Carnsore Ecosystem Accounts

- Extent Account
- Condition Account
- Risk Register

Glossary

Term	Definition
Abiotic characteristics	Contributions to benefits from the environment that are not underpinned by, or reliant on, ecological characteristics and processes
Biotic characteristics	Contributions to benefits from the environment that are underpinned by, or reliant on ecological characteristics and processes.
Chemical state	Chemical composition of abiotic ecosystem compartments.
Compositional state	Composition/diversity of ecological communities at a given location and time.
Ecosystem Accounting Area (EAA)	The total area within which the NCA are created - i.e., the windfarm boundary.
Ecosystem assets	Contiguous spaces of a specific ecosystem type characterised by a distinct set of biotic and abiotic components and their interactions.
Ecosystem capacity	An ecosystem's ability to generate an ecosystem service under current conditions and type of use.
Ecosystem characteristics	the system properties of the ecosystem and its major abiotic and biotic components (water, soil, topography, etc.).
Ecosystem condition	The quality of an ecosystem measured in terms of its abiotic and biotic factors.
Ecosystem condition typology (ECT)	A hierarchical typology for organising data on ecosystem condition characteristics.
Ecosystem extent	The size of an ecosystem asset - usually measured in terms of spatial area.
Functional state	Summary statistics of the biological, chemical, and physical interactions between the main ecosystem compartments.
Landscape/seascape characteristics	Metrics describing mosaics of ecosystem types at coarse spatial scales (beyond EEA).
Natural capital	Term for nature's assets, incl. soil, water, forests, biodiversity, etc.
Natural capital accounting (NCA)	A systematic way to report on stocks and flows of natural capital by organising this information in an accounting format.
Physical state	Physical descriptors of the abiotic components of the ecosystem (e.g., soil structure, water availability).
Reference condition	The condition against which past, present, and future ecosystem condition is compared to in order to measure relative change over time.
Structural state	Aggregate properties of the whole ecosystem or its main biotic communities.
System of Environmental Economic Accounting-Ecosystem Accounting (SEEA-EA)	A spatially-based, integrated statistical framework for organising biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity.

Fossitt Codes used:

A Guide to Habits in Ireland – Fossitt

Habitat Code	Habitat Name	Description
GA1	Improved agricultural grassland	Intensively managed grassland. Has been reseeded, and/or regularly fertilised. Heavily grazed or used for silage making.
GS1	Dry calcareous and neutral grassland	Unimproved or semi-improved dry grassland. Not acidic. Associated with low-intensity agriculture.
GS2	Dry meadows and grassy verges	Rarely fertilised or grazed – they are mown only once or twice a year.
GS4	Wet grassland	Grass on wet/waterlogged, or poorly draining mineral soils.
WS1	Scrub	Areas that are dominated by at least 50% cover of shrubs, stunted trees, or brambles. Canopy height <5m. Frequently a precursor to woodland.
HD1	Dense bracken	Areas of open vegetation that are dominated by Bracken (*Pteridium aquilinum*) – a type of fern.
LR4	Mixed substrata shores	Seashore habitat - consists of a mixture of rock and sediment (sand). Occurs in moderately sheltered areas.
FS1	Reed and large sedge swamps	Species-poor stands of herbaceous vegetation dominated by reeds and other large grasses or large, tussock-forming sedges. Usually occupies an area of transitions at the edge of open water. Typically wet, although water levels do fluctuate.
ED2	Spoil and bare ground	Heaps of rubble and spoil – often transient, or if persistent experience ongoing disturbance or maintenance. Once the disturbance ends, the area is recolonised by plants.
ED3	Recolonising bare ground	Areas where bare and disturbed ground, rubble, tarmac and concrete surfaces are invaded by herbaceous plants. Vegetation cover of >50%.
BC1	Arable crops	Agricultural land that is cultivated and managed for the production of arable crops.
BL3	Buildings and artificial surfaces	Includes all buildings, other than derelict stone buildings and ruins. Als includes artificial surfaces – tarmac, concrete, paving, astroturf etc.

