

THERE ARE 14 HIGH-LEVEL MORPH INDICES:

Channel characteristics

- INDEX 1: Number of flow types**
- INDEX 2: Highest energy extensive flow type**
- INDEX 3: Number of bed material types**
- INDEX 4: Coarsest extensive bed material particle size**
- INDEX 5: Average bed material size (phi units)**
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Riparian (Bank Face and Bank Top) characteristics

- INDEX 10: Riparian physical habitat complexity**
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Human pressures and impacts

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THE INDICES ARE CALCULATED AS FOLLOWS:

INDEX 1: Number of flow types

The number of flow types recorded as P or E (total flow types is 10, but only 9 are mutually compatible and thus the maximum number feasible)

INDEX 2: Highest energy extensive flow type

The highest energy flow type recorded as E (i.e. in the order Freefall > Chute > Broken standing wave > Unbroken standing wave > Upwelling > Chaotic flow > Rippled > Smooth > No perceptible flow > Dry).

INDEX 3: Number of bed material types

NumBedMat: Number of channel bed natural materials sediment types (from section 4.1: the number of types that are P or E – potential maximum 9, likely maximum 6).

INDEX 4: Coarsest extensive bed material particle size

Excluding bedrock, organic and peat, the coarsest bed material recorded as E (i.e. one of the following in the order Boulder > Cobble > Gravel-pebble > Sand > Silt > Clay)

INDEX 5: Average bed material size and INDEX 6: Average bed material particle size class

Use only P and E observations of the following 6 bed material sizes: Boulder, Cobble, Gravel-pebble, Sand, Silt, Clay. For each record the abundance as 1 for P and 4 for E.

Average bed material size = $((-9 \times \text{Boulder abundance}) + (-7 \times \text{Cobble abundance}) + (-1.5 \times \text{Gravel abundance}) + (1.5 \times \text{Sand abundance}) + (6 \times \text{Silt abundance}) + (9 \times \text{Clay abundance})) / (\text{Boulder abundance} + \text{Cobble abundance} + \text{Gravel abundance} + \text{Sand abundance} + \text{Silt abundance} + \text{Clay abundance})$

The index is expressed in approximate phi units. To aid interpretation, these units translate into approximate particle sizes (**Average bed material particle size class**) as follows:

Particle size description	Minimum value (phi units)	Maximum value (phi units)
Boulder		-8
Cobble	>-8	-6
Gravel-pebble	>-6	-1
Sand	>-1	+4
Silt	>+4	+9
Clay	>+9	

INDEX 7: Extent of bed siltation

Using the following table of abundance scores add the scores for 'continuous silt layer' and 'patchy thin silt layer' to give an overall indication of the 'extent of bed siltation' (maximum possible value is 15)

	T	P	E
Patchy thin silt layer	0.5	2	5
Continuous silt layer	1	4	10

INDEX 8: Channel physical habitat complexity

The index value ranges from 1 (minimal complexity) to 10 (extremely high complexity) and is calculated as a weighted average of 4 sub-indices as follows (round down to nearest integer value):

NumBedMat (i.e. Index 1): Number of channel bed natural materials sediment types (from section 4.1: the number of types that are P or E – likely maximum 6)

NumFlow: Number of water surface flow types (from section 4.2: the number that are Present or Extensive - likely maximum is 6)

NumBedFeat: Number of types of natural bed features (from section 4.3, subsection 'Channel bed - Natural physical features': score 1 for each that is observed as P or E or count>0 – maximum 10)

NumVegInteraction: Number of ways in which vegetation is interacting with wetted channel (from section 4.4, subsection 'Vegetation interacting with the wetted channel': score 1 for each that is observed as P or E apart from large wood dams and fallen trees entirely/predominantly which score 2 if count>0 – maximum 8)

Channel physical habitat complexity = ((NumBedMat + NumFlow + NumBedFeat + NumVegInteraction)/3)

INDEX 9: Number of aquatic vegetation morphotypes

This index illustrates the number of aquatic vegetation morphotypes that are present. The index value is an integer ranging from 0 (no aquatic vegetation) to 10 (all aquatic vegetation morphotypes are present). Score 1 each for every plant morphotype that is P or E (maximum 10 types, ranging from liverworts/mosses/lichens to filamentous algae) based on observations (i) on the channel bed sheet (section 4.4, subsection 'Vegetation within wetted channel') and (ii) the bank face sheet (section 3.4, subsection 'Aquatic vegetation at the bank-water margin', where 5 of the types can also be recorded). Only score each morphotype once.

