Natural England Evidence Information Note EIN040

Natural Capital Indicators: Annex 1 Detailed logic chains

This Evidence Information Note contains all of the completed logic chains, used to identify the Natural Capital Indicators, for provisioning, regulating and cultural services for all eight broad habitats.

Indicators were only identified where they could be practically used to inform management action. For example, climate affects the provision of ecosystem services but indicators were not identified for climate, as it was not considered to be actionable, that is, not directly affected by management interventions. Indicators were also not identified by this project for management interventions, drivers of change, or individual perceptions, motivations and experiences in the case of cultural services.

From the eight broad habitat templates, the bespoke detailed logic chains were developed by adding-in attributes specific to a service and broad habitat, such as location, ecosystem service flow and benefits. Any attribute that was completely irrelevant to a particular logic chain was removed.

To identify the key indicators, two workshops were run, one with Natural England and one with Environment Agency specialists. A further Natural England workshop was run for cultural services. In total fifty nine Natural England and twenty nine Environment Agency staff contributed to the project, with specialisms that included habitats, ecology, species, geomorphology, geology, water quality, flood regulation, fisheries, climate change, air quality, landscape, access and engagement, green infrastructure, historic environment, natural capital, social science, economics and data management.

In the workshops, specialists used their expert opinion to highlight on the detailed logic chains, those attributes which they considered to be key indicators for measuring change in natural capital. They also deleted any further attributes that were considered to be irrelevant for a specific logic chain. If an attribute was considered to be relevant but not a key attribute, it remained on the detailed logic chain but was not highlighted. The logic chain outputs were circulated to participants and other specialists, following the workshop to seek further input.

To ensure consistency across all the logic chains, a quality assurance (QA) exercise was undertaken by two Natural England Deputy Chief Scientists. As part of the QA, short and long list key indicators were identified. A good indicator conveys information about more than just itself. As such the short list

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indicators aimed to provide a succinct but comprehensive suite, to measure across the full range of services and habitats through a limited number of indicators. Recognising that data might not be available to measure all the short list indicators, a longer list was also retained. Long list indicators were considered to be important for measuring change in natural capital but were judged to be covered by the short list indicators. Only short list indicators were identified during the QA of the cultural logic chains.

Complex natural processes underpin the provision of ecosystem services and there is a lack of full understanding of the relationship between the biotic and abiotic attributes of natural capital assets and the ecosystem services they support (Maseyk and others 2017). Smith and others (2017), building on the work of Harrison and others (2014), have undertaken a systematic literature review of the evidence for biotic and abiotic attributes of natural capital underpinning ecosystem services. The short and long list indicators, for provisioning and regulating and cultural services, have been checked against Smith and others (2017).

Natural Capital Indicators: Annex 1 Detailed Logic Chains

Contents

URBAN Noise regulation: Mediation of wastes, toxins and other nuisances by ecosystems & Biota

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent (& number/density) of:

- Semi-natural habitats
- Woodland scrub and hedge
- Urban/street trees, canopy cover
- Urban blue space: ponds, lakes, reservoirs rivers, canals, streams, SUDs and associated vegetation
- Open mosaic habitats
- Urban green space (not semi-natural)

Quality

Soil/sediment processes:

- Soil depth
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration

Vegetation:

- Vegetation cover/bare soil/concrete or tarmac
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Building integrated vegetation: including green roofs & walls
- 'Naturalness': vegetation that arises & develops through natural processes (i.e. not planted/designed).
- Vegetation management i.e. maintained or not

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Noise abatement

Quality continued:

Hydrology and geomorphology:

- Permeability of ground surface & amount of surface water run-off (including Sustainable Urban Drainage schemes)

Geology & topography:

- Geology
- Altitude, slope, aspect , land form
- Catchment characteristics

Climatic:

- Air temperature
- Sunlight/cloud cover
- Precipitation (incl. distribution, seasonality, intensity)
- Snow cover and length of snow lie
- Wind (including localised effects due to buildings)
- Drought
- Length of growing season (for vegetation)

Spatial Configuration:

- Distribution of habitats & trees in relation to buildings and transport routes

Benefit

Health benefits e.g. reduced stress, hypertension, hearing impairment; benefits to sustainable ecosystems through reduction in disturbance; reduced impacts on educational & work performance

Management Interventions

- Cutting of grassland (including frequency/absence of)
- Removal of arising
- Enhancing grassland/woodland eg planting, seed sowing
- Gardening, including for food
- Grazing – including deer and under grazing
- Woodland management, thinning/coppicing etc
- Land drainage
- Irrigation
- Land wetting
- Hedge & tree management – frequency and type
- Increase in non-permeable surfaces, including paving front gardens
- Designed/retrofit green infrastructure
- Sustainable Urban Drainage Scheme

Other drivers of change

- Demographic - increasing human population
- Climate change
- Market forces/ Commercial growth/decline
- Technological change
- New housing & transport needs
- Increased density of development
- Decline in heavy industry, dereliction
- Domestic traffic
- Public transport
- Water abstraction
- Atmospheric pollution – especially particulates & ozone
- Noise and artificial lighting
- Regulation/de-regulation
- Policy, local initiatives & targets
- Availability of funding & management for urban greenspace: public, private, lottery, charitable
- Awards/accreditation e.g. Green Flag
- Attitudes to greenspace & public health
- Recreational pressures

URBAN Air Quality: mediation of wastes, toxins and other nuisances by ecosystems & Biota/Maintenance of air quality

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent (& number/density) of:

- Semi-natural habitats
- Woodland, scrub and hedge
- Urban/street trees, canopy cover
- Urban blue space: ponds, lakes, reservoirs rivers, canals, streams, SUDs and associated vegetation
- Urban green space (not semi-natural habitats)
- Open mosaic habitats

Quality

Soil/sediment processes:

- Soil depth
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient & chemical status:

- Soil N, P, K, C, pH
- Chemical status of land/soil (not nutrients)
- Atmospheric deposition: exceedance of critical loads : particulates; ozone; N; S; pH
- Nutrient status of water bodies (e.g. P, N, C, BOD, NH_3)
- Chemical status of water bodies, not nutrients (12)

Vegetation:

- Vegetation cover/bare soil/concrete or tarmac
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Building integrated vegetation: including green roofs & walls
- 'Naturalness': vegetation that arises & develops through natural processes (i.e. not planted/designed).
- Vegetation management i.e. maintained or not
- Tree type

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Air pollutants removed by vegetation

Quality continued:

Hydrology and geomorphology:

- Permeability of ground surface & amount of surface water run-off (including Sustainable Urban Drainage schemes)
- 'Naturalness' of channel morphology & sediment processes.
- Loss of natural flood plain or its connection to river
- Water table level & aquifer function

Geology & topography:

- Geology
- Altitude, slope, aspect , land form
- Catchment characteristics

Climatic:

- Air temperature
- Sunlight/cloud cover
- Precipitation (incl. distribution, seasonality, intensity)
- Snow cover and length of snow lie
- Wind (including localised effects due to buildings)
- Drought
- Length of growing season (for vegetation)

Spatial Configuration:

- Distribution of habitats and trees in relation to buildings and transport routes

Benefit

Clean air, also underpinning health benefits and sustainable ecosystems

Management Interventions

- Cutting of grassland (including frequency/absence of)
- Removal of cuttings
- Enhancing grassland/woodland eg planting, seed sowing
- Fertiliser applications
- Gardening, including for food
- Grazing – including deer and under grazing
- Woodland creation & management, thinning/coppicing etc
- Land drainage
- Irrigation
- Land wetting
- Pesticide & herbicide use
- Hedge & tree management – frequency and type
- Increase in non-permeable surfaces, including paving front gardens
- Designed/retrofit green infrastructure
- Sustainable Urban Drainage Scheme
- Salt/de-icing roads/airports

Other drivers of change

- Demographic - increasing human population
- Climate change
- Market forces/ Commercial growth/decline
- Technological change
- New housing & transport needs
- Increased density of development
- Decline in heavy industry, dereliction
- International trade & transport
- Domestic traffic
- Public transport
- Water abstraction
- Atmospheric pollution – especially particulates & ozone
- Noise and artificial lighting
- Water pollution – including urban & road run-off, cross connections: overflows from foul to storm sewers
- Contaminated land
- Invasive non-native species
- Pests & disease
- Regulation/de-regulation
- Policy, local initiatives & targets
- Availability of funding & management for urban greenspace: public, private, lottery, charitable
- Awards/accreditation e.g. Green Flag
- Attitudes to greenspace & public health
- Recreational pressures
- Shift from burial to cremation

URBAN Global, regional and local climate regulation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent (& number/density) of:

- Green space (not semi-natural)
- Semi-natural habitats
- Woodland scrub and hedge
- Wood pasture/historic parkland & veteran trees
- Urban/street trees, canopy cover
- Urban blue space: ponds, lakes, reservoirs rivers, canals, streams, SUDs and associated vegetation
- Open mosaic habitats

Quality

Soil/sediment processes:

- Soil depth
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient & chemical status:

- Soil carbon
- Soil N, P, K, , pH
-
- Atmospheric deposition: exceedance of critical loads : particulates; ozone; N; S; pH

Vegetation:

- Vegetation cover/bare soil/concrete or tarmac
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Urban tree canopy (extent/height), age, density & health (including drought stress), species
- Building integrated vegetation: including green roofs & walls
- 'Naturalness': vegetation that arises & develops through natural processes (i.e. not planted/designed).
- Vegetation management i.e. maintained or not

Ideal indicators highlighted: short list & long list

Ecosystem Service Flow

- Local urban cooling
- Carbon sequestration by soil/vegetation and fixing of greenhouse gases

Quality continued:

Hydrology and geomorphology:

- Naturalness of water level regime

Geology & topography:

- Geology
- Altitude, slope, aspect , land form
- Catchment characteristics

Climatic:

- Air temperature
- Sunlight/cloud cover
- Precipitation (incl. distribution, seasonality, intensity)
- Snow cover and length of snow lie
- Wind (including localised effects due to buildings)
- Drought
- Length of growing season (for vegetation)
- microclimate – particularly reduced temperature from green space and street trees

Spatial Configuration:

- Position of habitats and trees to provide cooling to housing and buildings

Benefit

Equitable climate e.g. reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport disruption

Management Interventions

- Cutting of grassland (including frequency/absence of)
- Removal of arising
- Enhancing grassland/woodland eg planting, seed sowing
- Fertiliser applications
- Gardening, including for food
- Grazing – including deer and under grazing
- Woodland creation & management, thinning/coppicing etc
- Land drainage
- Irrigation
- Land wetting
- Pesticide & herbicide use
- Hedge & tree management – frequency and type
- Increase in non-permeable surfaces, including paving front gardens
- Designed/retrofit green infrastructure
- Sustainable Urban Drainage Scheme
- Salt/de-icing roads/airports

Other drivers of change

- Demographic - increasing human population
- Climate change
- Market forces/ Commercial growth/decline
- Technological change
- New housing & transport needs
- Increased density of development
- Decline in heavy industry, dereliction
- Domestic traffic
- Public transport
- Water abstraction
- Atmospheric pollution – especially particulates & ozone
- Noise and artificial lighting
- Contaminated land
- Invasive non-native species
- Pests & disease
- Regulation/de-regulation
- Policy, local initiatives & targets
- Availability of funding & management for urban greenspace: public, private, lottery, charitable
- Awards/accreditation e.g. Green Flag
- Attitudes to greenspace & public health
- Recreational pressures
- Shift from burial to cremation

URBAN Maintenance of nursery populations and habitats (and other stages of life cycles)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent (& number/density) of:

- Semi-natural habitats (including open mosaic habitats)
- Woodland scrub and hedge
- Urban/street Trees canopy cover
- Urban green space (not semi-natural habitat)
- Urban blue space: ponds, lakes, reservoirs rivers, canals, streams, SUDs and associated vegetation
- Open mosaic habitats

Quality

Soil/sediment processes:

- Soil depth
- Soil water retention
- Soil Type
- Degree of compaction

Nutrient (& chemical) status:

- Soil N, P, K, C, pH

Vegetation:

- Vegetation cover/bare soil/tarmac or concrete
- Surface roughness/microtopography
- Building integrated vegetation: including green roofs and green walls
- Vegetation structure
- Vegetation management i.e. maintained or not

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Maintenance of sustainable ecosystems and life cycle stages

Quality continued:

Hydrology and geomorphology:

- Naturalness of hydrological regime
- Amount of surface water run-off
- Sustainable Urban Drainage schemes (area, volume)

Species Composition, abundance and diversity of:

- Number of trophic levels & community composition in each level

Geology &/topography:

- Geology
- Altitude, slope, aspect , land form5

Climatic:

- Air temperature
- Sunlight/cloud cover
- Precipitation (incl. distribution, seasonality, intensity)
- Drought
- Length of growing season (for vegetation)

Spatial Configuration:

- Proximity to other habitats
- Patch size, shape and edge
- Green grids – linking urban & rural green space

Benefit

Biodiversity, in of itself, and underpinning all other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations, climate regulation

Management Interventions

- Cutting of grassland (depends on frequency of cut and when. Too often is negative, too little get succession)
- Removal of arisings
- Enhancing grassland/woodland eg planting,seed sowing
- Grazing – including deer and under grazing
- Woodland management, thinning/coppicing etc
- Land drainage
- Irrigation
- Land wetting
- Pesticide & herbicide use
- Hedge & tree management – frequency and type
- Increase in non-permeable surfaces, including paving front gardens
- Designed/retrofit green infrastructure
- Sustainable Urban Drainage Scheme

Other drivers of change

- Demographic - increasing human population
- New housing & transport needs
- Densification (related to the above the pressure to built upwards in part due to constraints of green belt)
- Recreational pressures
- Market forces/ Commercial growth/decline
- Decline in heavy industry/dereliction + wider technological change
- Climate change
- Coastal squeeze
- Transport
- Domestic traffic
- Water pollution – including urban & road run-off, cross connections: overflows from foul to storm sewers
- Regulation/de-regulation
- Policy, local initiatives & targets
- Availability of funding for urban greenspace management
- Awards/accreditation e.g. Green Flag
- Pests & disease
- Water abstraction
- Contaminated land

WOODLAND Plant-based energy

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (PH = Priority Habitat)

- Coniferous woodland
- Broadleaved, mixed & yew woodland
- Individual trees

Quality

Soil/sediment processes:

- Soil depth
- Soil bacteria
- Soil mycorrhizal associations
- Soil moisture
- Soil type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads S, N, ozone

Vegetation:

- Age structure (including veteran trees)
- Canopy – density and species composition
- Understorey - density and species composition
- Shadiness
- Regeneration of tree species
- Plant growth rate
- Biomass
- Deadwood – including standing
- Tree health

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Wood-based fuel harvested

Quality continued:

Hydrology & geomorphology:

- Water table level (esp. for wetlands)
- Amount of surface water run-off/overland flow

Species Composition:

- Invasive non-native species (absence of)
- Pest species (e.g. absence of grey squirrel)

Geology, geomorphology &/topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: accessibility of woodland for planting and harvesting.

Benefit

- Energy from wood

Management Interventions

- Afforestation (conifer plantations)
- Woodland creation (broadleaved)
- Harvesting practices – felling, thinning, selective felling, size of coupes
- Coppicing & pollarding (including abandonment of)
- Grazing/browsing by wild herbivores: especially deer (also grey squirrel, rabbit etc)
- Deer management
- Pesticide & herbicide use
- Energy crops: e.g. short rotation coppice
- Past management decisions
- Aging of plantation tree stock (affecting management decisions)

Other drivers of change

- Climate change
- Pollution – especially atmospheric
- Regulation
- Policies (afforestation, biodiversity, agricultural) including impacts of past policies
- Woodland & agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Invasive non-native species
- Pests and diseases
- Changes in woodland ownership (private/public)
- Technological advances (e.g in management practices)

WOODLAND Air Quality: Mediation of wastes, toxins and other nuisances by ecosystems & Biota

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Coniferous woodland
- Broadleaved, mixed & yew woodland
- Individual trees/ veteran trees

Quality

Soil/sediment processes:

- Soil depth
- Soil bacteria
- Soil mycorrhizal associations
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil N, P, C, pH
- Atmospheric deposition: exceedance of critical loads S, N, ozone

Vegetation:

- Age structure (including veteran trees)
- Canopy – density and species composition
- Leaf surface area and duration across year
- Understorey - density and species composition
- Shadiness
- Structural diversity
- Cover/bare soil
- Surface roughness/microtopography
- Tree health

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Air pollutants removed by vegetation

Quality continued:

Hydrology & geomorphology:

Species Composition:

- Naturalness of biological assemblage: number of trophic levels and species composition within levels

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: distribution, connectivity & fragmentation of woodland and interaction with other habitats

- Distribution of woodland in relation to settlements.