Extent Account

Ecosystem extent accounts measure the size of ecosystem assets. It is a starting point to organise ecosystem information on the size, type and change over time within the EAA. Gathering this extent data provides an underlying infrastructure for the measurement of ecosystem condition later, and also over time it can be used to determine how ecosystem assets have changed (United Nations et al., 2021). Ecosystem assets are contiguous spaces of a specific ecosystem type characterised by a distinct set of biotic and abiotic components and their interactions (United Nations et al., 2021). Here, we have defined ecosystem assets as contiguous areas which fit into one habitat type defined in Fossitt (2000) 'A Guide to Habitats in Ireland' – the standard guidance document for classifying Irish habitats. To standardise and facilitate defining ecosystem assets, a minimum mappable area of 400 m^2 was used for ecosystem assets – as described in Smith et al. (2011) Best Practice Guidance for Habitat Survey and mapping.

GIS data was collated for the site – including boundary polygons, turbine locations, roadways, and any other site features. Preliminary habitat maps were generated based on habitats identified in EIAR and operational reports. These habitat maps were then ground-truth on site during fieldwork in the summer of 2022 and any habitat or features missed were recorded.

The preliminary maps and the maps created onsite were input to ArcGISPro. Here, we extracted all the area data to calculate the ecosystem extent in metres squared (m^2). We have also presented it here as a percentage of the total EAA.

Ecosystem type	Fossitt Code	Habitat Name	Area (m2)	Area (%)
Grassland	GA1	Improved agricultural grassland	545910	69.31486
	GS1	Dry calcareous and neutral grassland	17097	2.170827
	GS2	Dry meadows and grassy verges	22936	2.912212
	GS4	Wet grassland	27122	3.443714
		Total:	**613065**	**77.84162**
Woodland & Scrub	WS1	Scrub	91727	11.64669
		Total:	**91727**	**11.64669**
Heath & Dense Bracken	HD1	Dense bracken	5050	0.641205
		Total:	**5050**	**0.641205**
Littoral (intertidal)	LR4	Mixed substrata shores	5965	0.757383
		Total:	**5965**	**0.757383**
Freshwater	FS1	Reed and large sedge swamps	9547	1.212194
		Total:	**9547**	**1.212194**
Exposed rock and disturbed ground	ED2	Spoil and bare ground	22419	2.846568
	ED3	Recolonising bare ground	13500	1.714112
		Total:	**35919**	**4.56068**
Cultivated and built land	BC1	Arable crops	24982	3.171995
	BL3	Buildings and artificial surfaces	1325	0.168237
		Total:	**26307**	**3.340232**
		Total:	**787580**	**100**

Extent Description

In Carnsore, grassland habitats account for the largest proportion of the site (78%), with improved agricultural grassland (GA1) dominating (69%). The area of windfarm operations is estimated to be approximately 60180 m^2 (8% of total site area), consisting of buildings and artificial surfaces (BL3 – substation), spoil and bare ground (ED2 – roadways), recolonising bare ground (ED3 - turbine hardstands), and dry meadows and grassy verges (GS2 – road verges and turbine hardstands).

