Information pack on the habitat assessment framework underlying Defra indicator B6 – Natural functions of water and wetland ecosystems

Natural England, May 2023

This information pack is intended to support Defra's publication of an interim version of the B6 indicator, as part of the annual update of its Outcome Indicator Framework. The pack is divided into three parts: 1) explanatory notes; 2) assessment outputs; and 3) attribute information sheets. The primary storage location of this pack is presently the Document store on the Discovering priority habitats website jointly maintained by the Freshwater Biological Association and Natural England.

***Access to underlying data**: A supplementary Excel workbook (available on the same Document store) provides all of the aggregated naturalness scores on which this information pack is based. A geodatabase is being prepared that will indicate spatial variations in naturalness scores across England, as far as this can be shown with available datasets. The primary data used to generate naturalness scores for different attributes comes from multiple sources, explained in detail in Part 3 of this information pack.*

PART 1 – EXPLANATORY NOTES

It is important to note that the B6 indicator and the underlying assessment framework are still undergoing development. Datasets and attributes will improve over time and for this interim version of the indicator it is best to focus on the nature of the assessment framework, in terms of its structure, the attributes used, and the way data are processed into assessments and portrayed in outputs. In particular, the portrayal of status is very different to conventional habitat assessments and it is important to read the explanatory notes in this part of the information pack to understand the nature of the outputs.

Acknowledgements

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1. What is natural functioning of ecosystems and why is it important?

Natural ecosystem function is an ecological state generated by natural environmental processes (hydrology, chemistry, soil and sediment processes, vegetation and wider native biological assemblages) that are unmodified by human activities. It generates naturally functioning habitat mosaics, which are dynamic and ecologically resilient and capable of sustaining our native plants and animals in natural balance with each other. These mosaics provide a wealth of ecosystem services including catchment storage of clean and plentiful water, flood attenuation, and adaptation to/mitigation of climate change.

Natural ecosystem function is a critical reference point for understanding how landscapes and seascapes naturally provide for wildlife and what they can provide in terms of natural capital. Yet to date there has been no explicit or holistic framework for assessing naturalness of ecosystem function on which to build our understanding. We need such a framework to help ensure that our efforts to restore wildlife and manage the water environment aim to protect and build back more natural ecosystem function as far as this is possible, to different degrees in different places depending on local circumstances.

The ecological rationale for using natural function as the basis for conserving freshwater and wetland ecosystems is explained in this freshwater and wetland habitats narrative, and summarised in a series of biodiversity fact sheets generated to inform the Catchment-Based Approach (CaBA) initiative. More integrated recognition of the importance of protecting and restoring natural ecosystem function across terrestrial, wetland and aquatic environments (see this report) is helping to promote an ecological shift in the way nature recovery is planned, maximising the co-benefits for natural capital.

2. What is the role of the assessment framework underlying the B6 indicator?

The assessment framework upon which the B6 Indicator is built sits in the overlap between biodiversity and water objectives, feeding into both biodiversity and water assessment, planning and reporting processes and helping to build an ecological bridge between the two. From a biodiversity perspective, the assessment framework provides the basis for building ecosystem restoration more squarely into biodiversity planning and associated operational processes, as envisaged by the Convention on Biological Diversity. From a water management perspective, the assessment framework provides a means of emphasising the critical importance of natural processes in protecting and restoring the water environment and planning nature-based solutions (for flood risk, water quality and water resource management).

Defra's outcome indicator framework is divided into number of key themes, including water (Theme B) and wildlife (Theme D), which makes it difficult to position indicators like B6 in a way that reflects their integrating nature. Whilst B6 sits in the water theme, the habitat assessment framework which B6 uses is designed to provide the freshwater component of indicator D1 (extent, quality and connectivity of habitats) within the wildlife theme.

3. What is the spatial scope of the assessment framework?

The B6 indicator in intended to cover freshwater habitats (rivers, streams, lakes and ponds), terrestrial wetlands (bogs and fens) and coastal/estuarine waters. The assessment framework has its origins in Natural England report JP016, which proposed an approach to assessing the naturalness of freshwater habitats for biodiversity reporting processes. The freshwater habitat elements of the framework are consequently most developed and are the focus of the interim version of the B6 indicator. Other elements of the framework are progressing and will be added as and when they are ready.