Benefit

- Clean air, also underpinning health benefits and sustainable ecosystems

Management Interventions

- Afforestation (conifer plantations)
- Woodland creation (broadleaved)
- Grazing/browsing by livestock: especially sheep
- Grazing/browsing by wild herbivores: especially deer (also grey squirrel, rabbit etc)
- Deer management
- Other game management
- Pesticide & herbicide use
- Energy crops: e.g. short rotation coppice

Other drivers of change

- Climate change
- Pollution – especially atmospheric
- Policies (afforestation, biodiversity, agricultural) including impacts of past policies
- Woodland & agri-environment schemes/cross compliance/changes in subsidy payments
- Recreational pressures & facilities
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Technological advances (e.g in management practices)

WOODLAND Global, regional and local climate regulation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (PH = Priority Habitat)

- Coniferous woodland
- Broadleaved, mixed & yew woodland
  - Woodland Priority Habitats
- Individual trees/ veteran trees

Quality

Soil/sediment processes:

- Soil depth
- Soil bacteria
- Soil carbon/organic matter
- Soil mycorrhizal associations
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads S, N, ozone

Vegetation:

- Age structure (including veteran trees) and regeneration
- Structural diversity
- Vegetation cover/bare soil
- Plant growth rate
- Above & below ground biomass
- Surface roughness/microtopography
- Deadwood – including standing
- Tree health

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Carbon sequestration by soil/vegetation and fixing of greenhouse gases

Quality continued:

Hydrology and geomorphology:

- Loss of natural flood plain or its connection to river
- Water table level (esp. for wetlands)

Species Composition:

- Lichen
- Fungi
- Bird populations: breeding; wintering; passage

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

Not relevant for this service

Benefit

Equitable climate e.g. reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport disruption

Management Interventions

- Afforestation (conifer plantations)
- Woodland creation (broadleaved)
- Harvesting practices – felling, thinning, selective felling, size of coupes
- Coppicing & pollarding (including abandonment of)
- Grazing/browsing by livestock: especially sheep
- Grazing/browsing by wild herbivores: especially deer (also grey squirrel, rabbit etc)
- Deer management
- Pesticide & herbicide use
- Energy crops: e.g. short rotation coppice
- Past management decisions
- Aging of plantation tree stock (affecting management decisions)

Other drivers of change

- Climate change
- Pollution – especially atmospheric
- Regulation
- Policies (afforestation, biodiversity, agricultural) including impacts of past policies
- Woodland & agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Pests and diseases
- Technological advances (e.g in management practices)

WOODLAND Maintenance of nursery populations and habitats (and other stages of life cycles)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of;

- Coniferous woodland
- Broadleaved, mixed & yew woodland
- Woodland Priority Habitats
- Individual trees/ veteran trees

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil mycorrhizal associations
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil N, P, C, pH
- Atmospheric deposition: exceedance of critical loads S, N, ozone

Vegetation:

- Age structure (including veteran trees) and regeneration
- Canopy – density and species composition
- Understorey - density and species composition
- Shadiness
- Regeneration of tree species
- Structural diversity
- Vegetation cover/bare soil
- Plant growth rate
- Above & below ground biomass
- Surface roughness/microtopography
- Deadwood – including standing
- Tree health

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Maintenance of sustainable ecosystems/life cycle stages

Quality continued:

Hydrology and geomorphology:

- Lack of physical modification (for wet woodland)
- Naturalness of flooding regime
- Water table level (esp. for wetlands)
- Amount of surface water run-off/overland flow

Species Composition:

- Naturalness of biological assemblage: number of trophic levels and species composition within levels
- Invasive non-native species

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Connectivity for small woodlands
- Patch size, shape and edge

Benefit

Biodiversity, in of itself, and underpinning all other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations, climate regulation

Management Interventions

- Afforestation (conifer plantations)
- Woodland creation (broadleaved)
- Harvesting practices – felling, thinning, selective felling, size of coupes
- Coppicing & pollarding (including abandonment of)
- Grazing/browsing by livestock: especially sheep
- Grazing/browsing by wild herbivores: especially deer (also grey squirrel, rabbit etc)
- Deer management
- Other game management
- Pesticide & herbicide use
- Energy crops: e.g. short rotation coppice
- Past management decisions
- Aging of plantation tree stock (affecting management decisions)

Other drivers of change

- Climate change
- Pollution – especially atmospheric
- Regulation
- Policies (afforestation, biodiversity, agricultural) including impacts of past policies
- Woodland & agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Recreational pressures & facilities
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Invasive non-native species
- Pests and diseases
- Changes in woodland ownership (private/public)
- Technological advances (e.g in management practices)
- Renewable energy

WOODLAND Materials from plants, animals and algae for direct use or processing

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (PH = Priority Habitat)

- Coniferous woodland
- Broadleaved, mixed & yew woodland
- Individual trees/ veteran trees

Quality

Soil/sediment processes:

- Soil depth
- Soil bacteria
- Soil mycorrhizal associations
- Soil moisture
- Soil type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads S, N, ozone

Vegetation:

- Age structure (including veteran trees)
- Regeneration of tree species
- Plant growth rate
- Biomass
- Tree health

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Production of timber, paper and other wood products

Quality continued:

Hydrology & geomorphology:

- Water table level (esp. for wetlands)
- Amount of surface water run-off/overland flow

Species Composition:

- Invasive non-native species (absence of)
- Pest species (e.g. absence of grey squirrel)

Geology, geomorphology &/topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: accessibility of woodland for planting and harvesting.

Benefit

- Timber, paper and other products from wood

Management Interventions

- Afforestation (conifer plantations)
- Woodland creation (broadleaved)
- Harvesting practices – felling, thinning, selective felling, size of coupes
- Grazing/browsing by wild herbivores: especially deer (also grey squirrel, rabbit etc)
- Deer management
- Pesticide & herbicide use
- Past management decisions
- Aging of plantation tree stock (affecting management decisions)

Other drivers of change

- Climate change
- Pollution – especially atmospheric
- Regulation
- Policies (afforestation, biodiversity, agricultural) including impacts of past policies
- Woodland & agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Invasive non-native species
- Pests and diseases
- Changes in woodland ownership (private/public)
- Technological advances (e.g. in management practices)

COASTAL Mass stabilisation and control of erosion rates

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (barrier and source of sediment):

- Sand dunes
- Salt marsh
- Shingle
- Intertidal sediment (Beach and Mud flats)
- Sea cliff
- Coastal lagoons

Quality

Soil/sediment processes:

- Sediment supply/availability (including type, grain size)
- Sediment (& cliff) erosion, deposition & transportation
- Intertidal steepening
- Beach lowering
- Salt marsh vertical accretion
- Soil biota
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil nutrient status

Vegetation:

- Cover/bare soil (esp. dunes, shingle, dynamic between saltmarsh/mudflat)
- Type/composition
- Plant growth
- Surface roughness/microtopography
- Structure
- Vegetation litter
- Natural strandline – triggers formation of new dunes & saltmarsh

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Sediment stabilisation

Quality continued:

Hydrology and geomorphology:

- Water table level (esp. for dune slacks)
- Network of saltmarsh ditches/creeks
- Sediment cell characteristics
- Geomorphological processes e.g bar or dune formation

Species Composition:

- Plant diversity
- Invasive non-native species

Geology & topography:

- *Geology: structure; hardness; porosity; jointing/faulting*
- *Altitude, slope, aspect , land form*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*
- *Wave and sea level*

Spatial Configuration: distribution/connectivity and interaction of habitats

- Transition and connectivity of coastal and terrestrial habitats – coastal squeeze
- Width/area/location for dynamic movement & development of coastal habitats e.g. saltmarsh & sand dune

Benefit (note: local disbenefits may result in overall benefits for a sediment cell)

Erosion control e.g. soil/land retention, lack of transport disruption, protection of housing, businesses & infrastructure, reduced health & safety risk, reduced flood risk

Management Interventions

- Cliff protection/shore armouring, groynes
- Management of beaches, ditches & creeks
- Dredging for navigation
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land drainage and agricultural improvement
- Grazing/trampling: livestock type; intensity; cessation
- Rotational burning: scale; pattern; frequency
- Afforestation (sand dunes)
- Agricultural nutrient applications
- Renewable energy: wind
- Coastal access – including dog walking
- Physical disturbance & vehicular damage

Other drivers of change

- Climate change – esp. sea level rise, increased storms
- Land claim for development or agriculture
- Coastal development – urban, industrial & harbour, caravan parks, golf courses, holiday accommodation etc
- Pollution – toxic & nutrient enrichment
- Regulation, including WFD, habitat protection
- Policy including Shore Line Management Planning
- Offshore renewables – affecting sediment supply
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)
- Increasing human population
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases

COASTAL Global, regional and local climate regulation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Sand dunes
- Salt marsh
- Intertidal sediment (Beach and Mudflats)
- Shingle
- Sea cliff
- Coastal lagoons

Quality

Soil/sediment processes:

- Sediment supply/availability (including type, grain size)
- Sediment (& cliff) erosion, deposition & transportation
- Intertidal steepening
- Beach lowering
- Salt marsh vertical accretion
- Sediment biota - biomass
- Soil depth
- Soil bacteria
- Soil water retention
- Soil Type
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Carbon in soil/sediment
- Soil N, P, C, pH
- Nutrient status of water bodies
- Atmospheric deposition: exceedance of critical loads S, N, ozone
- Chemical status of water bodies, not nutrients

Vegetation:

- Cover/bare soil (esp. dunes, shingle, saltmarsh/mudflat)
- Type/composition
- Plant growth rate
- Surface roughness/microtopography
- Structure
- Vegetation litter
- Natural strandline – triggers formation of new dunes & saltmarsh

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list & long list

Ecosystem Service Flow

- Carbon sequestered (tonnes CO_2, per m^2 or m^3) and greenhouse gases fixed

Quality continued:

Hydrology and geomorphology:

- Salinity (lagoons)
- Turbidity (lagoons)
- Water table level (esp. for dune slacks)
- Network of saltmarsh ditches/creeks
- Sediment cell characteristics
- Geomorphological processes e.g bar or dune formation

Species Composition:

- Plant diversity
- Invasive non-native species
- Fish: populations, spawning & nursery grounds
- Bird populations: breeding; wintering; passage
- Invertebrate populations

Geology & topography:

- *Geology: structure; hardness; porosity; jointing/faulting*
- *Altitude, slope, aspect , land form*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*
- *Wave and sea level*

Spatial Configuration: distribution/connectivity and interaction of habitats

- Transition and connectivity of coastal and terrestrial habitats – coastal squeeze

Benefit

Equitable climate e.g. reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport disruption.

Management Interventions

- Cliff protection/shore armouring
- Dredging for navigation
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land drainage and agricultural improvement
- Grazing/trampling: livestock type; intensity; cessation
- Rotational burning: scale; pattern; frequency
- Afforestation (sand dunes)
- Agricultural nutrient applications
- Renewable energy: wind
- Coastal access – including dog walking
- Physical disturbance & vehicular damage

Other drivers of change

- Climate change – esp. sea level rise, increased storms
- Land claim for development or agriculture
- Coastal development – urban, industrial & harbour
- Caravan parks, golf courses, holiday accommodation etc
- Pollution – toxic & nutrient enrichment
- Regulation, including WFD, habitat protection
- Policy including Shore Line Management Planning
- Offshore renewables – affecting sediment supply
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)
- Increasing human population
- Seasonal peaks in human population e.g. with

COASTAL Flood Protection

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Sand dunes
- Salt marsh
- Intertidal Sediment (Beach and Mudflats)
- Shingle
- Sea cliff
- Coastal lagoons

Quality

Soil/sediment processes:

- Sediment supply & availability (including type, grain size)
- Sediment stabilisation
- Sediment (& cliff) erosion, deposition & transportation
- Intertidal steepening
- Beach lowering
- Salt marsh vertical accretion
- Soil biota
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil/sediment nutrient status

Vegetation:

- Cover/bare soil (esp. dunes, shingle, dynamic between saltmarsh/mudflat)
- Type/composition
- Plant growth rate
- Surface roughness/microtopography
- Structure
- Vegetation Litter
- Natural strandline – triggers formation of new dunes & saltmarsh

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Reduced inundation of terrestrial areas from marine flooding

Quality continued:

Hydrology and geomorphology:

- Water table level (esp. for dune slacks)
- Sediment cell characteristics
- Geomorphological processes e.g. bar formation
- Network of saltmarsh ditches/creeks

Species Composition:

- Number of trophic levels & community composition in each level
- Plant diversity
- Invasive non-native species
- Invertebrate populations

Geology & topography:

- *Geology: porosity; hardness; jointing/faulting; structure*
- *Altitude, slope, aspect, land form*

Climatic:

- *Precipitation (incl. distribution, seasonality, intensity)*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*
- *Wave & sea level*

Spatial Configuration:

- Width/area/location of habitats providing flood protection, for housing and infrastructure

Benefit

Reduced flood risk, affecting e.g. reduced health & safety risk, protection of housing, businesses & infrastructure, lack of transport disruption

Management Interventions

- Cliff protection/shore armouring
- Dredging for navigation
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land drainage and agricultural improvement
- Grazing/trampling: livestock type; intensity; cessation
- Rotational burning: scale; pattern; frequency
- Afforestation (sand dunes)
- Agricultural nutrient applications
- Renewable energy: wind
- Coastal access – including dog walking
- Physical disturbance & vehicular damage

Other drivers of change

- Climate change – esp. sea level rise (7, 9), increased storms
- Land claim for development or agriculture
- Coastal development – urban, industrial, harbour, caravan parks, golf courses, holiday accommodation etc
- Pollution – toxic & nutrient enrichment
- Regulation, including WFD, habitat protection
- Policy including Shore Line Management Planning (7)
- Offshore renewables – affecting sediment supply
- Recreational pressures (esp. on sand dunes)
- Atmospheric deposition (acidification, eutrophication)
- Increasing human population
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases

COASTAL Maintenance of nursery populations and habitats (and other stages of life cycles)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Sand dunes
- Salt marsh
- Intertidal Sediment (Beach and Mudflats)
- Shingle
- Sea cliff
- Coastal lagoons

Quality

Soil/sediment processes:

- Sediment supply/availability (including type, grain size)
- Sediment (& cliff) erosion, deposition & transportation
- Intertidal steepening
- Beach lowering
- Salt marsh vertical accretion
- Soil depth
- Sediment/soil biota
- Soil water retention
- Soil Type
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil/sediment nutrient status
- Nutrient status of water bodies (coastal lagoons)
- Atmospheric deposition: exceedance of critical loads S, N, ozone
- Chemical status of water bodies, not nutrients (coastal lagoons)

Vegetation:

- Cover/bare soil (esp. dunes, shingle, dynamic between saltmarsh/mudflat)
- Type/composition
- Plant growth rate
- Surface roughness/microtopography
- Structure
- Vegetation litter
- Natural strandline – triggers formation of new dunes & saltmarsh

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Maintenance of sustainable ecosystems/life cycle stages

Quality continued:

Hydrology and geomorphology:

- Salinity (lagoons)
- Turbidity (lagoons)
- Water table level (esp. for dune slacks)
- Network of saltmarsh ditches/creeks
- Sediment cell characteristics
- Geomorphological processes e.g bar or dune formation

Species Composition:

- Number of trophic levels & community composition in each level
- Plant diversity
- Invasive non-native species
- Fish: populations, spawning & nursery grounds
- Bird populations: breeding; wintering; passage
- Invertebrate populations

Geology & topography:

- *Geology: structure; hardness; porosity; jointing/faulting*
- *Altitude, slope, aspect , land form*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*
- *Wave and sea level*

Spatial Configuration: distribution/connectivity and interaction of habitats

- Transition and connectivity from subtidal to terrestrial habitats
- Width/area/location for dynamic movement & development of coastal habitats e.g. saltmarsh & sand dune

Benefit Biodiversity, in of itself, and underpinning all other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations & aquaculture, flood protection (sea grass beds, dunes), climate regulation.