There are a number of habitats of potential biodiversity-interest on site, including dry calcareous and neutral grassland (GS1 – 2%), scrub (WS1 – 12%), and reed and large sedge swamps (FS1 – 1.2%).
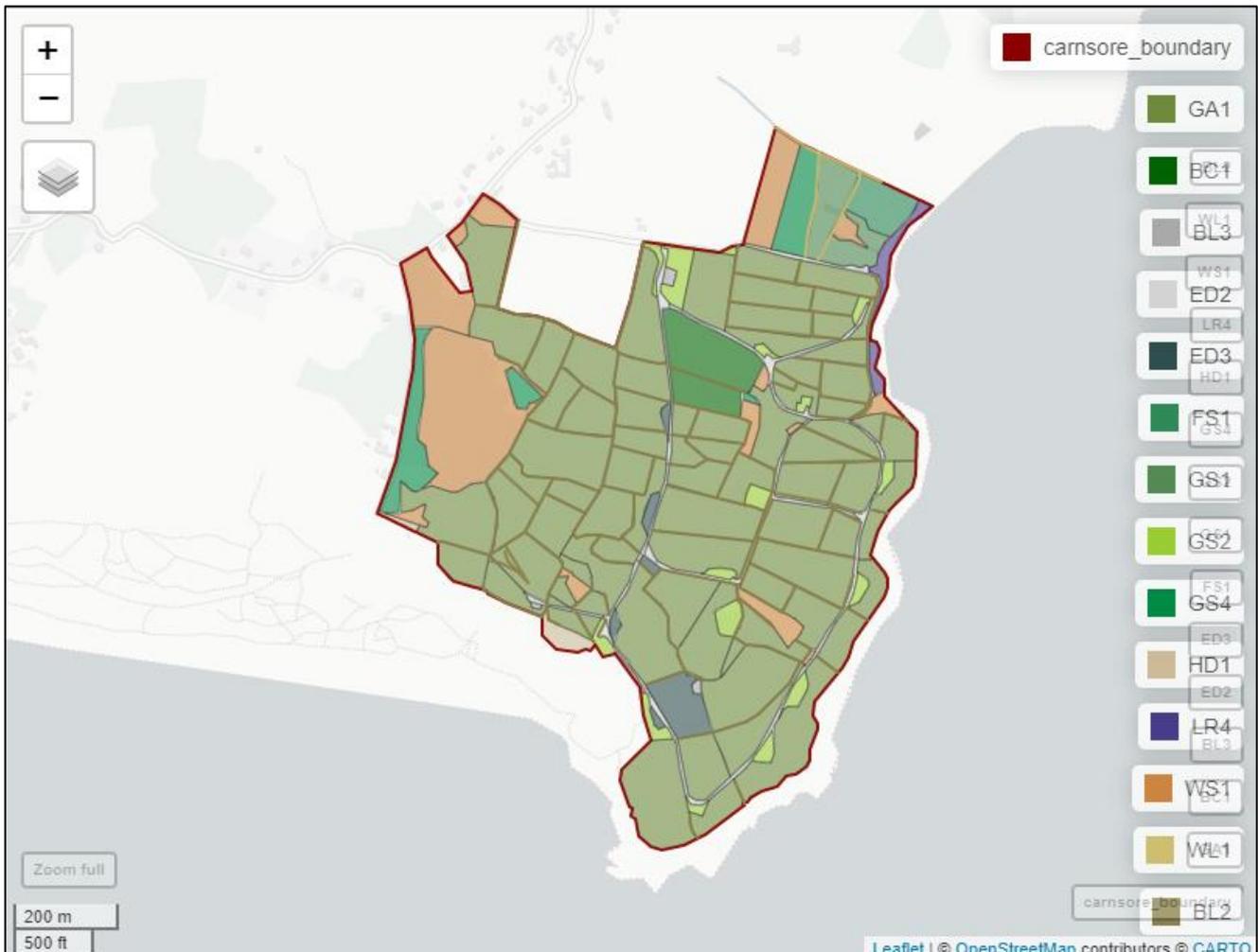
Condition Account

Ecosystem condition accounts measure the quality of an ecosystem which is quantified in terms of its abiotic and biotic factors (United Nations et al., 2011). The accounts presented here are biodiversity-themed accounts; they evaluate the capacity of habitats to support biodiversity. Biodiversity is usually defined as species, genetic and ecosystem diversity (IPBES secretariat, 2019), and our accounts focus on ecosystem diversity in the hopes it will also encompass and protect both genetic and species diversity also. For a biodiversity condition account, it is necessary to include habitat-specific condition characteristics that are relevant to the capacity of that habitat to support biodiversity. These characteristics need to be able to show a directional change over consecutive accounting periods in a scientifically sound way. This will indicate changes to the overall biodiversity capacity of the habitat.