INDEX 10: Riparian Physical Habitat Complexity

This index represents the number and extent of riparian physical habitats found within the survey site, accumulating those related to wood, water-related features on the bank top, physical features on the bank face and water's edge, and natural bank profiles. The index value ranges from 0 (extremely low complexity) to 10 (extremely high riparian physical habitat complexity across both banks). It is made up of the following components:

WoodHab: is the extent of wood-related habitat features calculated for each bank separately (i.e. *LeftBankWoodHab*, *RightBankWoodHab*) and is the total of the scores from the following table, summed for the bank top (section 2.2, subsection 'Terrestrial vegetation') and the bank face (section 3.4 'Terrestrial vegetation on bank face'). Maximum score = 22 for each bank. Divide by 2.2 to give a final score in the range 0 to 10 for each bank.

Feature	P	E
Large wood (sections 2.2 and 3.4)	2	4
Fallen trees (sections 2.2 and 3.4)	2	4
Exposed tree roots (section 3.4)	2	4
Discrete organic accumulation (section 3.4)	1	2

BankTopWatFeat: is the number and extent of water-related habitats on the bank top. It is calculated for each bank separately (i.e. *LeftBankTopWatFeat*, *RightBankTopWatFeat*) and is the total of the scores on the following table from the bank top (section 2.3). Maximum score = 12 for each bank. Divide by 1.2 to give a final score in the range 0 to 10 for each bank.

Feature	P	E
Pond (disconnected)	1	2
Pond (connected)	1	2
Side channel	1	2
Wetland (short non-woody vegetation)	1	2
Wetland (tall non-woody vegetation)	1	2
Wetland (shrubs and trees)	1	2

BankFaceNatFeat: is the number and extent of natural physical features on the bank face and along the water's edge. It is calculated for each bank separately (i.e. *LeftBankFaceNatFeat*, *RightBankFaceNatFeat*) and is the total of the scores on the following table from the bank face (section 3.3 – Natural physical features). Maximum score = 27 for each bank. Divide by 2.7 to give a final score in the range 0 to 10 for each bank.

Feature	P	E
Vegetated side bar (> 50% veg cover)	1	3
Unvegetated side bar (< 50% veg cover)	1	3
Toe	1	3
Berm	1	3
Bench	1	3
Stable cliff (> 0.5 m)	1	2
Eroding cliff (> 0.5m)	1	3
Animal burrows	1	1
Marginal backwater	1	3
Tributary confluence	3	

BankProfile: is the number and extent of natural bank profiles. It is calculated for each bank separately (i.e. *LeftBankProfile*, *RightBankProfile*). Assign a score of 3 to each natural bank profile type (section 3.1, only score natural profiles, i.e. vertical (V), vertical with top overhang (Vo), undercut (Vu), vertical with toe (Vt), steep (St), gentle (Gt), composite (Cm)). If both dominant and subdominant profiles are natural, the maximum potential score is 6 for each bank. The above scores are combined into an integrated index of Riparian Physical Habitat Complexity:

Riparian Physical Habitat Complexity = (*LeftBankWoodHab* + *RightBankWoodHab* + *LeftBankTopWatFeat* + *RightBankTopWatFeat* + *LeftBankFaceNatFeat* + *RightBankFaceNatFeat* + *LeftBankProfile* + *RightBankProfile*)/(7.2)

INDEX 11: Riparian Vegetation Complexity

This index represents the number and extent of riparian vegetation morphotypes found within the survey site. The index value is rounded down to an integer ranging from 0 (completely bare banks) to 10 (highly complex vegetation across both banks).

To calculate the index, vegetation is scored separately for the bank top (section 2.2, subsection 'Terrestrial vegetation') and bank face (section 3.4, subsection 'Terrestrial vegetation on bank face') of each bank according to the following table.

Vegetation type	T	P	E
Mosses (etc.)	1	2	4
Short/creeping herbs/grasses	1	1	1
Tall herbs/grasses	1	2	3
Scrub or shrubs	1	2	3
Saplings or trees	1	2	4

The scores for the vegetation types are summed for the top and face of each bank and then the two bank scores are summed giving a potential maximum score of 60 across both banks, although more than 50 is very unlikely. The total is then divided by 4 to provide an index value ranging from 0 (bare banks) to 10 (highly complex and well-developed vegetation).