The assessment framework covers the whole of the habitat resource, inside and outside of specially protected wildlife sites. **Within protected wildlife sites it does not provide a substitute for existing condition assessment procedures** – this is subject to a separate monitoring and assessment regime and separate attributes and targets.

4. What are the detailed interactions with other Defra indicators?

Being a compound indicator employing data relating to a range of pressures, B6 has interactions and inter-dependencies with a range of other indicators in Defra's indicator framework. The use of complex compound indicators like B6 makes the Defra indicator framework much more interconnected, using the same or similar data to portray different perspectives on the natural environment. In some cases, data relevant to other indicators are re-processed in different ways (such as data on non-native species used in Defra indicator H2). In other cases pre-processed data from another attribute are used directly (such as water-related attributes from B3, wetland attributes in the D1 indicator).

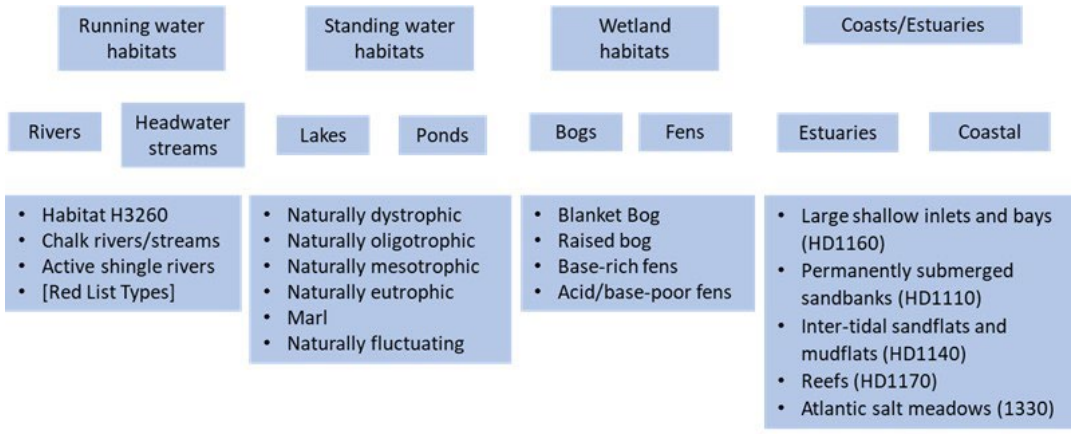
The relationship with indicator D1 (extent, quality and connectivity of habitats) is particularly important. The D1 indicator aims to evaluate the entire national resource of all land-based (non-marine) habitats, including open freshwater and wetland habitats. The intention is that the assessment framework used for B6 will provide the freshwater habitat component of D1, whilst development of the wetland habitat component of B6 is a combined endeavour between D1 and B6 indicator work. There is on-going collaboration between the development of D1 and B6 to try and ensure a complementary framework is developed for the two indicators, explicitly incorporating characterisation of naturalness of ecosystem function and making best use of available water-related datasets.

The B6 indicator provides a valuable accompaniment to other water-related indicators within the Defra OIF. It includes and builds on the assessment of ecological status of waterbodies in the B3 indicator to generate a more holistic and nuanced appraisal of modifications to natural ecosystems. This provides an important vehicle for expressing and highlighting progressive synergies between biodiversity and water objectives, based on protection and restoration of natural ecosystem function.

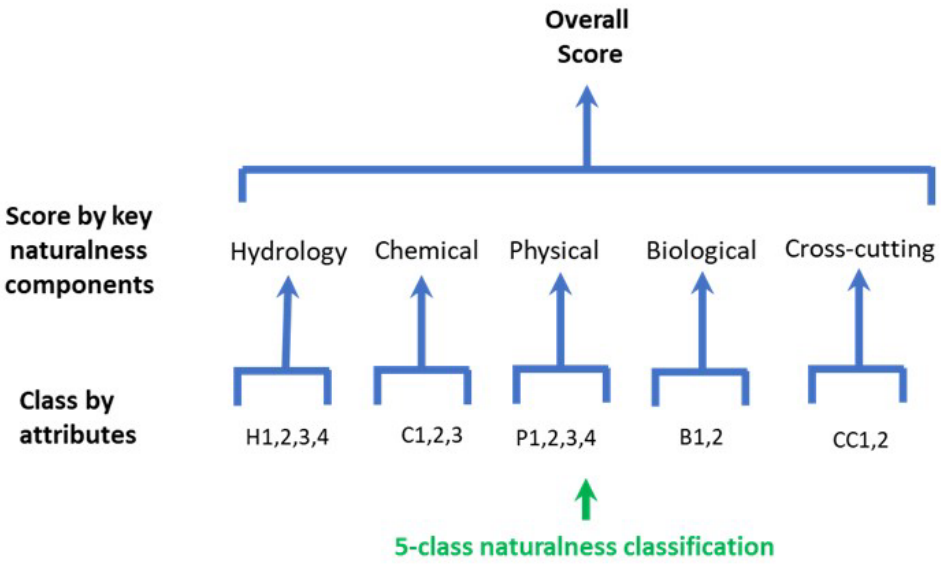
5. How is the assessment framework structured?