Ecosystem condition is measured using characteristics are measured using variables and indicators. Variables are quantitative metrics describing characteristics which have an unambiguous definition and well-defined measurement units (e.g., metres, kilograms, etc.). Variables are rescaled against reference levels to create indicators. As windfarms are part of anthropogenic ecosystems and usually sited within highly modified anthropogenic ecosystems the 'best-attainable condition' was selected for use as the reference condition. This allows us to compare condition against what would be the most attainable condition for biodiversity under good management in a modified environment.

To select and organise the data collated for the biodiversity condition accounts the SEEA (System of Economic Environmental Accounting) ecosystem condition typology (ECT) was used. It provided a template and structure for variable and indicator selection and organisation, in an ecologically meaningful way. Typically, there are six classes in the ECT, however, to fit the available data and fairly represent the biodiversity theme we did not include 'Functional state characteristics' – as the indicators/variables selected could be better placed into other classes and this is recommended (United Nations et al., 2011). A combination of academic and grey literature was used as a primary source to inform the development of the chosen variables, but we also based our variables on biodiversity indicators used in other projects for similar habitat types (e.g., Wild Atlantic Nature Scorecards, Hen Harrier Project Scorecards, FarmPeat Scorecards). The main constraint on the selection of variables was the availability of data. Data needed to have explicit spatial information associated, so indicators could be accurately assigned to habitats on site and reduce uncertainty (e.g., National Biodiversity Data Centre data did not contain spatially explicit coordinates). Most variables were gathered in the field through the development of a scorecard index, which allowed us to generate the indicator scores for variables in the field. For remote variables, such as proportion of protected area within a 500 m radius, GIS manipulation was required.

Grasslands
GA1, GS1, GS2, GS3, GS4

Abiotic characteristic(s) – Physical State
Bare Soil:

|	Standard Index	Bare Soil
0	Unfavourable	Large areas of bare soil/poaching fragment >50% of habitat
1	Adequate	Medium size patches of bare soil throughout habitat
2	Favourable	Small, isolated patches of bare soil less than 10% of habitat
3	Highly favourable	No evidence of bare soil in habitat

Biotic characteristic(s) – Compositional State
Hedgerow cover (Perimeter)

To get exact hedgerow cover of the perimeter, GIS tools were used. The length of the linear feature that intersected the perimeter was extracted, then calculated the percentage coverage of this over the total perimeter of the habitat polygon. Hedgerow cover could also be estimated in the field if the boundary of the habitat polygon is available and easy to identify.

	Standard Index (% Conversion)	Hedgerow cover (Perimeter)
0	0-25%	Hedgerow covers between 0-25% of total perimeter
1	26-50%	Hedgerow covers between 26-50% of total perimeter
2	51-75%	Hedgerow covers between 51-75% of total perimeter
3	76-100%	Hedgerow covers between 76-100% of total perimeter

Example of the scorecard indexes for variables used to measure biodiversity condition of grasslands.