Management Interventions

- Cliff protection/shore armouring
- Dredging for navigation
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land drainage and agricultural improvement
- Grazing/trampling: livestock type; intensity; cessation
- Rotational burning: scale; pattern; frequency
- Afforestation (sand dunes)
- Agricultural nutrient applications
- Renewable energy: wind
- Coastal access – including dog walking
- Physical disturbance & vehicular damage

Other drivers of change

- Climate change – esp. sea level rise, increased storms
- Land claim for development or agriculture
- Coastal development – urban, industrial & harbour
- Caravan parks, golf courses, holiday accommodation etc
- Pollution – toxic & nutrient enrichment
- Regulation, including WFD, habitat protection
- Policy including Shore Line Management Planning
- Offshore renewables – affecting sediment supply
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)
- Increasing human population
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases

CATCHMENT Water for drinking and non-drinking purposes (see also Water Quality logic chain)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

Note: all land within catchments where abstraction occurs, contributes to water supply). The following are particularly important:

Blanket bog
Woodland
Rivers
Lakes
Reservoirs
Groundwater aquifers
Other semi-natural habitats:

Quality

Soil/sediment processes:

- Soil depth
- Soil microorganisms/biota
- Soil organic matter
- Soil water retention, esp.peat/organic soils
- Soil Type
- Soil integrity including: peatland erosion; tracking; braiding
- Degree of compaction

Nutrient (& chemical) status:

- Soil N, P, C, pH
- Nutrient status of water bodies (e.g P, N, C, BOD, NH_3)
- Atmospheric deposition: exceedance of critical loads S, N
- Chemical status of water bodies, not nutrients

Vegetation:

- Aquatic macrophytes: submerged & emergent
- Cover/bare soil
- Type/composition eg root depth, transpiration, interception
- Plant growth
- Above and below ground biomass
- Surface roughness/microtopography
- Proportion of peat mass actively forming peat
- Litter, including debris dams

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Availability of water for abstraction

Quality continued:

Hydrology and geomorphology:

- Naturalness of lake hydrological regime including pathways
- Infiltration
- Evapotranspiration rate
- Lack of physical modifications
- Sedimentological regime: erosion & deposition
- Naturalness of water level regime
- Naturalness of flow regime
- Natural aquifer function: recharge & discharge
- Amount of surface water run-off/overland flow
- Extent of artificial drainage

Species Composition:

- Naturalness of biological assemblage: number of trophic levels and community composition in each level

Geology, geomorphology &/topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*
- *Aquifer type & characteristics*

Climatic

- *Air temperature*
- *Precipitation (incl.type, distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: Not specified for this service

Benefit Plentiful water e.g. water for drinking, domestic use, irrigation, livestock, industrial use including cooling, wildlife

Management Interventions

- Flow modification/ water level regulation (e.g. appropriate management of impoundment/releases)
- Control pattern/timing of abstraction, discharges etc.
- Water efficiency (e.g. metering, leakages, farm advice)
- Alternative sources of abstraction (e.g. desalination) or relocate abstraction/discharge
- Catchment water demand management (e.g. abstraction license planning/spray irrigation restriction)
- River augmentation from groundwater
- Water impoundment & diversion
- Channel straightening, reprofiling, deepening
- In-channel structures: weirs; dams etc
- Bank reinforcements/flood defence schemes
- River restoration
- Squeezing/loss of freshwater-terrestrial transitions
- Land drainage and agricultural improvement
- Soil management practices
- Grazing/trampling: livestock type; intensity; cessation
- Rotational burning: scale; pattern; frequency
- Aquaculture
- Afforestation
- Habitat creation and restoration Scrub, bracken, gorse control
- Cutting aquatic & terrestrial vegetation, removal of wood
- Renewable energy: wind; hydro

Other drivers of change

- Climate change
- Soil erosion and landslips
- Regulation, including WFD
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Peat extraction
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Urban development & infrastructure
- Increasing human population & demand for water
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases
- Water abstraction: surface & ground water
- Saline intrusion (locally important)

CATCHMENT Flood Protection

Ecosystem Assets

(Factors affecting provision of ecosystem service)
Quantity – Extent of (PH = Priority Habitat)

Active flood-plain
Woodland
Blanket bog;
Coastal & floodplain grazing marsh
Other semi-natural habitats
Extent of enclosed farmland

Quality
Soil/sediment processes:

- Soil depth
- Soil microorganisms/biota
- Soil organic matter
- Soil moisture
- Soil Type
- Soil integrity including: peatland erosion; tracking; braiding
- Degree of compaction

Nutrient (& chemical) status:

Vegetation:

- Aquatic macrophytes: submerged & emergent
- Vegetation cover/bare soil
- Type/composition eg root depth, evapo-transpiration, interception
- Plant growth
- Above and below ground biomass
- Surface roughness/microtopography/vegetation roughness
- Bryophyte cover/Sphagnum cover
- Vegetation next to water bodies
- Vegetation litter, including debris dams
- Extent & density of field boundary features

Italics shows factors not affected by management interventions
Ideal indicators highlighted: short list & long list

Ecosystem Service Flow

- Regulation of flow regime for peak events

Quality continued:
Hydrology and geomorphology:

- Lack of physical modifications
- Sedimentological regime: erosion & deposition
- Naturalness of flooding regime
- Naturalness of water level regime
- Naturalness of flow regime
- Naturalness of lake hydrological regime including pathways:
- Natural aquifer function: recharge & discharge
- Amount of surface water run-off/overland flow
- Extent of artificial drainage

Species Composition:

- Number of trophic levels & community composition in each level

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Precipitation (incl.type, distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*
- *Tides*

Spatial Configuration: NOTE this is very specific to individual catchments.

- Distribution of flood mitigating land in relation to infrastructure & settlements

Benefit

- Reduced flood risk, affecting e.g. reduced health & safety risk, protection of housing, businesses & infrastructure, lack of transport disruption

Management Interventions

- Water abstraction: surface & ground water
- Flow modification/ water level regulation
- Water impoundment & diversion
- Channel straightening, reprofiling, deepening
- In-channel structures: weirs; dams etc
- Bank reinforcements/flood defence schemes
- River restoration
- Squeezing/loss of freshwater-terrestrial transitions
- Land & soil management practices
- Land drainage and agricultural improvement
- Tilling, ploughing
- Grazing/trampling: livestock type; intensity; cessation
- Rotational burning: scale; pattern; frequency
- Aquaculture
- Afforestation
- Woodland creation
- Pond, bog and other habitat creation & restoration
- Scrub, bracken, gorse control
- Cutting aquatic & terrestrial vegetation, removal of wood
- Renewable energy: wind; hydro
- Urban SUDS

Other drivers of change

- Climate change
- Soil erosion and landslips
- Regulation, including WFD
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Peat extraction
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Urban development & infrastructure
- Pests and diseases

CATCHMENT Water Quality: Mediation of wastes, toxins & other nuisances by ecosystems & Biota/ Maintenance of chemical water quality

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Blanket bog;
- Woodland
- Other semi-natural habitats

Quality

Soil/sediment processes:

- Peat depth
- Soil biota
- Soil organic matter/carbon
- Soil water retention, esp.peat/organic soils
- Soil Type
- Soil integrity including: peatland erosion; tracking; braiding
- Degree of compaction
- Infiltration
- Depth of 'iron pan'
-

Nutrient (& chemical) status:

- Soil nutrient status
- Nutrient and chemical status of water bodies (including pH)
- Atmospheric deposition: exceedance of critical loads S, N

Vegetation:

- Aquatic macrophytes: submerged & emergent
- Phytoplankton & diatoms (lakes), phytobenthos (rivers)
- Vegetation cover/bare soil
- Type/composition eg root depth, transpiration, interception
- Plant growth
- Above and below ground biomass
- Surface/vegetation roughness/microtopography
- Proportion of peat mass actively forming peat
- Vegetation next to water bodies
- Vegetation litter, including debris dams

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Ecological and chemical (including bacterial, viral and suspended sediment) quality of freshwater

Quality continued:

Hydrology and geomorphology:

- Naturalness of lake hydrological regime including pathways
- Infiltration
- Lack of physical modifications
- Sedimentological regime : erosion & deposition
- Flood plain & its connection to river
- Naturalness of water level regime
- Naturalness of flow regime
- Natural aquifer function: recharge & discharge
- Amount of surface water run-off/overland flow
- Extent of artificial drainage

Species Composition:

- Naturalness of biological assemblage: number of trophic levels and community composition in each level

Geology & topography:

- *Bed sediment and substrate*
- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature/air pressure*
- *Water temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl.type, distribution, seasonality, intensity)*
- *Wind*
- *Drought / extreme flows*
- *Length of growing season (for vegetation)*

Spatial Configuration:

Distribution of habitats, in relation to water quality source-pathway-receptor

Benefit Clean water, also underpinning e.g. water supply, sustainable ecosystems, cultural services, health benefits.

Management Interventions

- Water abstraction: surface & ground water
- Flow modification/ water level regulation
- Water impoundment & diversion
- Channel straightening, reprofiling, deepening
- In-channel structures: weirs; dams etc
- Bank reinforcements/flood defence schemes
- River restoration
- Squeezing/loss of freshwater-terrestrial transitions
- Land drainage and agricultural improvement
- Soil management practices
- Grazing/trampling: livestock type; intensity; cessation
- Rotational burning: scale; pattern; frequency
- Aquaculture
- Afforestation or deforestation
- Habitat restoration and creation (including woodland & wetland)
- SUDS, Natural Flood Management
- Scrub, bracken, gorse control
- Cutting aquatic & terrestrial vegetation, removal of wood
- Agricultural nutrient applications and waste to land
- Pesticide use e.g. sheep dip
- Renewable energy: wind; hydro
- Minewater Treatment
- Liming waterbodies/water courses
- Fisheries management
- Air pollution control

Other drivers of change

- Climate change
- Point source pollution - sewage
- Industrial pollution
- Diffuse pollution (including from agriculture)
- New pollutants e.g. endocrine disruptors, nano particles, microplastics
- Thermal discharges
- Soil erosion and landslips
- Regulation, including WFD
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Peat extraction
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Urban development & infrastructure
- Increasing human population & demand for water
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases
- Mining activity

FRESHWATERS: OPENWATERS, WETLANDS & FLOODPLAINS Global, regional and local climate regulation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (PH = Priority Habitat)

- Rivers
- Standing waters
- Groundwaters
- Coastal and flood plain grazing marsh
- Lowland fens
- Lowland raised bogs
- Reed beds

Quality

Soil/sediment processes:

- Peat depth
- Soil microorganisms/biota
- Soil organic matter
- Soil water retention/moisture
- Soil Type
- Soil integrity esp. peatland erosion;
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil carbon/organic matter
- Soil nutrient status N, P, , pH
- Nutrient status of water bodies (P, N, C, BOD, NH_3, etc.)
- Atmospheric deposition: exceedance of critical loads S, N
- Chemical status of water bodies, not nutrients

Vegetation:

- Aquatic macrophytes: submerged & emergent
- Phytoplankton & diatoms (lakes), phytobenthos (rivers)
- Vegetation cover/bare soil
- Type/composition eg root depth, transpiration, interception
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Proportion of peat mass actively forming peat
- Riparian/hydrosere transition vegetation cover/type
- Litter, including debris dams

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Carbon sequestration by soil/vegetation and fixing of green-house gases

Quality continued:

Hydrology and geomorphology:

- Naturalness of lake hydrological regime
- Infiltration
- Lack of physical modifications
- Sedimentological regime: erosion & deposition
- Naturalness of flooding regime
- Naturalness of water level regime(esp. for wetlands)
- Water depth
- Flow regime
- Natural aquifer function: recharge & discharge
- Extent of artificial drainage
- Amount of surface water run-off/overland flow

Species Composition:

- Invasive non-native species
- Invertebrates: macro & micro
- Fish: populations, spawning & nursery grounds
- Bird populations: breeding; wintering; passage

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl.type, distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

Not relevant to this service

Benefit

Equitable climate e.g. reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport disruption

Management Interventions

- Water abstraction: surface & ground water
- Flow modification/ water level regulation
- Water impoundment & diversion
- Channel straightening, reprofiling, deepening
- In-channel structures: weirs; dams etc
- Bank reinforcements/flood defence schemes
- River restoration
- Squeezing/loss of freshwater-terrestrial transitions
- Land drainage and agricultural improvement
- Tilling, ploughing
- Grazing/trampling: livestock type; intensity; cessation
- Rotational burning: scale; pattern; frequency
- Aquaculture
- Afforestation
- Woodland creation
- Pond, bog and other habitat creation & restoration
- Scrub, bracken, gorse control
- Cutting aquatic & terrestrial vegetation, removal of wood
- Agricultural nutrient applications
- Pesticide use e.g. sheep dip
- Renewable energy: wind; hydro

Other drivers of change

- Climate change
- Point source pollution - sewage
- Industrial pollution
- Diffuse pollution (including from agriculture)
- New pollutants e.g. endocrine disruptors, nano particles
- Thermal discharges
- Soil erosion and landslips
- Regulation, including WFD
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Peat extraction
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Urban development & infrastructure
- Increasing human population & demand for water
  Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases

FRESHWATERS: OPENWATERS, WETLANDS & FLOODPLAINS Maintenance of nursery populations and habitats (and other stages of life cycles)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Rivers
- Still waters (e.g. lakes, ponds)
- Wetland: fen; bog, reedbed; grazing marsh
- Modified waters (e.g. canals, reservoirs)
- Groundwaters

Quality

Soil/sediment processes:

- Soil depth
- Soil microorganisms/biota
- Soil organic matter/carbon
- Soil water retention, esp.peat/organic soils
- Soil Type
- Soil erosion including: peatlands; tracking; braiding
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil nutrient status
- Nutrient status of water bodies (P, N, C, BOD, NH_3, etc.)
- Dissolved oxygen
- Atmospheric deposition: exceedance of critical loads S, N
- Chemical status of water bodies (not nutrients)
- Acidification: pH status of water bodies

Vegetation:

- Aquatic macrophytes: submerged & emergent
  Phytoplankton & diatoms (lakes), phytobenthos (rivers)
- Cover/bare soil
- Plant growth
- Above & below ground biomass
- Surface roughness/microtopography
- Proportion of peat mass actively forming peat
- Vegetation next to water bodies
- Vegetation litter, including debris dams

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Maintenance of sustainable ecosystems/life cycle stages

Quality continued:

Hydrology and geomorphology:

- Naturalness of lake hydrological regime including pathways
- Lack of physical modifications
- Sedimentological regime: erosion & deposition
- Naturalness of flooding regime
- River continuity (e.g. no obstructions)
- Naturalness of water level regime
- Naturalness of flow regime
- Natural aquifer function: recharge & discharge
- Extent of artificial drainage

Species Composition

- Naturalness of biological assemblage: number of trophic levels and species composition within levels
- Invasive non-native species

Geology & topography:

- *Channel/bed substrate*
- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Water temperature*
- *Air temperature*
- *Precipitation (incl.type, distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
  Frequency of freeze thaw
- *Drought & floods*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Transition/connectivity of aquatic and terrestrial habitats: naturalness of configuration of habitats

Benefit Biodiversity, in of itself, and underpinning all other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations, flood protection, climate regulation.

