

UKTAG River Assessment Method

Ecological indicators of severe water resources pressures

by

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Health and safety statement

WARNING. Working in or around water is inherently dangerous; persons using this standard should be familiar with normal laboratory and field practice. This published monitoring system does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and to ensure compliance with any national regulatory guidelines.

It is also the responsibility of the user if seeking to practise the method outlined here, to gain appropriate permissions for access to water courses and their biological sampling.

UKTAG Guide to ecological indicators of severe water resources pressures in rivers

1 Introduction

This method statement covers a number of physical and biological indicators that could be used individually, or in combination, to help assess whether there is major or severe impact on river ecology due to altered flows arising from water resource activities.

1.1 Geographic application

A range of indicators has been applied to rivers in Scotland, together with a small number of sites in northern England. Further testing and validation is ongoing and this will inform where, and to what extent, it may be appropriate to apply indicators in other geographic regions.

1.2 Quality element assessed by the method

The indicators encompass a range of biological and hydromorphological measures which relate to a number of the quality elements listed in the Water Framework Directive. Some indicators relate to single quality elements (e.g. invertebrates) but most do not allow the specific assessment of the condition of a particular biological quality element. Instead, an appropriate combination of indicators may give a broad assessment of ecological condition, in terms of physical habitat and a number of biological quality elements.

1.3 Pressures to which the method is known to be sensitive

The indicators are intended to provide weight of evidence of the impact of severe flow pressure.

1.4 Parameters used to assess the quality element

The indicators may allow an assessment of general ecological condition using a range of physical and biological measures of the impact of severe flow pressure. A list of potential indicators is given in Annex 2.

2 Sampling and analysis

Sampling and analysis should be appropriate to the indicator(s) being used, and should use standard methodologies where these exist (e.g. benthic macroinvertebrates).

3 Procedure for results calculation

Results calculation should be appropriate to the indicator(s) being used, and should use standard methodologies where these exist.

4 Application of the method for the purpose of classification

Evidence from the ecological indicators of severe flow pressure may be used to add to the weight of evidence needed to be confident that a waterbody is at poor or bad ecological status. They are not designed to be able to distinguish between high, good or moderate status.

The indicators may therefore be used, for example, in conjunction with information on compliance with river flow standards in assigning an appropriate status class, where this forms part of the classification system.

Annex 1. Further reading

SNIFFER (2012). Project WFD21d; Ecological indicators of the effects of abstraction and flow regulation; and optimisation of flow releases from water storage reservoirs; July 2012.

<http://www.wfduk.org/resources%20/ecological-indicators-effects-abstraction-and-flow-regulation-and-optimisation-flow>

SNIFFER (2013) Project WFD122 (WP1) Field trialling ecological indicators of water resource pressure. August 2013.

<http://www.sniffer.org.uk/knowledge-hubs/resilient-catchments/water-framework-directive-and-uktag-co-ordination/ecological-indicators/>

UKTAG (2013) River flow for good ecological potential. Final recommendations. December 2013.

<http://www.wfduk.org/sites/default/files/Media/Assessing%20the%20status%20of%20the%20water%20environment/UKTAG%20River%20Flow%20for%20GEP%20Final%2004122013.pdf>

HR Wallingford (2014) Ecological indicators to improve understanding of hydromorphological pressures in rivers. Project Report MAS1214-RT001-R02-00 to Scottish Government (Project HRW/001/13).

Annex 2. Details of ecological indicators of severe flow pressure

The information in the following tables includes the complete range of potential indicators which were included in the UKTAG 2013 'Final recommendations on new and updated biological standards'. The lists represent a wide range of potential indicators that may be observed in rivers subject to severe flow pressure, though not all indicators would be expected to present in all circumstances (e.g. depending on characteristics of the flow pressure, river type, etc.).

To date there has been some testing of a subset of these indicators, and additional assessment is underway which will help to further inform which indicators are appropriate to which circumstances. Each of the UK environment agencies may use the indicators in different ways to support their existing approaches.

Table 1 Physical indicators

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
1a	Loss or significant reduction of wetted channel. Absence of water in a river channel	Steady abstraction, spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water & HEP).	Not natural winterbournes	Natural drying, sinks (e.g. karstic streams) and winterbournes. Caution if used in extreme droughts
1b	Fragmentation of aquatic habitat in river channels	Steady abstraction, spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water & HEP).	Not natural winterbournes	Natural sinks (e.g. karstic streams) and winterbournes. Artificial structures (e.g. weirs). Caution use in extreme droughts
1c	Loss of riffles/ runs, preponderance of pools	Steady abstraction, spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water & HEP).	Not natural winterbournes or large lowland rivers	Natural sinks (e.g. karstic streams) and winterbournes. Caution if used in extreme droughts
1d	Fine sediment covering sensitive habitats (riffles, runs, glides)	Steady abstraction; spray irrigation; direct supply reservoir (water & HEP),	Gravel and cobble bed rivers	Excessive inputs of fine sediment from the catchment
1e	Dense plume of fine sediment occluding water column when	Steady abstraction; spray irrigation; direct supply reservoir	Gravel and cobble bed rivers	Excessive inputs of fine sediment from the catchment