The framework contains two hierarchies, one relating to habitat/ecosystem types and one relating to the assessment of naturalness (of ecosystem function).

The **habitat/ecosystem hierarchy** stretches from broad ecosystem types down to a range of detailed habitat types for which individual assessments are required for biodiversity reporting purposes.



The **naturalness assessment hierarchy** stretches from an overall assessment of naturalness down into the assessment of key naturalness components and individual attributes. Four key components of naturalness are used (physical, hydrological, chemical and biological) with a further cross-cutting component to sweep up attributes that are not clearly aligned with one of the four key components. Within this general structure, data on different attributes are resolved into a 5-class naturalness classification, aiming to provide sufficient discrimination of the higher end of the naturalness spectrum whilst allowing adequate detection of change/progress at the lower end of the spectrum.



Spatially, the assessment framework is structured to characterise the 'habitat resource' as a whole, providing outputs at different levels of the habitat/ecosystem hierarchy (for instance, the whole habitat resource of lakes, or the habitat resource of all oligotrophic lakes). Variations in naturalness within the habitat resource are portrayed solely as proportions of the resource in different naturalness classes. Whilst some datasets with the assessment framework can provide a more detailed spatial picture than this, others cannot.

6. What is the technical basis for assessing naturalness of ecosystem function?

To many people the assessment of ecosystem function relates to key ecosystem processes such as decomposition rates and nutrient fluxes, but there is no one answer to how naturalness of ecosystem function should be assessed. In addition to indicators of ecosystem processes, indicators of ecosystem structure or human modification can be used as proxies of function. Different approaches, or a mixture of approaches, may be appropriate depending on purpose. Key considerations include:

- Is the ecosystem or detailed habitat type being observed in any given place the ecosystem that would be expected under unimpacted conditions?
- Can the observed value of a potential attribute be compared with what would be expected in unimpacted conditions?
- Are suitable datasets available or is it feasible to generate them?
- How easily can information on the attribute be interpreted in relation to naturalness of function, and the action needing to be taken to improve that function?

Critically, it is far simpler to evaluate the nature and scale of modifications to natural ecosystem function than attempt to characterise the precise ecological outcome of natural processes in any given place. This is an inevitable consequence of the dynamic complexity of natural ecosystems, particularly those heavily influenced by water. For this reason, the assessment framework underlying B6 focuses on indicators of human modification, where the reference condition of unimpacted conditions is zero modification. This said, indicators of habitat structure and even process are also employed where these can be related to a realistic unimpacted reference condition.

The attributes selected for different habitat/ecosystem types are listed and described in Part 3 of this information pack.

7. What are the main outputs of the assessment framework used for the B6 indicator?

The standard outputs from the assessment framework are dashboards and wheel diagrams. Dashboards are better at characterising change through time whereas wheel diagrams provide a richer picture of the variation in naturalness across the habitat resource at any one time. There is cross-over between the two types of output, in that they both display summarised data on naturalness at the level of key naturalness components and across all naturalness components. The interplay between the hierarchies of ecosystems/habitats and naturalness assessment generate dashboards and wheel diagrams at different levels of detail.

- A headline dashboard of summary naturalness scores for all principal ecosystem types (larger rivers, streams, lakes, ponds, bogs, fens, coasts and estuaries) - this is the output included in the Defra summary of B6 on their Outcome Indicator Framework pages.
- A detailed dashboard providing summary naturalness scores for all detailed habitat types included in the assessment framework – this is the primary additional detail for the B6 indicator.
- Attribute-level dashboards and wheel diagrams for principal ecosystem types – this is secondary additional detail for the B6 indicator and provides summary information for Natural England's biodiversity reporting processes.
- Attribute-level dashboards and wheel diagrams for detailed habitat types – this is tertiary additional detail for the B6 indicator and provides the detailed information to assess progress with strategic biodiversity targets for these habitat types.