Developing the condition account takes place over three stages which produces three accounts along the way**: the variable account, indicator account and ecosystem condition account**. As biodiversity condition is often quite variable, we added a fourth standardisation step following the variable account. This allowed us to place every indicator on the same standard index (0-3) so that ranges could be used for reference conditions or for variables (e.g., for Tree Cover Density, where values in the range 0-15% and >60% are typically unfavourable, standardisation allowed us to facilitate this in the reference conditions for the indicator account in that those unfavourable ranges received the indicator 0). For each accounting stage, we generalised over the entire habitat type.
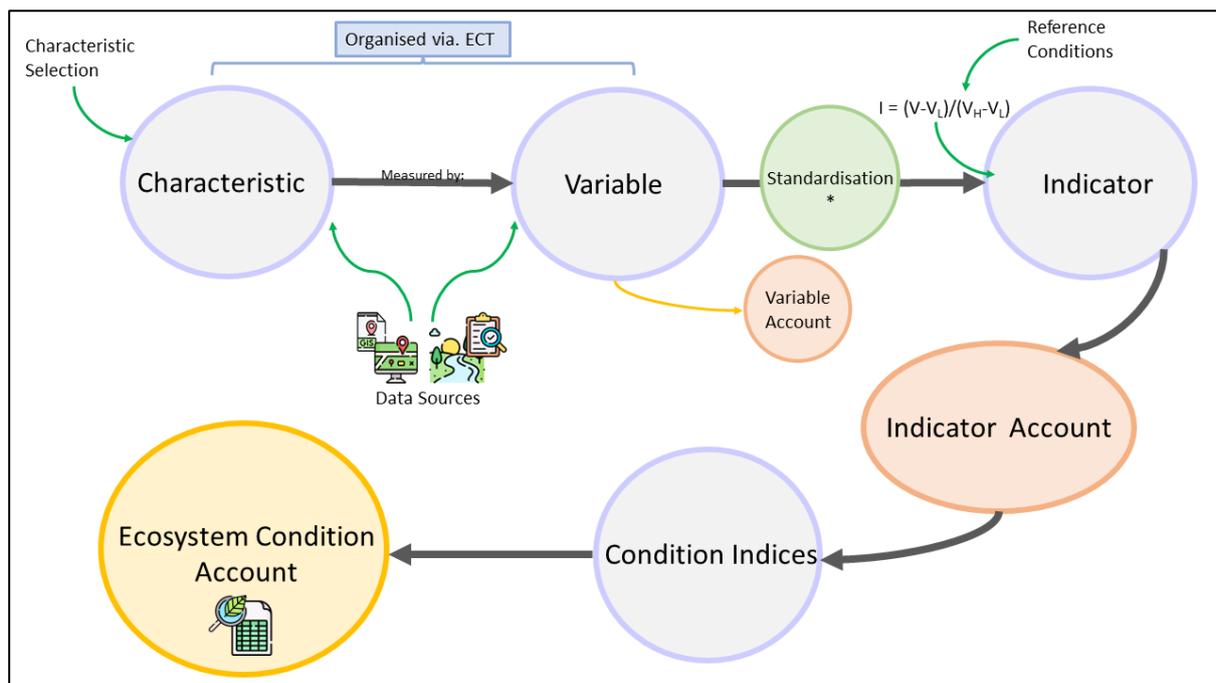
Following the development of indicators from reference conditions, condition indices were developed by weighting all the indicators used to develop a condition score for the habitat type. These condition scores are a value between 0-1, where 0 = poor condition and 1 = best attainable condition. Definitions of the variable descriptor can be found in the excel spreadsheet of the condition accounts.

SEEA Ecosystem Typology Class		Variable descriptor	Measurement unit	Habitat											
				GA1	GS4	GS2	GS1	WS1	BC1	HD1	ED3	FS1	LR4	BL3	ED2
Extent		*Area*	m²	545910	27122	22936	17097	91727	24982	5050	13500	9547	5965	1325	22419
		% Cover	%	69.31	3.44	2.91	2.17	11.65	3.17	0.64	1.71	1.21	0.76	0.17	2.85
Abiotic c	Physical state	Bare ground	Index (0-3)	2.00	1.00	2.00	2.00	1.00	3.00	2.00	3.00	3.00			
		Erosion	Index (0-5)										1.00		
	Chemical state														
Biotic ch	Compositional state	Hedgerow Cover (Perimeter)	Index (0-3)	1.00	0.00	0.00	1.00		1.00	0.00	0.00				
		Hedgerow Cover (Total Area)	Index (0-3)					0.00							
		Herbicide Use	Binary (0/1)						0.00		0.00				
		Vegetation Richness	Index (0-3)									3.00			
	Structural state	Vegetation Structure	Index (0-3)	1.00	2.00	3.00	2.00	1.00		2.00					
		Scrub encroachment	Index (0-3)	2.00	2.00	2.00	2.00			2.00			3.00	3.00	
		Grazing	Index (0-3)	1.00	2.00	3.00									
		Hedgerow Condition	Index (0-3)	2.00	1.00	2.00	1.00	2.00	2.00	1.00	2.00				
		Vegetation Height	m									3.00			
		Crop diversity	Index (0-3)						1.00						
Landscape/seascape characte		% 5 km buffer covered by protected areas	Index (0-3)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00		
		WFD Risk	Binary (-0/+1)										1.00		
		Condition Indices		0.54	0.40	0.54	0.56	0.38	0.58	0.47	0.58	0.89	0.72		