INDEX 12: Degree of human pressure imposed by land cover on the bank tops

The index indicates the degree of human pressure imposed by land cover on the bank tops. The index value is rounded down to an integer ranging from 0 (minimal modification/pressure) to 10 (high modification/pressure). Score the artificial ground cover recorded on each bank top by summing the dominant and subdominant cover (section 2.1) according to the following table.

		P	E
Fp	Pedestrianised, footpath	2	4
Tr	Transport infrastructure	5	10
Ic	Buildings (commercial / industrial)	4	8
Re	Buildings (residential)	4	8
Sy	Storage area	4	8
Ld	Landfill area	5	10
Ar	Arable agriculture / allotments	3	6
Pv	Permanently vegetated agriculture (e.g. pasture, orchard)	1	1
Pr	Permanently vegetated recreation (e.g. playing fields)	1	1
Pw	Plantation woodland	1	1
Ow	Artificial open water (e.g. canal, reservoir)	1	1

If dominant and subdominant artificial cover types are present, the maximum score = 20 for each bank. Sum the scores for the two banks (maximum 40) and divide by 4 to give a final score in the range 0 to 10.

INDEX 13: Channel reinforcement

The index indicates the extent and strength of reinforcement of the river banks and bed. The index ranges from 0 (no reinforcement) to 10 (fully reinforced with concrete and/or sheet piling).

For each bank (section 3.2, subsection 'Bank face reinforcement'):

ReinfVertExt (Reinforcement vertical extent), top = 1, bottom = 1.5, whole = 2 (maximum of 2 for each bank)

(i.e. *LeftBankReinfVertExt*, *RightBankReinfVertExt*)

For each bank (section 3.2, subsection 'Bank face reinforcement'):

ReinfLatExt (Reinforcement lateral extent), T = 0.5, P = 1, E = 2 (maximum of 2 for each bank)

(i.e. *LeftBankReinfLatExt*, *RightBankReinfLatExt*(right bank))

For the bed (section 4.1, subsection 'Channel bed reinforcement'):

BedReinfExt (bed reinforcement extent), T = 1, P = 2, E = 4 (maximum of 4)

For each bank and the bed (section 3.2, subsection 'Bank face reinforcement' and section 4.1, subsection 'Channel bed reinforcement')

LeftBankMatType, *RightBankMatType*, *BedMatType* are the dominant reinforcement material types for the left bank, right bank and channel bed scored from the following table (maximum of 5 for each bank and for the bed)

Code	Reinforcement type	Score
CC	Concrete	5
CB	Concrete & brick / laid stone (cemented)	4
BR	Brick / laid stone (cemented)	4
SP	Sheet piling	5
WP	Wood piling / panels	3
BW	Builders waste / hard core (tipped)	2
RR	Rip-rap (large laid stone, uncemented)	3
GA	Gabions	2
WS	Willow spiling	1
RE	Planted reeds	0
BC	Biotextiles / coir	0
WO	Washed out reinforcement	0

Channel reinforcement = $(LeftBankReinfVertExt * LeftBankReinfLatExt * LeftBankMatType) + (RightBankReinfVertExt * RightBankReinfLatExt * RightBankMatType) + (BedReinfExt * BedMatType)$ / (6)

INDEX 14: Extent of non-native invasive plants

The index indicates the number and extent of invasion by the 4 most common non-native invasive plants along British rivers. The index value ranges from 0 (no nuisance plants) through 5 (extensive invasion) to approximately 10 (extensive and diverse invasion).

The 4 species may be recorded on the bank top (section 2.2), bank face (section 3.4) and channel bed (section 4.4). This gives 12 possible location-species combinations, each of which should be scored 1 for Trace, 2 for Present and 4 for Extensive, giving a maximum possible but, in practice, unrealistic total of 48. In reality, no more than one species is likely to be extensive in each of the three locations, giving a maximum feasible score of 30 if all species are present at all 3 locations (bank top, bank face, bed).

Therefore, the index is calculated by adding scores of 1 (for T), 2 (for P) and 4 (for T) for the extent of each species at each of the 3 locations and then adding the scores for all 4 species together and dividing by 4 to give a score of 0 (no species at any of the 3 locations) or 1 to 10 (or thereabouts) where species are present to some degree.