engagement with the natural environment

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