Stage 1. Variable account

GS4	Wet Grassland			
	SEEA Ecosystem Condition Typology Class		Variable descriptor	Measurement unit	Variable values (observed) Opening
	(1)	(2)	(3)	(4)	(5)
	Abiotic characteristics	Physical state	Bare soil	Index (0-3)	2
		Chemical state			
	Biotic characteristics	Compositional state	Hedgerow Cover (Perimeter)	%	18.72
		Structural state	Vegetation Structure	Index (0-3)	2
			Scrub encroachment	Index (0-3)	2
			Grazing	Index (0-3)	2
			Hedgerow Condition	Index (0-3)	1
	Landscape/seascape characteristics		% 5km Buffer Covered by Protected	%	71.52

Stage 2. Standardisation

GS4	Wet Grassland					
	SEEA Ecosystem Condition Typology Class		Variable descriptor	Measurement unit	Variable values (observed) Opening	Standardised (0-3)
	(1)	(2)	(3)	(4)	(5)	(5*)
	Abiotic characteristics	Physical state	Bare soil	Index (0-3)	2	2
		Chemical state				
	Biotic characteristics	Compositional state	Hedgerow Cover (Perimeter)	%	18.72	0
		Structural state	Vegetation Structure	Index (0-3)	2	2
			Scrub encroachment	Index (0-3)	2	2
			Grazing	Index (0-3)	2	2
			Hedgerow Condition	Index (0-3)	1	1
	Landscape/seascape characteristics		% 5km Buffer Covered by Protected Area	%	71.52	2

Stage 3. Indicator account

| GS4	Wet Grassland							
	SEEA Ecosystem Condition Typology Class		Variable descriptor	Measurement unit	Variable values (observed) Opening	Reference level values Lower level	Upper level	Indicator values (rescaled) Opening
	(1)	(2)	(3)	(4)	(5*)	(7)	(8)	(9)
	Abiotic characteristics	Physical state	Bare ground	Index (0-3)	1	0	3	0.33
		Chemical state						
	Biotic characteristics	Compositional state	Hedgerow Cover (Perimeter)	%	0	0	3	0.00
		Structural state	Vegetation Structure	Index (0-3)	2	0	3	0.67
			Scrub encroachment	Index (0-3)	2	0	3	0.67
			Grazing	Index (0-3)	2	0	3	0.67
			Hedgerow Condition	Index (0-3)	1	0	3	0.33
	Landscape/seascape characteristics		% 5km Buffer Covered by Protected Area	%	2	0	3	0.67

Stage 4. Index account (Condition scores)

GS4	Wet Grassland						
	SEEA Ecosystem Condition Typology Class		Variable descriptor	Measurement unit	Indicator values (0 - 1) Opening	Weight in aggregate index Opening	Index values Opening
	(1)	(2)	(3)	(4)	(9)	(12)	(13)
	Abiotic characteristics	Physical state	Bare ground	Index (0-3)	0.33	0.25	0.08
		Chemical state					
		Total Abiotic					**0.08**
	Biotic characteristics	Compositional state	Hedgerow cover (perimeter)	Index (0-3)	0.00	0.25	0.00
		Structural state	Vegetation structure	Index (0-3)	0.67	0.06	0.04
			Scrub encroachment	Index (0-3)	0.67	0.06	0.04
			Grazing	Index (0-3)	0.67	0.06	0.04
			Hedgerow condition	Index (0-3)	0.33	0.06	0.02
		Total Biotic					**0.15**
	Landscape/seascape characteristics		% 5 km buffer covered by protected area	Index (0-3)	0.67	0.25	0.17
		Total Landscale/seascape					**0.17**
	Total					1.00	**0.40**