Management Interventions

- Water abstraction: surface & ground water
- Flow modification/ water level regulation
- Water impoundment & diversion
- Channel straightening, reprofiling, deepening
- In-channel structures: weirs; dams etc
- Bank reinforcements/flood defence schemes
- River restoration
- Squeezing/loss of freshwater-terrestrial transitions
- Soil management practices
- Land drainage and agricultural improvement
- Tilling, ploughing
- Grazing/trampling: livestock type; intensity; cessation
- Aquaculture
- Afforestation & deforestation
- Woodland creation
- Pond, bog and other habitat creation & restoration
- Cutting aquatic & terrestrial vegetation, removal of wood
- Agricultural nutrient applications
- Pesticide use e.g. sheep dip
- Renewable energy: wind; hydro and tidal

Other drivers of change

- Climate change
- Point source pollution - sewage
- Industrial pollution
- Diffuse pollution (including from agriculture)
- New pollutants e.g. endocrine disruptors, nano particles
- Thermal discharges
- Soil erosion and landslips
- Regulation, including WFD
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Peat extraction
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Land use change
- Urban development & infrastructure
- Increasing human population & demand for water
  Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases

MARINE Mediation of wastes, toxins and other nuisances by ecosystems and biota/ maintenance of chemical water quality

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity: Extent of (area, % cover)

- Intertidal rock
- Subtidal rock
- Shallow subtidal sediment
- Shelf subtidal sediment
- Sea grass bed
- Reefs
- Blue mussel beds

Quality:

Sediment processes:

- Sediment accumulation rates
- Slopes
- Seabed form
- Channel depths
- Erosion-deposition cycles
- Substratum area and distribution (ha), depth (m), type
- Sediment properties (including stability)

Nutrient (& chemical) status:

- Nutrient status of sediment & sea water (N, P, Si)
- Chemical status of sediment & sea water: toxic contaminants
- Atmospheric deposition: exceedance of critical loads S, N, ozone

Hydrology:

- Water depth
- Water volume
- Area of surface
- Tidal range
- pH
- Current speed (m/s) and direction
- Wave height
- Temperature - changes
- Salinity - changes
- Turbidity (mg/l) – changes
- North Atlantic Oscillation cycles

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Water quality (chemical & biological, including viral & bacterial)

Quality continued:

Habitat & Species (including algae; plankton, invertebrates; fish; birds; mammals):

- Abundance (no.)
- Biomass (kg)
- Net productivity by species (kcal/ha/yr)
- Productivity:biomass ratios
- Species diversity (diversity indices)
- Community composition
- Amount & number of decomposers/decomposition rate (kg/ha/year)
- Predator: prey ratios
- Population dynamics (recruitment, age classes, male:female ratios, age at maturity, growth rates)
- Changes in genetic diversity
- Non-native species (& non-indigenous e.g. rats on islands)
- Phenology e.g. phytoplankton blooms (&synchronicity with zooplankton & fish larvae), fish migrations
- Cold: warmer water species ratio
- Physical habitat damage/disturbance

Spatial Configuration:

Not specified for this service

Benefit

Clean water, also underpinning e.g. sustainable ecosystems, cultural services, health benefits.

Management Interventions

- Commercial fisheries, especially trawling
- Coastal defences
- Dredging for navigation
- Disposal of spoil
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land reclamation
- Renewable energy: wind, wave, tidal
- Physical disturbance & damage

Other drivers of change

- Climate change – esp. sea temperature, sea level rise, increased storms, acidification
- Coastal development – urban, industrial & harbour
- Pollution – toxic & nutrient enrichment (including oil, endocrine disruptors, nano particles, plastics & pharmaceuticals)
- Regulation
- Policy
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)?
- Increasing human population
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases

MARINE Provisioning: wild animals, plants and algae and their outputs.

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (area, % cover)

- Intertidal rock
- Subtidal rock
- Shallow subtidal sediment
- Shelf subtidal sediment
- Sea grass beds
- Maerl beds
- Reefs

Quality

Sediment processes:

- Sediment accumulation rates
- Slopes
- Seabed form
- Channel depths
- Erosion-deposition cycles
- Substratum area and distribution (ha), depth (m), type
- Sediment properties (including stability)
- Sediment biota

Nutrient (& chemical) status:

- Nutrient status of sediment & sea water (N, P, Si)
- Chemical status of sediment & sea water: toxic contaminants
- pH of sea water
- Dissolved oxygen
- Bacterial and viral water quality

Hydrology:

- Water depth
- Temperature - changes
- Salinity - changes
- Turbidity (mg/l) – changes

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Fish, shellfish, seaweed and other products (tonnes)
- Quality of fish & shellfish (age/length profile; % affected by disease)
- Seaweed quality (% affected by disease)

Quality continued:

Habitat & Species (including algae; plankton, invertebrates; fish; birds; mammals)

- Abundance (no.)
- Biomass (kg)
- Net productivity by species (kcal/ha/yr)
- Productivity: biomass ratios
- Species diversity (diversity indices)
- Number of trophic levels & community composition in each level
- Amount & number of decomposers/decomposition rate (kg/ha/year)
- Predator: prey ratios
- Population dynamics (recruitment, age classes, male: female ratios, age at maturity, growth rates)
- Changes in genetic diversity
- Non-native species
- Phenology e.g. phytoplankton blooms (& sychronisity with zooplankton & fish larvae), fish migrations
- Cold: warmer water species ratio

Spatial Configuration:

- Transition and connectivity from sub-tidal to coastal and terrestrial

Benefit

- Products from the sea e.g. fish, shellfish & seaweed for food, fertiliser, angling bait, medicines

Management Interventions

- Commercial fisheries, especially trawling
- Coastal defences
- Dredging for navigation
- Disposal of spoil
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land reclamation
- Renewable energy: wind, wave, tidal
- Physical disturbance & damage

Other drivers of change

- Climate change – esp. sea temperature, sea level rise, increased storms, acidification
- Coastal development – urban, industrial & harbour
- Pollution – toxic & nutrient enrichment (including oil, endocrine disruptors, nano particles, plastics & pharmaceuticals)
- Regulation
- Policy
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)?
- Increasing human population
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases

MARINE Animals, plants and algae from in-situ aquaculture

Includes finfish, crab tiling, rope grown seaweed, mussel & oyster cultivation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity: Extent of (area, % cover)

- Intertidal rock
- Shallow subtidal sediment
- Shallow subtidal rock
- Subtidal rock
- Subtidal and intertidal biogenic reef
- Sea grass beds
- Blue mussel beds

Quality:

Sediment processes:

- Sediment accumulation rates
- Slopes
- Seabed form
- Channel depths
- Erosion-deposition cycles
- Substratum area and distribution (ha), depth (m), type
- Sediment properties (including stability)

Nutrient (& chemical) status:

- Nutrient status of sediment & see water (N, P, Si)
- Chemical status of sediment & sea water: toxic contaminants
- Dissolved oxygen
- Bacteriological & viral water quality

Hydrology:

- pH
- Temperature - changes
- Salinity - changes
- Turbidity (mg/l) – changes

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Fish, shellfish & other products (tonnes)
- Quality of fish & shellfish (age/length profile; % affected by disease/toxic contamination/bacteria etc.)

Quality continued:

Habitat & Species (including algae; plankton, invertebrates; fish; birds; mammals)

- Abundance (no.) *
- Biomass (kg) *
- Net productivity by species (kcal/ha/yr) *
- Community composition (of relevant wild food source (algae & plankton))
- Amount & number of decomposers/decomposition rate (kg/ha/year)
- Populations of predators of aquaculture species
- Population dynamics:recruitment, age classes, male:female ratios, age at maturity, growth rates (mussels)
- Changes in genetic diversity (shellfish)
- Non-native species (& non-indigenous e.g. copepod parasite on mussels, jelly fish blooms, sea squirt invasions) (3)
- Phenology e.g. phytoplankton blooms & synchronicity with zooplankton (for mussel seed collection)
- Cold: warmer water species ratio

Spatial Configuration:

- Proximity to access and local processing site

Note:

Aquaculture reliant on human inputs to varying extents:

1. Fish – young stock and feeding
2. Oyster – import stock but no feed input
3. Mussel – often natural spat and natural food

Benefits

Products from aquaculture e.g. fish, shellfish & seaweed for food, fertiliser, angling bait, medicines

Management Interventions

- Commercial fisheries, wild mussels
- Coastal defences
- Dredging for navigation
- Disposal of spoil
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land reclamation
- Renewable energy: wind, wave, tidal
- Physical disturbance & damage

Other drivers of change

- Climate change – esp. sea temperature, sea level rise, increased storms, acidification
- North Atlantic Oscillation cycles
- Coastal development – urban, industrial & harbour/marina (including slipways)
- Marine infrastructure – oil rigs, renewable energy, pipelines & cables
- Pollution discharges including sewage – toxic & nutrient enrichment (including oil, endocrine disruptors, nano particles, plastics & pharmaceuticals)
- Regulation
- Policy
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)?
- Increasing human population
- Seasonal peaks in human population e.g. with tourism/recreation
- Invasive non-native species
- Pests and diseases

MARINE Global, regional and local climate regulation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (area, % cover)

- Intertidal rock
- Subtidal rock
- Seagrass beds
- Shallow subtidal sediment
- Shelf subtidal sediment
- Reefs

Quality

Sediment processes:

- Sediment accumulation rates
- Slopes
- Seabed form
- Channel depths
- Erosion-deposition cycles
- Substratum area and distribution (ha), depth (m), type
- Sediment properties (including stability)

Nutrient (& chemical) status:

- Nutrient status of sediment & sea water (N, P, Si)
- Chemical status of sediment & sea water: toxic contaminants
- Atmospheric deposition: exceedance of critical loads S, N,
- Carbon content of sediment

Hydrology:

- Water depth
- Water volume
- Area of surface
- Tidal range
- pH
- Current speed (m/s) and direction
- Wave height
- Temperature - changes
- Salinity - changes
- Turbidity (mg/l) – changes
- North Atlantic Oscillation cycles

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Carbon sequestered (tonnes CO_2, per m^2 or m^3) and Greenhouse gases fixed

Quality continued:

Habitat & Species (including algae; plankton, invertebrates; fish; birds; mammals):

- Abundance (no.)
- Biomass (kg)
- Net productivity by species (kcal/ha/yr)
- Productivity:biomass ratios
- Species diversity (diversity indices)
- Community composition
- Amount & number of decomposers/decomposition rate (kg/ha/year)
- Predator: prey ratios
- Population dynamics (recruitment, age classes, male:female ratios, age at maturity, growth rates)
- Changes in genetic diversity
- Non-native species (& non-indigenous e.g. rats on islands)
- Phenology e.g. phytoplankton blooms (& sychronisity with zooplankton & fish larvae), fish migrations
- Cold: warmer water species ratio
- Physical habitat damage/disturbance

Spatial Configuration: not relevant for this service.

Benefit

Equitable climate e.g. reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport

Management Interventions

- Commercial fisheries, especially trawling
- Coastal defences
- Dredging for navigation
- Disposal of spoil
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land reclamation
- Renewable energy: wind, wave, tidal
- Physical disturbance & damage

Other drivers of change

- Climate change – esp. sea temperature, sea level rise, increased storms, acidification
- Coastal development – urban, industrial & harbour
- Pollution – toxic & nutrient enrichment (including oil, endocrine disruptors, nano particles, plastics & pharmaceuticals)
- Regulation
- Policy
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)?
- Increasing human population
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species
- Pests and diseases

MARINE Maintenance of nursery populations and habitats (and other stages of life cycles)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (area, % cover) (1)

- Intertidal rock
- Subtidal rock
- Shallow subtidal sediment
- Shelf subtidal sediment
- Sea grass beds
- Maerl beds
- Reefs

Quality

Sediment processes:

- Sediment accumulation rates
- Slopes
- Seabed form
- Channel depths
- Erosion-deposition cycles
- Substratum area and distribution (ha), depth (m), type
- Sediment properties (including stability) – particle size analysis
- Sediment biota

Nutrient (& chemical) status:

- Nutrient status of sediment & sea water (N, P, Si)
- Redox status
- Chemical status of sediment & sea water: toxic contaminants
- Bacterial & viral water quality
- Atmospheric deposition: exceedance of critical loads S, N,
- Dissolved oxygen
- pH of sea water

Hydrology:

- Tidal range
- Current speed (m/s) and direction
- Temperature - changes
- Salinity – changes – estuaries, lagoons

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Maintenance of sustainable ecosystems/life cycle stages

Quality continued:

Habitat & Species (including algae; plankton, invertebrates; fish; birds; mammals): (5)

- Abundance (no.)
- Biomass (kg)
- Net productivity by species (kcal/ha/yr)
- Number of trophic levels & community composition in each level
- Predator: prey ratios (including terrestrial e.g. foxes on islands with bird colonies)
- Population dynamics (recruitment, age classes, male:female ratios, age at maturity, growth rates)
- Changes in genetic diversity
- Non-native species Phenology e.g. phytoplankton blooms (& synchronicity with zooplankton & fish larvae), fish migrations
- Cold: warmer water species ratio –intertidal species

Climatic:

- *Wind speed*

Spatial Configuration:

- Transition and connectivity from subtidal to coastal and terrestrial habitats.

Benefit

Biodiversity, in of itself, and underpinning all other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations & aquaculture, flood protection (sea grass beds, dunes), climate regulation

Management Interventions

- Commercial fisheries, especially trawling
- Coastal defences
- Dredging for navigation
- Disposal of spoil
- Aggregate extraction
- Beach nourishment
- Coastal squeeze
- Managed realignment
- Land reclamation
- Development: harbours, marinas, ports,
- Infrastructure including pipelines/cables
- Construction & decommissioning activities
- Renewable energy: wind, wave, tidal
- Physical disturbance & damage

Other drivers of change

- Climate change – esp. sea temperature, sea level rise, increased storms, acidification, North Atlantic Oscillation
- Coastal development – urban, industrial & harbour
- Pollution – toxic & nutrient enrichment (including oil, endocrine disruptors, nano particles, plastics & pharmaceuticals)
- Regulation
- Policy
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)?
- Increasing human population
- Seasonal peaks in human population e.g. with tourism/recreation
- Invasive non-native species
- Pests and diseases
- Disturbance: noise: visual: light
- Natural fluctuations e.g. in breeding success

MOUNTAIN, MOORLAND & HEATH Water Supply – Water for drinking and non-drinking purposes (see also Water Quality logic chain)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Lakes
- Rivers
- Reservoirs
- Blanket bog
- Woodland (above moorland line)
- Dwarf shrub heath -wet
- Dwarf shrub heath – dry
- Mountain heath and willow scrub
- Bracken
- Upland flushes fens and swamps
- Semi-natural grassland (above moorland line)
- Inland rock, scree and pavement (above the moorland line)

Quality

Soil:

- Soil depth
- Soil carbon (organic soils bind persistent organic compounds and heavy metals)
- Soil bacteria
- Soil nutrient status
- Soil Water retention
- Actively eroding peatland
- Soil erosion including tracking and braiding
- Soil Type
- Degree of compaction

Vegetation:

- Vegetation cover/bare soil
- Type/composition
- Plant growth
- Above and below ground biomass
- Surface roughness/microtopography
- Vegetation structure
- Bryophyte cover/Sphagnum cover in mires
- Riparian vegetation cover/type

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

Availability of water for abstraction

Quality continued:

Atmospheric deposition:

- Exceedance of critical loads for S, N (affecting vegetation type and condition e.g. loss of Sphagnum)

Hydrology and geomorphology:

- Extent of artificial drainage
- Naturalness of lake hydrological regime including pathways:
- Infiltration
- Lack of physical modifications
- Sedimentological regime: erosion & deposition
- Naturalness of flooding regime
- Naturalness of water level regime
- Naturalness of flow regime
- Natural aquifer function: recharge & discharge
- Amount of surface water run-off/overland flow

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: not specified for this service.