Part 2 of this information pack presents these different outputs according to the hierarchical habitat structure outlined above.

8. Why isn't there much biology in the assessment framework underlying B6?

Indicators of community composition or the presence or abundance of individual species are arguably most difficult to relate to naturalness of ecosystem function. Individual species each have a set of optimal ecological requirements which can be met in a variety of ways that are not simply related to naturalness. Any given species in any particular location can exploit opportunities generated by modifications to natural ecosystems, rather than be catered for by naturally functioning habitat mosaics. This logic also scales up to assemblages and is exacerbated in cases where assemblages are used as proxy indicators of habitat 'type' and the assessment process would require a reference (unimpacted) type to be set for a given location. Another drawback is that the biota responds to a range of human impacts on naturalness and it is difficult to interpret assessments in the context of individual naturalness components (hydrological, chemical, physical, biological). Limitations on the ability of biological survey design to characterise some elements of natural function (particularly natural hydrological and geomorphological regimes) compound the challenges of using biological assemblages in the assessment framework.

The most important use of biological data in the assessment framework for B6 relates to chemical naturalness, because of the practical difficulties of direct monitoring of episodic pollution and the wide range of hazardous chemicals affecting the naturalness of water and wetland ecosystems. Biological metrics developed for assessing ecological status are most useful in the detection of impacts on chemical naturalness and those metrics are therefore used for that naturalness component.

The biological naturalness component of the assessment framework is intended to house attributes relating to direct biological pressures on natural ecosystem function, such as non-native species, direct removals and additions of species (such as from exploitation or predator control). Biological attributes that are more designed to look holistically at loss of naturalness in native biological assemblages, and which might better reflect impacts across a range of key naturalness components, are placed in a cross-cutting category.

A number of indicators within the Wildlife theme of the Defra indicator framework are focused on the use of species data to indicate change. These indicators will need to be interpreted in the context of changes in ecosystem health, to ensure that changes in the number and abundance of individual species are not erroneously translated into changes in habitat quality and naturalness of ecosystem function. The B6 indicator, in tandem with the D1 indicator, will be very important in conditioning the results from these species indicators.

9. Where do the data for the B6 indicator come from?

The data framework used for B6 employs a mixture of data sources, including 'whole-inventory' spatial datasets and monitoring programmes based on representative sampling. Many of the datasets are generated and provided by the Environment Agency, through national representative surveillance programmes, model outputs and digital spatial layers. Others are provided by Natural England and other partners including via citizen science initiatives. This mixed data model harnesses as much information as possible to provide better insights into levels of natural function in the habitat resource. However, it also brings challenges associated with resolving disparate datasets into a common assessment framework. Part 3 of this information pack provides a detailed attribute-by-attribute account of the sources of information used in the assessment framework.

10. How are data for different attributes resolved into a common spatial framework?

The core statistics generated by the assessment framework are proportions of the habitat resource allocated to each of the five naturalness classes, using class boundaries defined for each attribute. No one common spatial framework is used to resolve data on different attributes into this format. Waterbodies used for assessing ecological status are often employed, but in some cases it is more beneficial to use individual monitoring sites without resolving these sites into waterbodies. The approach used for each attribute is described in the Attribute Information Sheets in Part 3 of this information pack.

11. How good is the data framework for change detection?

The ability to detect changes through space and time is central to any indicator. Sensitivity to change depends on issues such as the spatial intensity of representative sampling, the spatial resolution of any modelling undertaken, the timescales over which updated data are/can be generated, and the adequacy of any change-logging processes (for 'whole-inventory' attributes). These issues were considered in detail in Natural England Report JP016 and thinking has been progressively refined through the development of the B6 indicator.

The naturalness assessment framework is designed to operate at sufficient spatial resolution to provide a reasonable estimate of the statistical distribution of the habitat resource (including its component sub-types) across the naturalness spectrum, from very high to very low naturalness. Whether representative surveillance programmes provide data of sufficient spatial intensity to support this design will be dependent on the size and environmental/habitat stratification of the surveillance programmes – the adequacy of datasets can be characterised by confidence of assessment.