Condition Description

in Carnsore the condition scores ranged from 0.38-0.89. Reed and large sedge swamps (FS1) had the highest condition score of 0.89, while scrub (WS1) had the lowest score of 0.38. Both reed and large sedge swamps (FS1, condition score = 0.89) and mixed substrata shores (LR4, condition score = 0.72) are wetland/coastal features and habitats unique to this site, and both had relatively high condition indices. Improved agricultural grassland (GA1) is the most frequent habitat type on site and on average it scored 0.54, with the lowest indicators influencing the score including grazing, vegetation structure and proportion of the perimeter surrounded by hedgerows (WL1). The other grassland habitats dry calcareous grassland (GS1), dry meadows and grassy verges (GS2), and wet grassland (GS4) scored 0.56, 0.54, and 0.40 respectively. Wet grassland's low score can be attributed to the low indicator score for hedgerow coverage of the polygon perimeter (index score = 0 – hedgerows cover between 0-25% of total perimeter), and in addition the hedgerow that was present was only in an adequate condition (index score = 1). The heavily modified habitats such as arable crops (BC1) and recolonising bare soil (ED3) both scored 0.58.
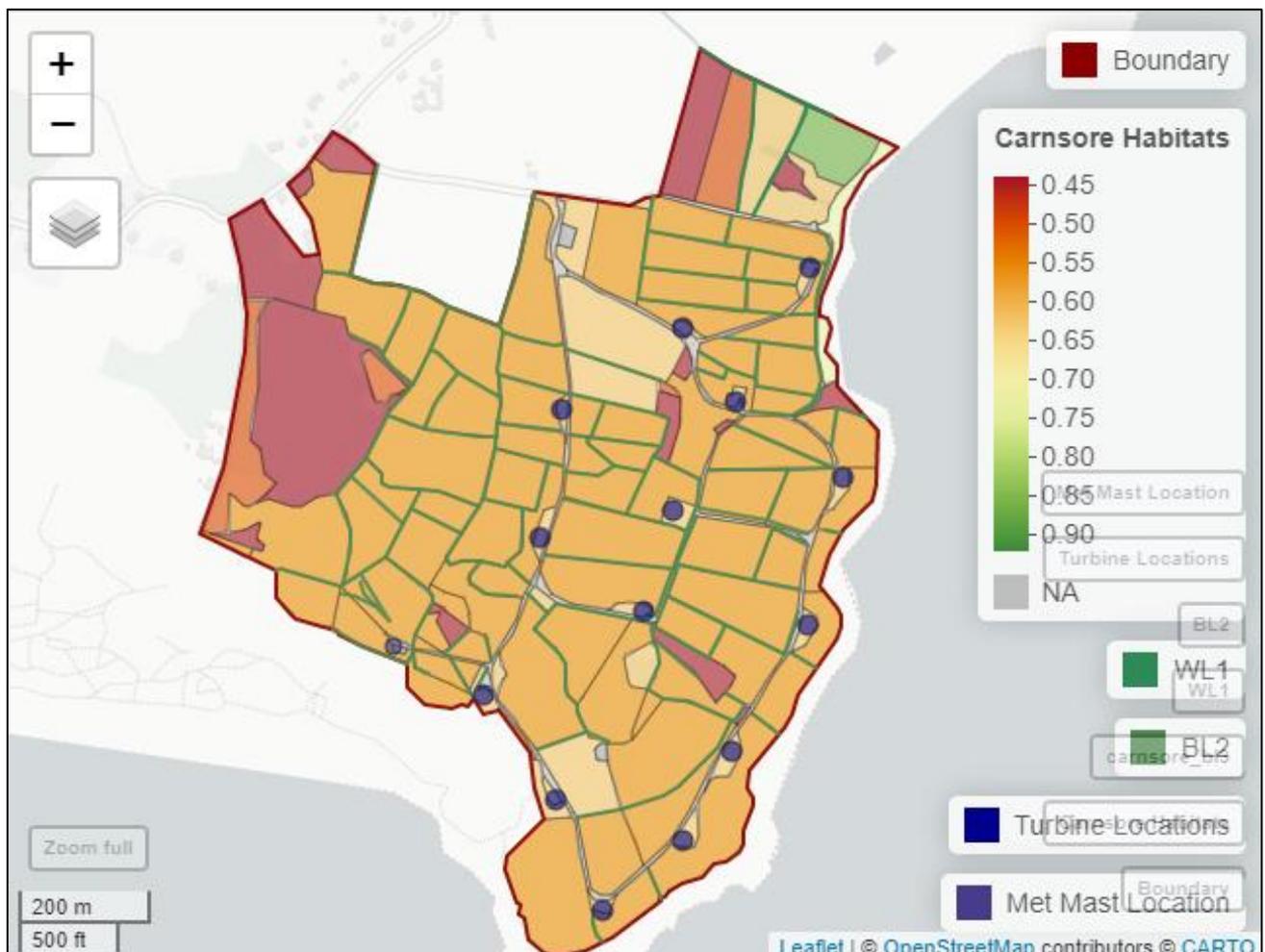
Map of habitat condition at Carnsore windfarm - showing the average condition score per habitat type.
For interactive version see:
file:///C:/Users/kinge8/Documents/R_WF_Maps/Carnsore/outputs/carnsore_avg_condition.html