Benefit

Plentiful water e.g. water for drinking, domestic use, irrigation, livestock, industrial use including cooling, wildlife

Management Interventions

- Grazing/trampling: livestock type; intensity; regime/seasonality
- Rotational burning: scale; pattern; frequency (also “wildfire”: not for management)
- Land drainage
- Infrastructure (e.g. tracks) and associated drainage
- Afforestation & deforestation
- Woodland creation
- Bog and other habitat restoration
- Conversion of heath to rough grazing (through liming, fertiliser, slurry application, burning, grazing)
- Cutting
- Pesticide use e.g. sheep dip (Persistent Organic Compounds)
- Renewable energy: wind; hydro
- Medicated grit use for grouse moors
- Use of lead shot
- Water abstraction
- Water transfer

Other drivers of change

- Soil erosion and landslips
- Climate change
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Regulation
- Increasing human population
- Demand for water abstraction
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species (especially freshwater)
- Pests and diseases
- Urbanisation

MOUNTAIN, MOORLAND & HEATH Global, regional and local climate regulation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Blanket bog
- Woodland (above moorland line)
- Dwarf shrub heath -wet
- Dwarf shrub heath – dry
- Mountain heath and willow scrub
- Bracken
- Upland flushes fens and swamps
- Semi-natural grassland (above moorland line)
- Inland rock, scree and pavement (above the moorland line)

Quality

Soil:

- Soil depth
- Soil carbon/organic matter
- Soil biota
- Soil nutrient status
- Soil Water retention
- Amount bare soil/vegetation cover
- Soil erosion & gullying of peatland
- Soil pH
- Soil Type
- Degree of compaction
- Infiltration

Vegetation:

- Vegetation cover/bare soil
- Type/composition
- Plant growth
- Above and below ground biomass
- Surface roughness/microtopography
- Structure
- Proportion of peat mass actively forming peat
- Primary production – biomass
- Riparian vegetation cover/type
- Litter amount and structure

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Carbon sequestration by vegetation and soils and fixing of greenhouse gases

Quality continued:

Atmospheric deposition:

- Exceedance of critical loads for S, N (affecting vegetation type and condition e.g. loss of Sphagnum)

Hydrology and geomorphology:

- Extent of artificial drainage
- Naturalness of water level regime
- Flow regime
- Aquifer recharge
- Amount of surface water run-off/overland flow
- Presence of peat pipes
- Area of bog restoration

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: not relevant for this service

Benefit

Equitable climate e.g. reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport disruption

Management Interventions

- Grazing/trampling: livestock type; intensity; regime/seasonality
- Deer population & management
- Rotational burning: scale; pattern; frequency (also “wildfire”: not for management)
- Land drainage
- Infrastructure (e.g. tracks) and associated drainage
- Afforestation
- Woodland creation
- Bog and other habitat restoration
- Conversion of heath to rough grazing (through liming, fertiliser, slurry application, burning, grazing)
- Scrub, bracken, gorse control
- Cutting
- Renewable energy: wind; hydro
- Water abstraction
- Water transfer

Other drivers of change

- Soil erosion and landslips
- Climate change
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Urban development (lowland heath)
- Regulation
- Increasing human population
- Demand for water abstraction
- Seasonal peaks in human population e.g. with tourism
- Urbanisation

MOUNTAIN, MOORLAND & HEATH Flood Protection

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Blanket bog
- Woodland (above moorland line)
- Dwarf shrub heath
- Mountain heath and willow scrub
- Bracken
- Upland flushes fens and swamps
- Semi-natural grassland (above moorland line)
- Inland rock, scree and pavement (above the moorland line)

Quality

Soil:

- Soil depth
- Soil carbon/organic matter
- Soil biota
- Soil Water retention
- Actively eroding peatland
- Soil erosion including tracking and braiding
- Soil Type
- Degree of compaction
- Infiltration

Vegetation:

- Vegetation cover/bare soil
- Type/composition
- Plant growth
- Above and below ground biomass
- Surface roughness/microtopography
- Structure
- Sphagnum cover in mires
- Primary production – biomass
- Vegetation next to water bodies
- Litter amount and structure

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Regulation of flow regime for peak events

Quality continued:

Hydrology and geomorphology:

- Extent of artificial drainage
- Naturalness of lake hydrological regime including pathways
- Infiltration
- Lack of physical modification
- Sedimentological regime: erosion & deposition
- Naturalness of flooding regime
- Naturalness of water level regime
- Naturalness of flow regime
- Natural aquifer function: recharge & discharge
- Amount of surface water run-off/overland flow

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: Distribution of flood mitigating land in relation to infrastructure & settlements

Benefit

- Reduced flood risk, affecting e.g. reduced health & safety risk, protection of housing, businesses & infrastructure, lack of transport disruption

Management Interventions

- Grazing/trampling: livestock type; intensity; regime/seasonality
- Deer population & management
- Rotational burning: scale; pattern; frequency (also “wildfire”: not for management)
- Land drainage
- Infrastructure (e.g. tracks) and associated drainage
- Afforestation
- Woodland creation
- Bog and other habitat restoration
- Conversion of heath to rough grazing (through liming, fertiliser, slurry application, burning, grazing)
- Scrub, bracken, gorse control
- Cutting
- Renewable energy; hydro
- Water abstraction
- Water transfer

Other drivers of change

- Soil erosion and landslips
- Climate change
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Recreational pressures (soil erosion)
- Regulation
- Increasing human population
- Demand for water abstraction
- Pests and diseases
- Urbanisation

MOUNTAIN, MOORLAND & HEATH Maintenance of nursery populations and habitats (and other stages of life cycles)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Blanket bog
- Woodland (above moorland line)
- Dwarf shrub heath -wet
- Dwarf shrub heath – dry
- Mountain heath and willow scrub
- Bracken
- Upland flushes fens and swamps
- Semi-natural grassland (above moorland line)
- Inland rock, scree and pavement (above the moorland line)
- Rivers and streams (above moorland line)
- Lakes (above moorland line)

Quality

Soil:

- Soil depth
- Soil carbon/organic matter
- Soil bacteria
- Soil N
- Soil Water retention
- Amount bare soil/vegetation cover
- Extent of gullying in peatlands
- Soil pH
- Nutrient cycling
- Soil Type
- Degree of compaction
- Infiltration

Vegetation:

- Vegetation cover/bare soil
- Type/composition
- Plant growth
- Above and below ground biomass
- Surface roughness/microtopography
- Structure & structural diversity
- Proportion of peat mass actively forming peat
- Riparian vegetation cover/type
- Litter amount and structure

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Maintenance of sustainable ecosystems/life cycle stages

Quality continued:

Species Composition:

- Naturalness of biological assemblage: number of trophic levels and species composition within levels
- Invasive non-native species

Atmospheric deposition:

- Exceedance of critical loads for S, N (affecting vegetation type and condition e.g. loss of Sphagnum)

Hydrology and geomorphology:

- Extent of artificial drainage
- Naturalness of lake hydrological regime
- Lack of physical modification of water bodies
- Extent of artificial drainage
- Naturalness of flooding regime
- Naturalness of water level regime
- Naturalness of flow regime
- Aquifer recharge
- Amount of surface water run-off/overland flow
- Presence of peat pipes

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Connectivity to other populations and habitats not in MMH
- Mosaics/spatial distribution of different habitats
- Patch size (lowland heath

Benefit

Biodiversity, in of itself, and underpinning all other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations, flood protection, climate regulation

Management Interventions

- Grazing/trampling: livestock type; intensity; regime/seasonality
- Deer population & management
- Rotational burning: scale; pattern; frequency (also “wildfire”: not for management)
- Land drainage
- Infrastructure (e.g. tracks) and associated drainage
- Afforestation
- Woodland creation
- Bog and other habitat restoration
- Conversion of heath to rough grazing (through liming, fertiliser, slurry application, burning, grazing)
- Scrub, bracken, gorse control
- Cutting
- Pesticide use e.g. sheep dip (Persistent Organic Compounds)
- Renewable energy: wind; hydro
- Medicated grit use for grouse moors
- Use of lead shot
- Water abstraction
- Water transfer

Other drivers of change

- Soil erosion and landslips
- Climate change
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Regulation
- Predator control
- Wildlife crime
- Increasing human population
- Demand for water abstraction
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species (especially freshwater)
- Pests and diseases
- Urbanisation

MOUNTAIN, MOORLAND & HEATH Mass stabilisation and control of erosion rates

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Blanket bog
- Woodland (above moorland line)
- Dwarf shrub heath -wet
- Dwarf shrub heath – dry
- Mountain heath and willow scrub
- Bracken
- Upland flushes fens and swamps
- Semi-natural grassland (above moorland line)
- Inland rock, scree and pavement (above the moorland line)

Quality

Soil:

- Soil depth
- Soil carbon/organic matter
- Soil bacteria
- Soil N
- Soil Water retention
- Soil erosion and gullying of peatland
- Soil Type
- Degree of compaction
- Infiltration

Vegetation:

- Vegetation cover/bare soil
- Proportion of peat mass actively forming peat
- Type/composition
- Plant growth
- Above and below ground biomass
- Surface vegetation roughness/microtopography
- Structure
- Sphagnum cover in mires
- Primary production – biomass
- Riparian vegetation cover/type
- Litter amount and structure

Species

- Invasive species

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Stabilisation of soils

Quality continued:

Atmospheric deposition:

- Exceedance of critical loads for S, N (affecting vegetation type and condition e.g. loss of Sphagnum)

Hydrology and geomorphology:

- Extent of artificial drainage
- Loss of natural flood plain or its connection to river
- Naturalness of water level regime
- Flow regime
- Aquifer recharge
- Amount of surface water run-off/overland flow
- Presence of peat pipes
- Presence of drainage grips

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: distribution/connectivity and interaction of habitats

- Distribution of habitats, other vegetation and boundary features mitigating soil erosion and landslip

Benefit

Erosion control e.g. soil/land retention, lack of transport disruption, protection of housing, businesses & infrastructure, reduced health & safety risk, reduced flood risk

Management Interventions

- Grazing/trampling: livestock type; intensity; regime/seasonality
- Deer population & management
- Rotational burning: scale; pattern; frequency (also “wildfire”: not for management)
- Land drainage
- Infrastructure (e.g. tracks) and associated drainage
- Afforestation
- Woodland creation
- Bog and other habitat restoration
- Conversion of heath to rough grazing (through liming, fertiliser, slurry application, burning, grazing)
- Scrub, bracken, gorse control
- Cutting
- Renewable energy: wind; hydro
- Water abstraction
- Water transfer

Other drivers of change

- Soil erosion and landslips
- Climate change
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Urban development (lowland heath)
- Regulation
- Increasing human population
- Demand for water abstraction
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species (especially freshwater)
- Pests and diseases
- Urbanisation

MOUNTAIN, MOORLAND & HEATH Reared animals and their Outputs

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Blanket bog
- Woodland (above moorland line)
- Dwarf shrub heath -wet
- Dwarf shrub heath – dry
- Mountain heath and willow scrub
- Bracken
- Upland flushes fens and swamps
- Semi-natural grassland (above moorland line)
- Inland rock, scree and pavement (above the moorland line)

Quality

Soil:

- Soil depth
- Soil carbon (organic soils bind persistent organic compounds and heavy metals)
- Soil biota
- Soil nutrient status
- Soil Water retention
- Amount bare soil/vegetation cover
- Actively eroding peatland
- Soil erosion including tracking and braiding
- Soil pH
- Nutrient cycling
- Soil Type
- Degree of compaction
- Infiltration

Vegetation:

- Type/composition
- Plant growth rate
- Above and below ground biomass
- Structure
- Litter amount and structure
- Invasive species
- Ratio of grasses to forbs

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Number and type of reared animals
- Growth rate of livestock
- Breeding productivity
- Mortality rates
- Pests/disease

Quality continued:

Atmospheric deposition:

- Exceedance of critical loads for S, N (affecting vegetation type and condition e.g. loss of Sphagnum)

Hydrology and geomorphology:

- Water table level (esp. for peat)
- Presence of drainage grips

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: not specified for this service

Benefit

- Products from animals e.g. meat, dairy products, honey.

Management Interventions

- Grazing/trampling: livestock type; intensity; regime/seasonality
- Deer population & management
- Rotational burning: scale; pattern; frequency (also “wildfire”: not for management)
- Land drainage
- Infrastructure (e.g. tracks) and associated drainage
- Afforestation
- Woodland creation
- Bog and other habitat restoration
- Conversion of heath to rough grazing (through liming, fertiliser, slurry application, burning, grazing)
- Scrub, bracken, gorse control
- Cutting
- Pesticide use e.g. sheep dip (Persistent Organic Compounds)
- Renewable energy: wind; hydro
- Use of lead shot

Other drivers of change

- Soil erosion and landslips
- Climate change
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Recreational pressures
- Atmospheric deposition (acidification, eutrophication)
- Urban development (lowland heath)
- Regulation
- Increasing human population
- Demand for water abstraction
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species (especially freshwater)
- Pests and diseases
- Urbanisation
- Market price for meat & other products

MOUNTAIN, MOORLAND & HEATH Water Quality: Mediation of wastes, toxins and other nuisances by ecosystems & Biota/ Maintenance of chemical water quality

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Blanket bog
- Woodland (above moorland line)
- Dwarf shrub heath -wet
- Dwarf shrub heath – dry
- Mountain heath and willow scrub
- Bracken
- Upland flushes fens and swamps
- Semi-natural grassland (above moorland line)
- Inland rock, scree and pavement (above the moorland line)

Quality

Soil:

- Soil depth
- Soil carbon/organic matter
- Soil biota
- Soil nutrient status
- Soil Water retention
- Soil erosion & gullying in peatland
- Soil pH
- Soil Type
- Degree of compaction
- Infiltration

Vegetation:

- Vegetation cover/bare soil
- Type/composition
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Structure
- Proportion of peat body actively forming peat
- Primary production – biomass
- Vegetation cover adjacent to water bodies
- Litter amount and structure
- Invasive species

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Ecological and chemical water quality (including pH, bacterial, viral and suspended sediment)

Quality continued:

Atmospheric deposition:

- Exceedance of critical loads for S, N (affecting vegetation type and condition e.g. loss of Sphagnum)

Hydrology and geomorphology:

- Extent of artificial drainage
- Loss of natural flood plain or its connection to river
- Naturalness of water level regime
- Flow regime
- Aquifer recharge
- Amount of surface water run-off/overland flow
- Presence of peat pipes

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

Distribution of habitats, in relation to water quality source-pathway-receptor

Benefit

Clean water, also underpinning e.g. water supply, sustainable ecosystems, cultural services, health benefits.

Management Interventions

- Grazing/trampling: livestock type; intensity; regime/seasonality
- Deer population & management
- Rotational burning: scale; pattern; frequency (also “wildfire”: not for management)
- Land drainage
- Infrastructure (e.g. tracks) and associated drainage
- Afforestation
- Woodland creation
- Bog restoration
- Conversion of heath to rough grazing (through liming, fertiliser, slurry application, burning, grazing)
- Scrub, bracken, gorse control
- Cutting
- Pesticide use e.g. sheep dip (Persistent Organic Compounds)
- Herbicide use
- Renewable energy: wind; hydro
- Drugs e.g. medicated grit use for grouse moors
- Use of lead shot
- Water abstraction
- Water transfer

Other drivers of change

- Soil erosion and landslips
- Climate change
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Recreational pressures (soil erosion)
- Atmospheric deposition (acidification, eutrophication)
- Regulation
- Increasing human population
- Demand for water abstraction
- Seasonal peaks in human population e.g. with tourism
- Invasive non-native species (especially freshwater)
- Pests and diseases
- Urbanisation

ENCLOSED FARMLAND Reared animals and their Outputs

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Arable & rotational leys
- Improved grassland
- Horticulture
- Orchards & top fruit
- Bio-energy crops

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil moisture
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration
- Soil organic matter content

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads N

Vegetation/features:

- Plant growth rate
- Surface roughness/microtopography
- Small farm woodlands/scrub
- Hedgerows – length, density, species richness
- Hedgerow trees – number
- Hedge structure
- Species rich arable margins – extent & species richness
- "Beetle banks" - extent & species richness

Rotational features:

- Cover/bare soil
- Nectar & pollen mixes
- Wild bird mix

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Number and type of reared animals
- Livestock health & productivity

Quality continued:

Hydrology and Geomorphology:

- Loss of natural flood plain or its connection to river
- Water table level
- Amount of surface water run-off/overland flow
- Ponds – number/density

Species Composition:

- Invasive non-native species
- Invasive native species (e.g. ragwort, bracken, bog asphodel)

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought & low precipitation*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Not specified for this service

Benefit

Products from animals e.g. meat, dairy products, honey

Management Interventions

- Arable cropping/rotation
- Fertiliser (N, P, K) lime & slurry applications
- Ploughing & re-seeding of improved grassland
- Interchange between grass/arable & between crops
- Grazing – livestock type,breed, intensity and season
- Overgrazing & trampling
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Irrigation
- Flood risk management
- Water table management
- Supplementary feeding
- Pesticide & herbicide use
- Bio-energy crops
- Game management
- Hedge management – frequency and type
- Field boundary management and removal
- Rough grass "beetle" banks
- Organic farming systems
- Precision farming
- Farm advice

Other drivers of change

- Market forces: domestic/global for food; livestock feed.
- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation
- Agriculture and other land management policies
- Agricultural subsidy
- Agri-environment, woodland & bio-energy schemes/cross compliance
- Farm accreditation & national labelling standards
- Urban development, infrastructure & quarries
- Increasing human population
- Changing demography, including migration: impacting on labour & management
- Invasive non-native species
- Pests & disease
- Fertiliser (& other inputs) price
- Technological development of crops and livestock e.g livestock breeds, water-efficient crops, GM,
- Technological development of machinery & methods
- Brexit
- Short-term economic factors
- Resistance to change

ENCLOSED FARMLAND Global, regional and local climate regulation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Arable & rotational leys
- Improved grassland
- Horticulture
- Orchards & top fruit
- Bio-energy crops
- Permanent pasture

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil moisture
- Soil Type & texture
- Soil erosion
- Degree of compaction
- Infiltration
- Soil carbon/organic matter

Nutrient (& chemical) status:

- Soil chemical status
- Soil nutrient statusAtmospheric deposition: exceedance of critical loads N

Vegetation/features:

- Extent of permanent vegetation cover
- Surface roughness/microtopography
- Small farm woodlands/scrub
- Boundary features: extent and condition
- Above and below ground biomass
- Species rich arable margins – extent & species richness
- “Beetle banks” - extent & species richness

Rotational features:

- Cover/bare soil
- Nectar & pollen mixes
- Wild bird mix

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Carbon sequestration by soil/vegetation and fixing of greenhouse gases

Quality continued:

Hydrology & geomorphology:

- Loss of natural flood plain or its connection to river
- Water table level
- Amount of surface water run-off/overland flow
- Ponds – number/density

Species Composition:

- Invasive non-native species
- Soil invertebrate diversity: earthworms
- Butterfly abundance & diversity (specialist species)
- Bird populations: breeding; wintering; passage

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought & low precipitation*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Not relevant for this service.