The updateability of the datasets used in the assessment framework is a critical issue for detecting change over time. The intention for B6 is that all attributes must be updateable at least every 5 years but preferably more frequently. Some attributes based on surveillance programmes will be updateable on a more frequent basis whereas attributes relying on baseline 'whole-inventory' datasets may only likely to be updateable on longer timescales.

12. How are data filtered to generate assessments of detailed habitat types?

A key requirement of habitat evaluation and reporting for biodiversity purposes is the ability to provide assessments of different habitat components of the overall habitat resource. A range of detailed habitat types are

defined in domestic and international biodiversity legislation and commitments, including priority habitats defined as part of the UK's commitments to the Convention on Biological Diversity, the European 'Habitats and Species' Directive, and IUCN Red Lists of habitats (at European and Global levels). The data framework addresses this need through the spatial filtering of datasets covering the whole habitat resource, based on our best understanding of the spatial distribution of different detailed habitat types.

The precise nature of the spatial filtering employed varies across the assessment framework, depending on the nature of the datasets involved. For **whole-inventory** attributes, data filtering is generally achieved by GIS overlay of datasets with spatial layers of the distribution of each detailed habitat type. Filtering of **representative** attributes is best achieved by assigning sampling sites within datasets to detailed habitat types and selecting the relevant sub-set of sites. For some representative attributes, data on sampling sites are pre-aggregated to waterbody-level for water reporting purposes. This is a particular challenge for rivers and streams, estuaries and coasts, because there is considerable variation in detailed habitat types within defined waterbodies. Generally, the aim is to use the most detailed spatial sub-setting of datasets that is possible, bearing in mind the limitations of the datasets involved (of attributes and also our understanding of the spatial distribution of detailed habitat types).

13. How are naturalness data aggregated for change detection?

In traditional reporting of habitat condition (UK Common Standards Monitoring of Sites of Special Scientific Interest, reporting of ecological status of waterbodies), data aggregation across attributes is undertaken by adopting the status of the worst-performing attribute at any given location. Whilst this approach is important for ensuring that action to achieve objectives in a given location addresses all components of impact, it is of less value for detecting changes in contributing attributes because no change is evident until there is a significant positive change across all attributes. Aggregation by averaging provides a vehicle for reflecting any improvements in any attribute in the aggregated indicator, thereby improving sensitivity to change.

Statistically speaking, the method of averaging we have adopted for the B6 indicator is somewhat 'clunky'. For each attribute, integer naturalness class values assigned to spatial assessment units within the habitat resource (which may be survey sites, waterbodies etc) are averaged to generate a mean attribute score for the habitat resource. These mean attribute scores for the habitat resource are then averaged across attributes (within each key naturalness component, and then across all key naturalness components) to provide summary scores. To achieve an adequate level of resolution for indicating change, these scores are calculated to two decimal places. Although clunky, classifying attribute-level data prior to aggregation does allow standardisation of different types of data, even though this is at the expense of losing the continuous nature of the underlying data on each attribute. There are more statistically elegant ways of aggregating the data whilst preserving the continuous nature of the underlying data, but this can only be achieved at the expense of losing the common language of naturalness classes at the attribute level and the simplicity of interpretation that comes with it.

Unlike traditional assessment of habitat condition, aggregation of data across individual attributes is not performed within individual spatial units of the habitat resource (generally waterbodies or individual sampling sites), but rather at the habitat resource-level. This approach is dictated by the mixed data model used in B6 (which is itself dictated by the datasets available) and has implications for precisely what can be said about the naturalness of individual spatial units within the habitat resource. Within the habitat resource as a whole, changes in one attribute may be happening in different locations to changes in another; for instance, parts of the habitat resource with highly naturally functioning hydrology may be different parts of the habitat resource to those with highly naturally functioning chemistry or physical habitat.

Whilst this approach does improve our ability to detect change, it is less useful in the context of highlighting specific locations where naturalness is at a high level across all attributes or where action is being taken to improve naturalness across all attributes. Since restoring highly naturally functioning habitat mosaics across all naturalness components is a key strategic ambition, some other operational cross-checks are needed to ensure delivery is planned in a holistic way so that improvements in naturalness are co-located as far as possible for

maximum ecological/ecosystem effect. The way in which the B6 data framework is intended to be used to set strategic biodiversity targets is key to this, helping to target delivery processes for nature recovery and water planning across and within landscapes.