Risk Register

The risk register spreadsheets are broken down into two main parts: 1) biodiversity status and trends; and 2) risk register. The biodiversity status and trends tab are based off Mace et al. (2015). The main idea is that the condition indicators for biodiversity that were used in the ecosystem accounts are transferred to the risk register where the current status and overall trend can be examined in more detail for each habitat type. The current is compared to a target status. The target can be based off the indexes developed for characteristics in the condition scorecards or they can come from sources such as national guidelines or literature. The trend is described as either 1) positive or not discernible; 2) negative; or 3) strongly negative based on the degree of difference between the current and target statuses. The red, amber, green (RAG) key included in the spreadsheet can then be used to describe the combination of the trend and status. RAG scores B and C indicate areas where biodiversity interventions will be necessary to improve the status.

The risk register tab is intended to serve as a risk assessment for each habitat type within a site. The primary threats for each habitat type are threats that were identified through field visits while habitat mapping. These were threats that were pronounced and actively occurring on sites which damage biodiversity. The risk is broken down into specific risks that occur due to the primary threat and a description of the risk. The likelihood of each risk was determined by what was observed on site as well as a literature review that was performed after the field season. The impacts of risks were similarly determined through a combination of observation and literature review. There is also a column on current risk strategies which will need input from stakeholders. This will be important to help inform the site-specific biodiversity action plans. The proposed risk management strategies were developed through observation (i.e., when high density cattle grazing was causing obvious habitat destruction and vegetation loss, we recommend that grazing was managed to allow vegetation to recover through the interventions that are supported in the literature. The monitoring and review, as well as the timeframe columns are not yet filled in because these will also require stakeholder feedback to determine what resources can be used as well as timelines.

Ecosystem Type	Fossitt Code	Habitat Name	Primary Threat
Grassland	GA1	Improved agricultural grassland	Cattle grazing
	GS1	Dry calcareous and neutral grassland	Scrub encroachment
	GS2	Dry meadows and grassy verges	Roads & infrastructure
	GS4	Wet grassland	Scrub encroachment
Woodland & Scrub	WS1	Scrub	Habitat fragmentation
Heath & Dense Bracken	HD1	Dense bracken	Habitat fragmentation
Littoral (intertidal)	LR4	Mixed substrata shores	Erosion
Freshwater	FS1	Reed and large sedge swamps	Proximity to agriculture
Exposed rock and disturbed ground	ED2	Spoil and bare ground	Development and maintenance of bare habitats
	ED3	Recolonising bare ground	Development and maintenance of bare habitats
Cultivated and built land	BC1	Arable crops	Herbicide use
	BL3	Buildings and artificial surfaces	