Benefit

Equitable climate e.g. reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport disruption

Management Interventions

- Arable cropping/rotation
- Fertiliser (N, P, K) lime & slurry applications
- Ploughing & re-seeding of improved grassland
- Interchange between grass/arable & between crops
- Grazing – livestock type,breed, intensity and season
- Overgrazing & trampling
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Irrigation
- Flood risk management
- Water table management
- Supplementary feeding
- Pesticide & herbicide use
- Bio-energy crops
- Game management
- Hedge management – frequency and type
- Field boundary management and removal
- Rough grass “beetle” banks
- Organic farming systems
- Precision farming
- Farm advice

Other drivers of change

- Market forces: domestic/global for food; livestock feed.
- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation
- Agriculture and other land management policies
- Agricultural subsidy
- Agri-environment, woodland & bio-energy schemes/cross compliance
- Farm creditation & national labelling standards
- Urban development, infrastructure & quarries
- Increasing human population
- Changing demography, including migration: impacting on labour & management
- Invasive non-native species
- Pests & disease
- Fertiliser (& other inputs) price
- Technological development of crops and livestock e.g livestock breeds, water-efficient crops, GM,
- Technological development of machinery & methods
- Brexit
- Short-term economic factors

ENCLOSED FARMLAND Cultivated crops

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Arable & rotational leys
- Improved grassland
- Horticulture
- Orchards & top fruit

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil moisture
- Soil type
- Soil erosion
- Degree of compaction
- Infiltration
- Soil carbon/organic matter
- Soil pH
- Soil saline status
- Soil compaction

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads N

Vegetation/features (semi-natural grassland covered under separate broad habitat):

- Plant growth rate
- Surface roughness/microtopography
- Hedgerow trees – number
- "Beetle banks" - extent & species richness

Rotational features:

- Cover/bare soil

Hydrology and geomorphology:

- Loss of natural flood plain or its connection to river
- Water table level
- Amount of surface water run-off/overland flow
- Ponds – number/density
- Water available for irrigation
- Flooding – over-topping of water courses

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Production of crops
- Crop health

Quality continued:

Species Composition:

- Invasive non-native species
- Weed species
- Pest species e.g. insects, fungal pathogens
- Bird populations: breeding; wintering; passage

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought & low precipitation*
- *Length of growing season*

Spatial Configuration:

Not specified for this service.

Benefit

Food from crops e.g. cereals, vegetables, fruit

Management Interventions

- Arable cropping/rotation
- Fertiliser (N, P, K) lime & slurry applications
- Ploughing & re-seeding of improved grassland
- Interchange between grass/arable & between crops
- Grazing – livestock type, breed, intensity and season
- Overgrazing & trampling
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Irrigation
- Flood risk management
- Water table management
- Supplementary feeding
- Pesticide & herbicide use
- Bio-energy crops
- Game management
- Hedge management – frequency and type
- Field boundary management and removal
- Rough grass "beetle" banks
- Organic farming systems
- Precision farming
- Farm advice

Other drivers of change

- Market forces: domestic/global for food; livestock feed.
- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation
- Agriculture and other land management policies
- Agricultural subsidy
- Agri-environment, woodland & bio-energy schemes/cross compliance
- Farm creditation & national labelling standards
- Urban development, infrastructure & quarries
- Increasing human population
- Changing demography, including migration: impacting on labour & management
- Invasive non-native species
- Pests & disease
- Fertiliser (& other inputs) price
- Technological development of crops and livestock e.g livestock breeds, water-efficient crops, GM,
- Technological development of machinery & methods
- Brexit
- Short-term economic factors
- Resistance to change

ENCLOSED FARMLAND Maintenance of nursery populations and habitats

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Arable & rotational leys
- Improved grassland
- Horticulture
- Orchards & top fruit
- Bio-energy crops

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil water retention
- Soil Type & texture
- Soil erosion
- Degree of compaction
- Infiltration
- Soil carbon/organic matter

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads N

Vegetation/features:

- Extent & condition of linear vegetation features and pockets of semi-natural habitats
- Plant growth rate
- Surface roughness/microtopography
- Small farm woodlands/scrub
- Above and below ground biomass
- Species rich arable margins – extent & species richness
- "Beetle banks" - extent & species richness

Rotational features:

- Cover/bare soil
- Nectar & pollen mixes
- Wild bird mix

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Maintenance of sustainable ecosystems/life cycle stages

Quality continued:

Hydrology and geomoprhology:

- Loss of natural flood plain or its connection to river
- Water table level
- Amount of surface water run-off/overland flow
- Ponds – number/density

Species Composition:

- Naturalness of biological assemblage: number of trophic levels and species composition within levels

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought & low precipitation*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Proximity to semi-natural habitats

Benefit Biodiversity, in of itself, and underpinning other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations, climate regulation

Management Interventions

- Arable cropping/rotation
- Fertiliser (N, P, K) lime & slurry applications
- Ploughing & re-seeding of improved grassland
- Interchange between grass/arable & between crops
- Grazing – livestock type,breed, intensity and season
- Overgrazing & trampling
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Irrigation
- Flood risk management
- Water table management
- Supplementary feeding
- Pesticide & herbicide use
- Bio-energy crops
- Game management
- Hedge management – frequency and type
- Field boundary management and removal
- Rough grass "beetle" banks
- Organic farming systems
- Precision farming
- Farm advice

Other drivers of change

- Market forces: domestic/global for food; livestock feed.
- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation
- Agriculture and other land management policies
- Agricultural subsidy
- Agri-environment, woodland & bio-energy schemes/cross compliance
- Farm creditation & national labelling standards
- Urban development, infrastructure & quarries
- Increasing human population
- Changing demography, including migration: impacting on labour & management
- Invasive non-native species
- Pests & disease
- Fertiliser (& other inputs) price
- Technological development of crops and livestock e.g livestock breeds, water-efficient crops, GM,
- Technological development of machinery & methods
- Brexit
- Short-term economic factors
- Resistance to change

ENCLOSED FARMLAND Mass stabilisation and control of erosion rates

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Arable & rotational leys
- Improved grassland
- Horticulture
- Orchards & top fruit
- Bio-energy crops
- Permanent pasture

Quality

Soil/sediment processes:

- Soil depth
- Soil biota, including bacteria, worms etc.
- Soil water retention
- Soil Type & texture
- Soil erosion
- Degree of compaction
- Infiltration
- Soil carbon/organic matter

Nutrient (& chemical) status:

- Soil N, P, K, C, pH, S, $CaCO_3$
- Atmospheric deposition: exceedance of critical loads N

Vegetation/features:

- Extent of permanent vegetation cover
- Extent & condition of linear vegetation features & pockets of semi-natural vegetation
- Plant growth rate
- Surface roughness/microtopography
- Small farm woodlands/scrub
- Boundary features: extent & condition
- Above and below ground biomass
- Species rich arable margins – extent & species richness
- "Beetle banks" - extent & species richness
- Buffer strips

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Stabilisation of soils

Quality continued:

Hydrology and geomorphology:

- Loss of natural flood plain or its connection to river
- Water table level
- Amount of surface water run-off/overland flow
- Ponds – number/density

Species Composition:

- Invasive non-native species

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought & low precipitation*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Distribution of habitats, other vegetation & boundary features mitigating soil erosion & landslip risk

Benefit

Erosion control e.g. soil/land retention, lack of transport disruption, protection of housing, businesses & infrastructure, reduced health & safety risk, reduced flood risk

Management Interventions

- Arable cropping/rotation & cultivations
- Fertiliser (N, P, K) lime & slurry applications
- Ploughing & re-seeding of improved grassland
- Interchange between grass/arable & between crops
- Grazing – livestock type,breed, intensity and season
- Overgrazing & trampling
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Irrigation
- Flood risk management
- Water table management
- Supplementary feeding
- Pesticide & herbicide use
- Bio-energy crops
- Game management
- Hedge management – frequency and type
- Field boundary management and removal
- Rough grass "beetle" banks
- Organic farming systems
- Precision farming
- Farm advice

Other drivers of change

- Market forces: domestic/global for food; livestock feed.
- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation
- Agriculture and other land management policies
- Agricultural subsidy
- Agri-environment, woodland & bio-energy schemes/cross compliance
- Farm creditation & national labelling standards
- Urban development, infrastructure & quarries
- Increasing human population
- Changing demography, including migration
- Invasive non-native species
- Pests & disease
- Fertiliser (& other inputs) price
- Technological development of crops and livestock e.g livestock breeds, water-efficient crops, GM,
- Technological development of machinery & methods
- Brexit
- Short-term economic factors
- Resistance to change

ENCLOSED FARMLAND Pest & disease control

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Arable & rotational leys
- Improved grassland
- Horticulture
- Orchards & top fruit
- Bio-energy crops

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil bacteria/fungal ratio
- Soil water retention
- Soil Type & texture
- Soil erosion
- Degree of compaction
- Infiltration
- Soil organic matter content

Nutrient (& chemical) status:

- Soil N, P, K, C, pH, S, $CaCO_3$
- Atmospheric deposition: exceedance of critical loads N

Vegetation/features:

- Extent and condition of linear vegetation features & pockets of semi-natural vegetation
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Small farm woodlands/scrub

Rotational features:

- Cover/bare soil
- Nectar & pollen mixes
- Wild bird mix

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Abundance and species richness of pest controlling species e.g. predatory carabid beetles
- Intact fungal network to reduce infection of plants

Quality continued:

Hydrology and geomorphology:

- Loss of natural flood plain or its connection to river
- Water table level
- Amount of surface water run-off/overland flow
- Ponds – number/density

Species Composition:

- Invasive non-native species
- Invertebrate diversity – relevant species/characteristic community (occupied niches)
- Butterfly abundance & diversity (specialist species)
- Bird populations: breeding; wintering; passage
- Crop wild relatives
- Propagules of disease resistant strains

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought & low precipitation*
- *Length of growing season (for vegetation)*

Spatial Configuration: Proximity to semi-natural habitats

Benefit

Natural control of agricultural pest species and diseases

Management Interventions

- Arable cropping/rotation
- Fertiliser (N, P, K) lime & slurry applications
- Ploughing & re-seeding of improved grassland
- Interchange between grass/arable & between crops
- Grazing – livestock type,breed, intensity and season
- Overgrazing & trampling
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Irrigation
- Flood risk management
- Water table management
- Supplementary feeding
- Pesticide & herbicide use
- Bio-energy crops
- Game management
- Hedge management – frequency and type
- Field boundary management and removal
- Rough grass “beetle” banks
- Organic farming systems
- Precision farming
- Farm advice

Other drivers of change

- Market forces: domestic/global for food; livestock feed.
- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation
- Agriculture and other land management policies
- Agricultural subsidy
- Agri-environment, woodland & bio-energy schemes/cross compliance
- Farm creditation & national labelling standards
- Urban development, infrastructure & quarries
- Increasing human population
- Changing demography, including migration: impacting on labour & management
- Invasive non-native species
- Pests & disease
- Fertiliser (& other inputs) price
- Technological development of crops and livestock e.g livestock breeds, water-efficient crops, GM,
- Technological development of machinery & methods
- Brexit
- Short-term economic factors
- Resistance to change

ENCLOSED FARMLAND Pollination and seed dispersal

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Arable & rotational leys
- Improved grassland
- Horticulture
- Orchards & top fruit
- Bio-energy crops

Quality

Soil/sediment processes:

- Soil depth
- Soil biota, including bacteria, worms etc.
- Soil water retention
- Soil Type & texture
- Soil erosion
- Degree of compaction
- Infiltration
- Soil carbon/organic matter

Nutrient (& chemical) status:

- Soil nutrient status
- Soil chemical status (not nutrients)
- Atmospheric deposition: exceedance of critical loads N

Vegetation/features:

- Presence & frequency of pollinator larval & adult food plants
- Extent & condition of linear vegetation features and pockets of semi-natural vegetation
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Small farm woodlands/scrub
- Species rich arable margins – extent & species richness
- "Beetle banks" - extent & species richness

Rotational features:

- Cover/bare soil
- Nectar & pollen mixes

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Abundance, species richness & distribution of pollinators

Quality continued:

Hydrology and geomorpholgy:

- Loss of natural flood plain or its connection to river
- Water table level
- Amount of surface water run-off/overland flow
- Ponds – number/density

Species Composition:

- Invasive non-native species
- Invertebrate diversity, including in ponds
- Butterfly abundance & diversity (specialist species)
- Bird populations: breeding; wintering; passage

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought & low precipitation*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Proximity of boundary features and semi-natural habitat patches to insect pollinator crops.

Benefit

Pollination underpinning cultivated crops dependent on insect pollination e.g. field beans, apples, plums, pears, cucumbers, plums, strawberries, oil seed rape

Management Interventions

- Arable cropping/rotation
- Fertiliser (N, P, K) lime & slurry applications
- Ploughing & re-seeding of improved grassland
- Interchange between grass/arable & between crops
- Grazing – livestock type,breed, intensity and season
- Overgrazing & trampling
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Irrigation
- Flood risk management
- Water table management
- Supplementary feeding
- Pesticide & herbicide use
- Bio-energy crops
- Game management
- Hedge management – frequency and type
- Field boundary management and removal
- Rough grass "beetle" banks
- Organic farming systems
- Precision farming
- Farm advice

Other drivers of change

- Market forces: domestic/global for food; livestock feed.
- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation
- Agriculture and other land management policies
- Agricultural subsidy
- Agri-environment, woodland & bio-energy schemes/cross compliance
- Farm creditation & national labelling standards
- Urban development, infrastructure & quarries
- Increasing human population
- Changing demography, including migration: impacting on labour & management
- Invasive non-native species
- Pests & disease
- Fertiliser (& other inputs) price
- Technological development of crops and livestock e.g livestock breeds, water-efficient crops, GM,
- Technological development of machinery & methods
- Brexit
- Short-term economic factors

SEMI-NATURAL GRASSLAND Reared animals and their Outputs

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Hay meadows
- Other semi-natural grasslands

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil moisture
- Soil Type
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads N

Vegetation:

- Plant species diversity
- Proportion of more competitive, nutrient demanding species
- Cover/bare soil
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Vegetation Litter

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Number and type of reared animals
- Growth rate
- Breeding productivity
- Mortality rates
- Pests/disease

Quality continued:

Hydrology and geomorphology:

- Water table level (esp. for marshy grassland)
- Amount of surface water run-off/overland flow

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Proximity to farmstead, barns etc.