14. What is the level of confidence in the assessments made?

A range of factors influence the level of confidence we have in the assessment of an individual attribute, a naturalness component or a habitat resource. There is currently no structured confidence assessment associated with the data framework, but the assessment process does provide for a subjective expert assessment of the level of confidence of any given output. This can be used to take account of issues such as the spatial intensity of representative surveys in different parts of the habitat resource, the robustness of survey methods, the spatial coverage and accuracy of whole-inventory datasets, and the general ability of attributes to reflect the modifications to natural function that need to be portrayed.

15. How will the assessment framework be used for setting strategic biodiversity targets?

The habitat assessment framework outlined here is being built into the definition of Favourable Conservation Status (FCS) for freshwater habitats in England and will help inform the approach to FCS for other habitats covered by the B6 indicator. The concept of FCS originates from the EU Habitats Directive but has been extended by Natural England to provide a holistic framework within which our long-term ambitions for all habitat/ecosystems and priority species can be expressed. For the freshwater habitat resource, a series of nested FCS targets is being developed, based on naturalness of ecosystem function and incorporating targets for: 1) favourable condition of specially protected freshwater sites (SSSIs and SACs), 2) ecological status under water legislation and 3) broader natural functioning of the habitat resource. The detailed typology for freshwater habitats being used for FCS definition is aligned with the detailed habitat types being evaluated by the assessment framework used for the B6 indicator.

Provisional general FCS targets for the freshwater habitat resource as a whole are shown below. Those highlighted in green are assessed by data sourced from the assessment framework used by B6. The precise percentages of the habitat resource used in each target may be refined based on best understanding of long-term achievability (bearing in mind that FCS is long-term and aspirational in nature), and there is also potential to vary the values for each detailed freshwater habitat type based on more detailed understanding of long-term opportunities for and immovable constraints to restoring more natural function associated with each type.

Proposed general targets for assessing FCS of freshwater habitats.

1. All SACs designated for the habitat in question to be in favourable condition.
2. All SSSIs designated for the habitat to be in favourable condition.
3. All WFD waterbodies containing the habitat currently at HES maintained at HES (broadly equating to Naturalness Class 1).
4. 10% of national habitat extent to be in a highly naturally functioning state (Naturalness Class 1 across all naturalness components) - to be delivered in association with re-establishment of broader naturally functioning wetland and terrestrial habitats.
5. 25% of national habitat extent to exceed good levels of natural function (Naturalness Class 2 across all naturalness components).
6. 75% of national habitat extent to exceed good levels of chemical and hydrological function (Naturalness Class 2) and moderate levels of physical and biological function (Naturalness Class 3) - note that biological class relates specifically to direct biological pressures rather than biological indicators of naturalness.
7. 95% of national habitat extent to exceed good levels of chemical naturalness (Naturalness Class 2).

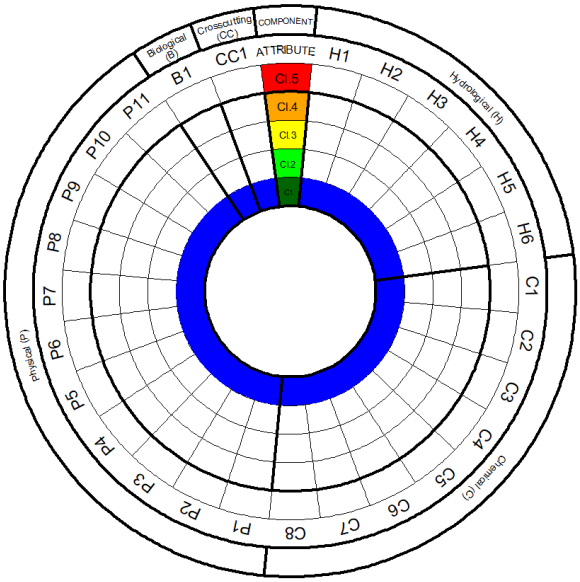
Setting targets for a desired state at the habitat resource-level is a very different process to setting environmental standards that act as a requirement for all parts of a habitat resource to achieve. FCS targets allow flexibility in where we set high levels of ambition for restoring naturally functioning habitat mosaics and where we accept heavy constraints to natural function generated by, for instance, urban development and other fixed infrastructure that cannot be considered removable even in the long-term. This encourages sufficient targeting of restoration action at places in landscapes that are most amenable to restoring high levels of natural ecosystem function, delivering resilient mosaics of freshwater, wetland and drier terrestrial habitats and their associated species in those locations. At the same time as delivering strategic biodiversity ambitions, such targeting provides a wealth of natural capital as co-benefits, including carbon sequestration and storage, resilient water resources, clean raw water for drinking and natural flood management.