Benefit

Products from animals e.g. meat, dairy products, honey

Management Interventions

- Fertiliser applications (N, P, K) & liming
- Slurry applications
- Ploughing & re-seeding
- Conversion to arable
- Grazing – livestock type, intensity and season
- Overgrazing & trampling (esp. upland acid grassland)
- Undergrazing (esp. calcareous, acid & purple moor-grass & rush pasture)
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Loss of traditional management
- Cutting – shift from hay-making to silage with earlier cutting date
- Supplementary feeding
- Pesticide & herbicide use
- Disease & predator management

Other drivers of change

- Climate change
- Diffuse agricultural pollution
- Regulation – esp. habitat protection
- Policies (afforestation, biodiversity, agricultural
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Recreational pressures & facilities
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Aging farming population
- Invasive non-native species

SEMI-NATURAL GRASSLAND Global, regional and local climate regulation

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of:

- Haymeadows
- Other semi-natural grasslands

Quality

Soil/sediment processes:

- Soil depth
- Soil Biota
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil Carbon/organic matter
- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads N

Vegetation:

- Plant species diversity
- Type / composition
- Proportion of more competitive, nutrient demanding species
- Cover/bare soil
- Plant growth rate (and balance with decomposition)
- Above and below ground biomass
- Surface roughness/microtopography
- Litter

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Carbon sequestration by soil/vegetation and fixing of Green House Gases
- Water balance
- Microclimate

Quality continued:

Hydrology and geomorphology:

- Loss of natural flood plain or its connection to river (for marshy grassland)
- Naturalness of water level regime
- Naturalness of flooding regime
- Amount of surface water run-off/overland flow

Species Composition:

- Invasive non-native species
- Soil invertebrate diversity: earthworms

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Not relevant for this service.

Benefit

Equitable climate e.g. reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport disruption

Management Interventions

- Fertiliser applications (N, P, K) & liming
- Slurry applications
- Ploughing & re-seeding
- Conversion to arable
- Grazing – livestock type, intensity and season
- Overgrazing & trampling (esp. upland acid grassland)
- Undergrazing (esp. calcareous, acid & purple moor-grass & rush pasture)
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Loss of traditional management
- Cutting – shift from hay-making to silage with earlier cutting date
- Supplementary feeding
- Pesticide & herbicide use

Other drivers of change

- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation – esp. habitat protection
- Policies (afforestation, biodiversity, agricultural
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Invasive non-native species

SEMI-NATURAL GRASSLAND Maintenance of nursery populations and habitats (and other stages of life cycles)

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (PH = Priority Habitat)

- Hay meadows
- Other semi-natural grasslands

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil carbon/organic matter
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads N

Vegetation:

- Structural diversity including bare ground
- Proportion of more competitive, nutrient demanding species
- Vegetation cover/bare soil
- Plant growth rate
- Above and below ground biomass
- Surface roughness/microtopography
- Vegetation Litter

Hydrology and geomorphology:

- Naturalness of flooding regime
- Naturalness of water level regime
- Amount of surface water run-off/overland flow

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Maintenance of sustainable ecosystems/life cycle stages

Quality continued:

Species Composition:

- Naturalness of biological assemblage: number of trophic levels and species composition within levels
- Plant species diversity

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Proximity to other semi-natural grasslands and habitats

Benefit

Biodiversity, in of itself, and underpinning all other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations, climate regulation

Management Interventions

- Fertiliser applications (N, P, K) & liming
- Slurry applications
- Ploughing & re-seeding
- Conversion to arable & improved grassland
- Grazing – livestock type, intensity and season
- Overgrazing & trampling (esp. upland acid grassland)
- Undergrazing (esp. calcareous, acid & purple moor-grass & rush pasture)
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Loss of traditional management
- Cutting – shift from hay-making to silage with earlier cutting date
- Pesticide & herbicide use

Other drivers of change

- Climate change
- Diffuse agricultural pollution
- Regulation – esp. habitat protection
- Policies (afforestation, biodiversity, agricultural
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Recreational pressures & facilities
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Aging farming population
- Invasive non-native species

SEMI-NATURAL GRASSLAND Provisioning: materials from plants animals and algae for agricultural/direct use or processing

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (PH = Priority Habitat)

- Hay meadows
- Other semi-natural grasslands

Quality

Soil/sediment processes:

- Soil depth
- Soil biota
- Soil moisture
- Soil type
- Soil erosion
- Degree of compaction
- Infiltration

Nutrient (& chemical) status:

- Soil nutrient status
- Atmospheric deposition: exceedance of critical loads N

Vegetation:

- Plant species diversity
- Proportion of more competitive, nutrient demanding species
- Cover/bare soil
- Plant growth rate
- Above and below ground biomass
- Litter

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Production of hay and other crops/products

Quality continued:

Hydrology and geomorphology:

- Loss of natural flood plain or its connection to river (for marshy grassland)
- Water table level (esp. for marshy grassland)
- Amount of surface water run-off/overland flow

Species Composition:

- Invasive non-native species
- Invertebrate diversity
- Butterfly abundance & diversity (specialist species)
- Bird populations: breeding; wintering; passage

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration: Not specified for this service

Benefit

Materials e.g. hay, grass for fodder

Management Interventions

- Fertiliser applications (N, P, K) & liming
- Slurry applications
- Ploughing & re-seeding
- Conversion to arable
- Grazing – livestock type, intensity and season
- Overgrazing & trampling (esp. upland acid grassland)
- Undergrazing (esp. calcareous, acid & purple moor-grass & rush pasture)
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Loss of traditional management
- Cutting – shift from hay-making to silage with earlier cutting date
- Supplementary feeding
- Pesticide & herbicide use

Other drivers of change

- Climate change
- Diffuse agricultural pollution
- Regulation – esp. habitat protection
- Policies (afforestation, biodiversity, agricultural
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Invasive non-native species

SEMI-NATURAL GRASSLAND Pollination and seed dispersal

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity – Extent of (PH = Priority Habitat)

- Haymeadows
- Other semi-natural grasslands

Quality

Soil/sediment processes:

- Soil depth
- Soil bacteria
- Soil water retention
- Soil Type
- Soil erosion
- Degree of compaction (burrowing insects)
- Infiltration

Nutrient (& chemical) status:

- Soil N, P, K, C, pH
- Atmospheric deposition: exceedance of critical loads N

Vegetation:

- Structural diversity including bare ground
- Vegetation cover/bare soil
- Plant growth rate
- Above and below ground biomass
- Presence & frequency of larval & adult food plants

Italics shows factors not affected by management interventions

Ideal indicators highlighted: short list and long list

Ecosystem Service Flow

- Abundance, species richness and distribution of pollinators and seed dispersers

Quality continued:

Hydrology and geomorphology:

- Loss of natural flood plain or its connection to river (for marshy grassland)
- Water table level (esp. for marshy grassland)
- Amount of surface water run-off/overland flow

Species Composition:

- Plant species diversity

Geology & topography:

- *Geology*
- *Altitude, slope, aspect , land form*
- *Catchment characteristics*

Climatic:

- *Air temperature*
- *Sunlight/cloud cover*
- *Precipitation (incl. distribution, seasonality, intensity)*
- *Snow cover and length of snow lie*
- *Frequency of freeze thaw*
- *Wind – especially for wind throw*
- *Drought*
- *Length of growing season (for vegetation)*

Spatial Configuration:

- Proximity of insect pollinator crops from semi- natural grassland.
- Proximity to other semi-natural grasslands and habitats

Benefit

Pollination underpinning cultivated crops dependent on insect pollination e.g. field beans, apples, plums, pears, cucumbers, plums, strawberries, oil seed rape

Management Interventions

- Fertiliser applications (N, P, K) & liming
- Slurry applications
- Ploughing & re-seeding
- Conversion to arable
- Grazing – livestock type, intensity and season
- Overgrazing & trampling (esp. upland acid grassland)
- Undergrazing (esp. calcareous, acid & purple moor-grass & rush pasture)
- Afforestation (plantations)
- Woodland creation
- Land drainage
- Loss of traditional management
- Cutting – shift from hay-making to silage with earlier cutting date
- Pesticide & herbicide use

Other drivers of change

- Climate change
- Atmospheric pollution – especially N
- Diffuse agricultural pollution
- Regulation – esp. habitat protection
- Policies (afforestation, biodiversity, agricultural
- Agri-environment schemes/cross compliance/changes in subsidy payments
- Market forces – domestic & global
- Atmospheric deposition (acidification, eutrophication)
- Urban development, infrastructure & quarries
- Increasing human population
- Aging farming population
- Invasive non-native species

WOODLAND Cultural Ecosystem Services

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity of Broad Habitat– Extent of:

- Coniferous woodland
- Broadleaved, mixed & yew woodland
- Woodland priority habitats
- Individual trees / veteran trees

Quality

Nature:

- Biodiversity: Visibility of wildlife (birds, mammals, butterflies); presence of flagship species; Presence of rare (red list) species; species diversity; habitat mosaics (%open space); structural diversity (% canopy/understorey); abundance of dead wood; extent of tree pest and disease; number of veteran trees; favourable condition of SSSIs
- Geodiversity: Geology; Altitude, slope, aspect , land form; favourable condition of designated geosites

Landscape:

- Size of environmental space (ha)
- Ownership by conservation/heritage organisations
- Designation (nature conservation; landscape; access; heritage)
- Boundary features – type, length & condition
- Attributes of landscape character

Culture & history:

- Ancient woodland (ha)
- Designated Historic Environment Assets – World Heritage Sites, Scheduled monuments – (% at risk), Historic Parks & Gardens, Listed Buildings, Conservation Area; registered battlefields
- Undesignated historical & archaeological remains; above and below ground archaeology
- Ancient routes – condition
- Geoheritage: building stones, industrial heritage
- Geoscience and history of geoscience
- Scientific importance e.g. for past climate/environmental history, geoarchaeology including human evolution
- Cultural associations with artists, writers, legends, folklore
- Presence of land/environmental art

Quietness:

- Dark skies
- Tranquillity
- Remoteness
- Noise

Facilities:

- Presence of car parks, toilets; cafe
- Presence of visitor centre
- Presence of Interpretation
- Number of organised events

Accessibility:

- mean number of perimeter access points per km
- Public Rights of Way / permissive paths; footpaths, bridleways, byway – length, density (km/ha)
- Presence of paths accessible to all – e.g. wheelchairs, pushchairs - length, density (km/ha)
- Quality of PRoW – surface, signposting
- Availability of public transport
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration

- % population who can access 2ha green space within 2 miles of home.

Ecosystem Service Flow Practices related to:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
  - Number of people carrying out each activity
  - Frequency – how many times they carried out the activity
  - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children)

Scientific / educational:

- Number of research projects; PhD / Masters projects
- Number of school visits.
- Number of citizen science projects

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual and/or emblematic:

- Number/continuation of traditional festivals and practices

Benefits

Identities e.g. belonging; sense of place; rootedness; spirituality; sense of history;

Experiences e.g. tranquillity; inspiration; escape; discovery

Capabilities e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

COASTAL MARGINS Cultural Ecosystem Services

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity of Broad Habitat– Extent of:

- Beach
- Sand dunes
- Salt marsh
- Mudflats
- Shingle
- Sea cliff
- Coastal lagoons

Quality

Nature:

- Biodiversity: Visibility of wildlife (birds, plants); presence of flagship species; Presence of rare (red list) species; species diversity; habitat mosaics; structural diversity; favourable condition of SSSIs
- Geodiversity: Geology; land form; topography; favourable condition of designated geosites

Landscape and Seascape:

- Size of environmental space (ha)
- Ownership by conservation/heritage organisations
- Designation (nature conservation; landscape; access; heritage)
- Boundary features – type, length & condition
- Attributes of landscape/seascape character

Culture & history:

- Designated Historic Environment Assets – World Heritage Sites, Scheduled monuments – (% at risk), Historic Parks & Gardens, Listed Buildings, Conservation Area; registered battlefields
- Undesignated historical & archaeological remains; above and below ground archaeology
- Ancient routes – condition
- Geoheritage: building stones, industrial heritage
- Geoscience and history of geoscience
- Scientific importance e.g. for past climate/environmental history, geoarchaeology including human evolution
- Cultural associations with artists, writers, legends, folklore
- Presence of land/environmental art

Quietness:

- Dark skies
- Tranquillity
- Remoteness
- Noise

Facilities:

- Presence of car parks, toilets; cafe
- Presence of visitor centre
- Presence of Interpretation
- Number of organised events

Accessibility:

- mean number of perimeter access points per km
- Public Rights of Way / permissive paths; footpaths, bridleways, byway – length, density (km/ha)
- Presence of paths accessible to all – e.g. wheelchairs, pushchairs - length, density (km/ha)
- Quality of PRoW – surface, signposting
- Availability of public transport
- Number of fishing licenses
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration

- % population who can access 2ha green space within 2 miles of home.

Ecosystem Service Flow Practices related to:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
  - Number of people carrying out each activity
  - Frequency – how many times they carried out the activity
  - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children)

Scientific / educational:

- Number of research projects; PhD / Masters projects
- Number of school visits.
- Number of citizen science projects

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual and/or emblematic:

- Number/continuation of traditional festivals and practices

Benefits

Identities e.g. belonging; sense of place; rootedness; spirituality; sense of history;

Experiences e.g. tranquillity; inspiration; escape; discovery

Capabilities e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

ENCLOSED FARMLAND Cultural Ecosystem Services

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity of Broad Habitat– Extent of:

- Arable & rotational leys
- Improved grassland
- Horticulture
- Orchards & top fruit
- Bio-energy crops
- Permanent pasture

Quality

Nature:

- Biodiversity: Visibility of wildlife (birds, mammals, flowers); presence of flagship species; Presence of rare (red list) species; species diversity; number of veteran trees; habitat mosaics; structural diversity; favourable condition of SSSIs
- Geodiversity: Geology; Altitude, slope, aspect , land form; favourable condition of designated geosites

Landscape:

- Size of environmental space (ha)
- Ownership by conservation/heritage organisations
- Designation (nature conservation; landscape; access; heritage)
- Boundary features – type, length & condition
- Built structures – barns, vernacular buildings
- Attributes of landscape character

Culture & history:

- Designated Historic Environment Assets – World Heritage Sites, Scheduled monuments – (% at risk), Historic Parks & Gardens, Listed Buildings, Conservation Area; registered battlefields
- Undesignated historical & archaeological remains; above and below ground archaeology
- Ancient routes – condition
- Geoheritage: building stones, industrial heritage
- Geoscience and history of geoscience
- Scientific importance e.g. for past climate/environmental history, geoarchaeology including human evolution
- Cultural associations with artists, writers, legends, folklore
- Presence of land/environmental art

Quietness:

- Dark skies
- Tranquillity
- Remoteness
- Noise

Facilities:

- Presence of car parks, toilets; cafe
- Presence of visitor centre
- Presence of Interpretation
- Number of organised events

Accessibility:

- mean number of perimeter access points per km
- Public Rights of Way / permissive paths; footpaths, bridleways, byway – length, density (km/ha)
- Presence of paths accessible to all – e.g. wheelchairs, pushchairs - length, density (km/ha)
- Quality of PRoW – surface, signposting
- Availability of public transport
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration

- % population who can access 2ha green space within 2 miles of home.

Ecosystem Service Flow Practices related to:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
  - Number of people carrying out each activity
  - Frequency – how many times they carried out the activity
  - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children)

Scientific / educational:

- Number of research projects; PhD / Masters projects
- Number of school visits.
- Number of citizen science projects

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual and/or emblematic:

- Number/continuation of traditional festivals and practices

Benefits

Identities e.g. belonging; sense of place; rootedness; spirituality; sense of history;

Experiences e.g. tranquillity; inspiration; escape; discovery

Capabilities e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

FRESHWATERS Cultural Ecosystem Services

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity of Broad Habitat– Extent of:

- Rivers
- Modified waters (e.g. canals, reservoirs)
- Groundwaters
- Coastal and floodplain grazing marsh
- Lakes and standing waters
- Lowland fens
- Lowland raised bog
- Ponds
- Reedbeds

Quality

Nature:

- Biodiversity: Visibility of wildlife (fish, birds, mammals); presence of flagship species; Presence of rare (red list) species; species diversity; habitat mosaics; structural diversity; favourable condition of SSSIs
- Geodiversity: Geology; Altitude, slope, aspect , land form; naturalness of watercourses; favourable condition of designated geosites

Landscape:

- Size of environmental space (ha)
- Ownership by conservation/heritage organisations
- Designation (nature conservation; landscape; access; heritage)
- Boundary features – type, length & condition
- Attributes of landscape character

Culture & history:

- Designated Historic Environment Assets – World Heritage Sites, Scheduled monuments – (% at risk), Historic Parks & Gardens, Listed Buildings, Conservation Area; registered battlefields
- Undesignated historical & archaeological remains; above and below ground archaeology
- Ancient routes – condition
- Geoheritage: building stones, industrial heritage
- Geoscience and history of geoscience
- Scientific importance e.g. for past climate/environmental history, geoarchaeology including human evolution
- Cultural associations with artists, writers, legends, folklore
- Presence of land/environmental art

Quietness:

- Dark skies
- Tranquillity
- Remoteness
- Noise

Facilities:

- Presence of car parks, toilets; cafe
- Presence of visitor centre
- Presence of Interpretation
- Number of organised events

Accessibility:

- mean number of perimeter access points per km
- Public Rights of Way / permissive paths; footpaths, bridleways, byway – length, density (km/ha)
- Presence of paths accessible to all – e.g. wheelchairs, pushchairs - length, density (km/ha)
- Quality of PRoW – surface, signposting
- Number of fishing licenses
- Availability of public transport
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration

- % population who can access 2ha green/blue space within 2 miles of home.

Ecosystem Service Flow Practices related to:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
  - Number of people carrying out each activity
  - Frequency – how many times they carried out the activity
  - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children)

Scientific / educational:

- Number of research projects; PhD / Masters projects
- Number of school visits.
- Number of citizen science projects

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual and/or emblematic:

- Number/continuation of traditional festivals and practices

Benefits

Identities e.g. belonging; sense of place; rootedness; spirituality; sense of history;

Experiences e.g. tranquillity; inspiration; escape; discovery

Capabilities e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

MARINE Cultural Ecosystem Services

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity of Broad Habitat– Extent of:

- Blue mussel beds
- Deep sea habitats
- Intertidal rock
- Intertidal sediment
- Maerl beds
- Reefs
- Sea grass beds
- Shallow subtidal sediment
- Shelf subtidal sediment
- Subtidal rock

Quality

Nature:

- Biodiversity: Visibility of wildlife (birds, mammals, fish); presence of flagship species; Presence of rare (red list) species; species diversity; habitat mosaics; structural diversity; favourable condition of SSSIs/Marine Protected Areas
- Geodiversity: Geology; land form; topography; favourable condition of designated geosites
- Bathing water quality

Seascape:

- Designation
- Presence of rigs, turbines etc.

Culture & history:

- Designated Historic Environment Assets – World Heritage Sites, Scheduled monuments – (% at risk), Protected wreck sites
- Undesignated historical & archaeological remains;
- Cultural associations with artists, writers, legends, folklore
- Presence of environmental art
- Presence of recorded Dive sites

Quietness:

- Dark skies
- Tranquillity
- Remoteness
- Noise

Facilities:

- Presence of car parks, toilets; cafe
- Designated recreation areas (windsurfing, water skiing etc.)
- Number of organised events
- Presence of visitor centre
- Presence of Interpretation
- Presence of clubs, schools, training centres
- Presence of moorings

Accessibility:

- Availability of public transport
- Presence of slipways
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration

- Nothing identified for this service

Ecosystem Service Flow

Practices related to:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
  - Number of people carrying out each activity
  - Frequency – how many times they carried out the activity
  - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children)

Scientific / educational:

- Number of research projects; PhD / Masters projects
- Number of school visits.
- Number of citizen science projects

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual and/or emblematic:

- Number/continuation of traditional festivals and practices

Benefits

Identities e.g. belonging; sense of place; rootedness; spirituality; sense of history;

Experiences e.g. tranquillity; inspiration; escape; discovery

Capabilities e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

MOUNTAIN, MOORLAND & HEATH Cultural Ecosystem Services

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity of Broad Habitat– Extent of:

- Rivers, lakes, reservoirs (above moorland line)
- Blanket bog
- Woodland (above moorland line)
- Dwarf shrub heath –wet & dry
- Mountain heath and willow scrub
- Bracken
- Upland flushes fens and swamps
- Semi-natural grassland (above moorland line)
- Inland rock, scree and pavement (above the moorland line)
- Wood pasture (above the moorland line)

Quality

Nature:

- Biodiversity: Visibility of wildlife (birds, mammals, plants, reptiles); presence of flagship species; Presence of rare (red list) species; species diversity; habitat mosaics; structural diversity; favourable condition of SSSIs
- Geodiversity: Geology; Altitude, slope, aspect , land form; naturalness of watercourses; favourable condition of designated geosites

Landscape:

- Size of environmental space (ha)
- Ownership by conservation/heritage organisations
- Designation (nature conservation; landscape; access; heritage)
- Uninterrupted views – absence of pylons, turbines
- Attributes of landscape character

Culture & history:

- Designated Historic Environment Assets – World Heritage Sites, Scheduled monuments – (% at risk), Historic Parks & Gardens, Listed Buildings, Conservation Area; registered battlefields
- Undesignated historical & archaeological remains; above and below ground archaeology
- Ancient routes – condition
- Geoheritage: building stones, industrial heritage
- Geoscience and history of geoscience
- Scientific importance e.g. for past climate/environmental history, geoarchaeology including human evolution
- Cultural associations with artists, writers, legends, folklore
- Presence of land/environmental art

Quietness:

- Dark skies
- Tranquillity
- Remoteness
- Noise

Facilities:

- Presence of car parks, toilets; cafe
- Presence of visitor centre
- Presence of Interpretation
- Number of organised events

Accessibility:

- mean number of perimeter access points per km
- Public Rights of Way / permissive paths; footpaths, bridleways, byway – length, density (km/ha)
- Presence of paths accessible to all – e.g. wheelchairs, pushchairs - length, density (km/ha)
- Quality of PRoW – surface, signposting
- Availability of public transport
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration

- % population who can access 2ha green space within 2 miles of home.

Ecosystem Service Flow Practices related to:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
  - Number of people carrying out each activity
  - Frequency – how many times they carried out the activity
  - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children)

Scientific / educational:

- Number of research projects; PhD / Masters projects
- Number of school visits.
- Number of citizen science projects

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual and/or emblematic:

- Number/continuation of traditional festivals and practices

Benefits

Identities e.g. belonging; sense of place; rootedness; spirituality; sense of history;

Experiences e.g. tranquillity; inspiration; escape; discovery

Capabilities e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

Non-use values: Existence, bequest, altruistic; option

SEMI-NATURAL GRASSLAND Cultural Ecosystem Services

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity of Broad Habitat– Extent of:

- Hay meadows
- Other semi-natural grasslands

Quality

Nature:

- Biodiversity: Visibility of wildlife (birds, flowers, butterflies); presence of flagship species; Presence of rare (red list) species; species diversity; number of veteran trees; habitat mosaics; structural diversity; favourable condition of SSSIs
- Geodiversity: Geology; Altitude, slope, aspect , land form; favourable condition of designated geosites

Landscape:

- Size of environmental space (ha)
- Ownership by conservation/heritage organisations
- Designation (nature conservation; landscape; access; heritage)
- Boundary features – type, length & condition
- Attributes of landscape character

Culture & history:

- Designated Historic Environment Assets – World Heritage Sites, Scheduled monuments – (% at risk), Historic Parks & Gardens, Listed Buildings, Conservation Area; registered battlefields
- Undesignated historical & archaeological remains; above and below ground archaeology
- Ancient routes – condition
- Geoheritage: building stones, industrial heritage
- Geoscience and history of geoscience
- Scientific importance e.g. for past climate/environmental history, geoarchaeology including human evolution
- Cultural associations with artists, writers, legends, folklore
- Presence of land/environmental art

Quietness:

- Dark skies
- Tranquillity
- Remoteness
- Noise

Facilities:

- Presence of car parks, toilets; cafe
- Presence of visitor centre
- Presence of Interpretation
- Number of organised events

Accessibility:

- mean number of perimeter access points per km
- Public Rights of Way / permissive paths; footpaths, bridleways, byway – length, density (km/ha)
- Presence of paths accessible to all – e.g. wheelchairs, pushchairs - length, density (km/ha)
- Quality of PRoW – surface, signposting
- Availability of public transport
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration

- % population who can access 2ha green space within 2 miles of home.

Ecosystem Service Flow Practices related to:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
  - Number of people carrying out each activity
  - Frequency – how many times they carried out the activity
  - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children)

Scientific / educational:

- Number of research projects; PhD / Masters projects
- Number of school visits.
- Number of citizen science projects

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual and/or emblematic:

- Number/continuation of traditional festivals and practices

Benefits

Identities e.g. belonging; sense of place; rootedness; spirituality; sense of history;

Experiences e.g. tranquillity; inspiration; escape; discovery

Capabilities e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

URBAN Cultural Ecosystem Services

Ecosystem Assets

(Factors affecting provision of ecosystem service)

Quantity of Broad Habitat– Extent of:

- Semi-natural habitats
- Open mosaic habitats
- Woodland, scrub and hedge
- Urban/street Trees canopy cover
- Green space not semi-natural habitat
- Blue space: open water ponds; lakes, reservoirs rivers, canals, streams, SUDs and associated vegetation

Quality

Nature:

- Biodiversity: Visibility of wildlife (birds, mammals; flowers, butterflies); presence of flagship species; Presence of rare (red list) species; species diversity; number of veteran trees; habitat mosaics; structural diversity; favourable condition of SSSIs
- Geodiversity: Geology; Altitude, slope, aspect , land form; favourable condition of designated geosites

Landscape, seascape and urban green space:

- Size of environmental space (ha)
- Ownership by conservation/heritage organisations
- Designation (nature conservation; landscape; access; heritage)
- Attributes of landscape character

Culture & history:

- Designated Historic Environment Assets – World Heritage Sites, Scheduled monuments – (% at risk), Historic Parks & Gardens, Listed Buildings, Conservation Area; registered battlefields
- Undesignated historical & archaeological remains; above and below ground archaeology
- Ancient routes – condition
- Geoheritage: building stones, industrial heritage
- Geoscience and history of geoscience
- Scientific importance e.g. for past climate/environmental history, geoarchaeology including human evolution
- Cultural associations with artists, writers, legends, folklore
- Presence of land/environmental art

Quietness:

- Dark skies
- Tranquillity
- Remoteness
- Noise

Facilities:

- Presence of car parks, toilets; cafe
- Presence of visitor centre
- Presence of Interpretation
- Number of organised events
- Positive management and maintenance

Accessibility:

- mean number of perimeter access points per km
- Public Rights of Way / permissive paths; footpaths, bridleways, byway – length, density (km/ha)
- Presence of paths accessible to all – e.g. wheelchairs, pushchairs - length, density (km/ha)
- Quality of PRoW – surface, signposting
- Availability of public transport
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration

- % population who can access 2ha green/blue space within 2 miles of home.

Ecosystem Service Flow Practices related to:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
    - Number of people carrying out each activity
    - Frequency – how many times they carried out the activity
    - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children)

Scientific / educational:

- Number of research projects; PhD / Masters projects
- Number of school visits.
- Number of citizen science projects

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual and/or emblematic:

- Number/continuation of traditional festivals and practices

Benefits

Identities e.g. belonging; sense of place; rootedness; spirituality; sense of history;

Experiences e.g. tranquillity; inspiration; escape; discovery

Capabilities e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

GEODIVERSITY: All abiotic & ecosystem services

Natural Capital Assets (terrestrial, coastal & marine)

(Factors affecting provision of abiotic/ecosystem service)

Quantity

- Geological strata/bedrock type
- Unconsolidated deposits
- Minerals, aggregates, fossil fuels

Quality

Geophysical:

- Landforms
- Substrate (including bare rock)
- Structures e.g. tectonic, sedimentary, faulting & jointing
- Permeability, porosity and aquifer properties
- Characteristics e.g. banding, cleavage, schistosity
- Exposure (including lack of artificial sealing)

Geochemical:

- Chemical composition (including pH, carbon, nutrients)
- Hydro geochemistry

Palaeontology and Minerals:

- Fossils
- Minerals

Formative geological processes:

- Active geomorphological processes; terrestrial, coastal & marine
- Naturalness of soil formation/weathering environments

Nature:

- Favourable condition of designated geosites

Landscape, seascape and urban green space:

- Ownership by conservation/heritage organisations
- Geological designated sites: e.g. Geosites; World Heritage Sites; GeoParks; SSSIs; Local Geological Sites; Limestone Pavement Orders, National Nature Reserves, Geoarchaeological Scheduled Monuments
- Landscape and seascape character

Culture & history:

- Geoheritage:, historic environment, building stones, industrial heritage
- Geoscience and history of geoscience
- Scientific importance e.g. for past climate/environmental history, geoarchaeology including human evolution
- Cultural associations with artists, writers, legends, folklore
- Land/environmental art

Ideal indicators highlighted: short list and long list

Quality continued

Facilities:

- Presence of car parks, toilets, cafe
- Presence of visitor centre covering geology
- Presence of geological and geoheritage interpretation

Accessibility:

- Accessibility of geological features, formations and land forms
- Availability of public transport
- Digital accessibility

Safety:

- Recorded crime

Spatial Configuration/location:

- Flood regulation: location of flood mitigating structures in relation to infrastructure & settlements
- Water quality: location in relation to water pollution sources, pathways and receptors.
- Geological designations creating green space: % population who can access 2ha green space within 2 miles of home.

Abiotic Service Flow

Provisioning:

- Surface or ground water used for nutrition (drinking), materials or energy
- Mineral substances used for nutrition, materials or energy
- Non-mineral substances or ecosystem properties used for nutrition, materials or energy e.g. renewable energy

Regulating:

- Mediation of waste, toxics and other nuisances by non-living processes
- Regulation of baseline flows and extreme events
- Maintenance of physical, chemical, abiotic conditions
- Climate regulation

Cultural: practices relating to geology:

Experiential & Physical Use:

- Number of visits
- Duration of visit
- Range of activities undertaken
    - Number of people carrying out each activity
    - Frequency – how many times they carried out the activity
    - Time spent – how long they spent at each activity
- Number of volunteer days
- Distance travelled from car park / transport
- Segmentation/demographic (including children

Scientific/educational

- Number of geological research projects; PhD / Masters projects
- School visits linked to geology

Aesthetic:

- Number of photos posted on social media
- Artistic representation on social media

Spiritual, symbolic and other interactions

- Number/continuation of traditional festivals and practices

Benefits

- Food and drink
- Fossil fuels and renewable energy
- Construction materials
- Industrial and metallic minerals
- Gemstones
- Fossils
- Habitat provision
- Burial and storage
- Equitable climate
- Reduced flood and erosion risk
- Clean water
- Clean air

Cultural Benefits:

- **Identities** e.g. belonging; sense of place; rootedness; spirituality; sense of history;
- **Experiences** e.g. tranquillity; inspiration; escape; discovery
- **Capabilities** e.g. Knowledge; health; dexterity; judgement

Non-use values: Existence, bequest, altruistic; option

Management Interventions and Drivers of Change

- Quarrying, mining & mineral extraction offshore extraction
- Development and infrastructure
- Waste disposal and landfill
- Loss of access e.g. due to vegetation
- Water abstraction and reservoir creation
- Drainage and other changes in water levels
- Coastal/river/slope management & engineering
- Pollution
- Climate change, including sea level rise
- Regulation and policies
- Market forces – domestic & global
- Increasing human population
- Technological advances (e.g. in mining practices)
- Recreational pressures
- Removal of geological specimens
- Energy generation