The nature of FCS targets means that we should avoid attempts to force hard linkages between them and water-related standards. Linkages between ambitions for biodiversity and water (at least outside of specially protected sites where more structured decision-making processes apply) need to be soft and high-level, aiming for broad compatibility at the habitat resource-level and synergies of message/direction (i.e. co-support for actions that restore natural ecosystem function, to different degrees in different places depending on local circumstances).

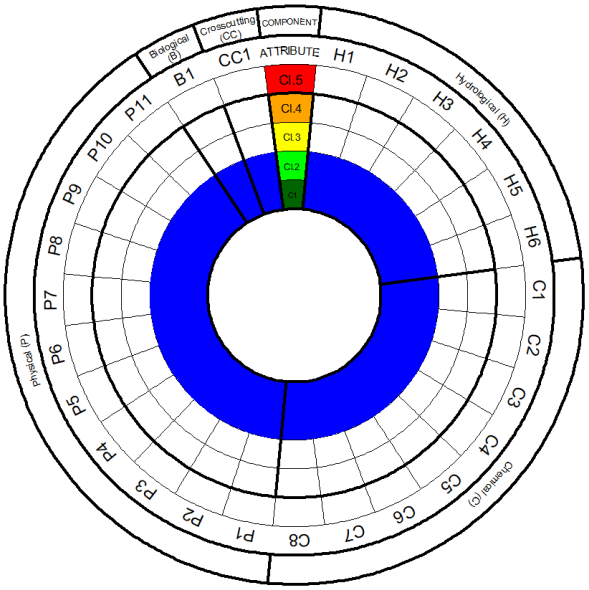
Defining targets for FCS requires that the assessment framework is used in a different way to its use in B6. The B6 indicator is geared to change detection; for setting FCS targets data need to be processed and portrayed to provide a picture of the proportion of the habitat resource that fulfils **all** of the individual requirements of a given FCS target, i.e. across all recent naturalness attributes. Conceptually this is similar to assessing the favourable condition of SSSIs and SACs and ecological status under the Water Framework Directive, in that any one naturalness component (and potentially any one attribute) can be the reason why a given location does not achieve the naturalness requirements of a given FCS target.

So, whilst outputs for the B6 indicator are designed to be sensitive to detecting improvements across all attributes, assessment of FCS requires an approach that provides a sensitive portrayal of the proximity of the habitat resource to meeting the layered FCS targets. A vision for how this might work is given by the diagrams below, which are based on the wheel diagrams used in Part 2 of this information pack but are designed to focus on FCS targets 4-7 above. The diagrams as portrayed show the naturalness components and class allocations that are relevant to each target. The blue areas can be coloured to indicate the proportion of the habitat resource (either for broad ecosystem types or detailed habitat types) that is compliant with the natural function requirements of each target, indicating distance from target and when each target is met.

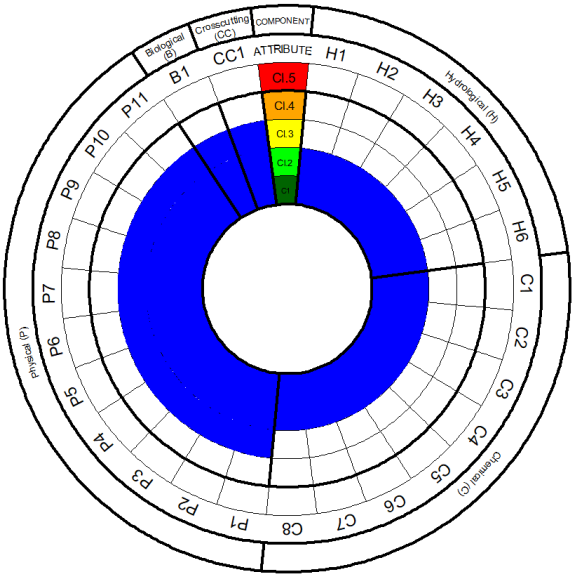
FCS Target 1 – 10% of habitat resource



FCS Target 2 – 25% of habitat resource



FCS Target 3 – 75% of habitat resource



FCS Target 4 – 95% of habitat resource