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
	submerged substrate disturbed	(water and HEP).		
1f	Absence of gravel from bed surface	Direct supply reservoir (water & HEP)	Gravel and cobble bed rivers, potentially also cascades and bedrock channels.	
1g	Uniform cobble particle size on bed surface (armouring or paving), 'static' (i.e. not active) riffles.	Direct supply reservoir (water & HEP)	Gravel and cobble bed rivers	
1h	All mid-channel substratum submerged during March-June for >1.5km downstream of impoundments	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	Naturally deep rivers.
1i	No active (unvegetated) channel bars	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1j	Presence of stable (vegetated) channel bars without presence of active (unvegetated) bars	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1k	Evidence of terrace formation	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1l	No exposed substrate on channel banks	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1m	Gradient of channel banks less than vertical	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
1n	Low width to depth ratio	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1o	Steep, undercut or eroding tributary banks	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1p	Tributary terraces	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1q	Exposed tree roots in bottom of tributary channels	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1r	Presence of active (unvegetated or semi-vegetated) bars downstream of tributary confluences	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	
1s	Widespread gravitational bank collapse	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), Regulating Reservoir (water)	Gravel and cobble bed rivers	

Table. 2 Fish Indicators

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
2a	Trout and salmon (0+ to 2+) absent in otherwise suitable and accessible habitat as assessed by appropriate model.	Steady abstraction, water supply and HEP reservoir	All except lowland floodplain rivers	Trout are considered more reliable indicators than salmon given their ubiquity
2b	Increased growth rate of trout	Water supply reservoir	All except lowland floodplain rivers	Further development needed to establish reference growth rates at different sites
2c	Decreased growth rate of trout	Water supply and HEP reservoir	All except lowland floodplain rivers	Further development needed to establish reference growth rates at different sites
2d	Absence of adult salmon or migratory trout in autumn	Steady abstraction, water supply reservoir	Upland spate rivers	
2e	Increased ratio of plant-spawning to gravel- spawning coarse fish	Steady abstraction; spray irrigation; direct supply reservoir	Chalk streams and lowland rivers. Excl. N. Ireland, much of Scotland.	
2f	Poor first summer recruitment of phytophilic coarse fish	Steady abstraction; spray irrigation; direct supply reservoir	Chalk streams and lowland rivers. Excl. N.Ireland, much of Scotland.	
2g	Poor winter survival of phytophilic and lithophilic coarse fish	Water supply (transfers), direct supply reservoir	Chalk streams and lowland rivers. Excl. N.Ireland, much of Scotland.	
2h	Poor first summer survival of lithophilic and phytophilic coarse fish	Water supply (transfers) direct supply reservoir	Chalk streams and lowland rivers. Excl. N.Ireland, much of Scotland.	

Table 3 Macro-invertebrate Indicators

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
3a	Major reduction in taxon richness	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	All rivers	Water pollution. Artificial physical modification of the channel
3b	LIFE O/E	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)		Water pollution. Artificial physical modification of the channel
3c	Abundance of large bodied predatory invertebrates, such as Coleoptera larvae and adults (especially Dytiscidae), Hemiptera (Notonectidae, Corixidae and Gerridae) and Odonata nymphs in main river channel	Steady abstraction, regulating reservoir (HEP), Spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	All rivers	Washout from local still waters during floods. Do not include if present only in natural backwaters or vegetated margins of rivers. Can colonise river reaches rapidly in response to seasonal low flows and drought. Need to compare to local reference sites and use in combination with other ecological indicators of chronic impacts.
3d	Presence or increased numbers of LIFE Flow Group V and VI species when not predicted by RIVPACS/RICT	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	Fast flowing, stony bottomed rivers.	Water pollution. Artificial physical modification of the channel
3e	Absence of LIFE I-III species when predicted to occur by RIVPACS/RICT	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	Fast flowing, stony bottomed rivers.	Water pollution. Artificial physical modification of the channel
3f	Presence of species described as winterbourne specialists in	Steady abstraction, spray irrigation	Chalk streams	Natural sinks (e.g. karstic streams) and winterbournes

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
	normally permanently flowing reaches near abstractions or downstream of impoundments			
3g	Absence of baetid mayflies when predicted to occur by RIVPACS/RICT	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	Unpolluted, stony/gravelly rivers. Not acidified streams with pH <5.5	Water pollution. Artificial physical modification of the channel
3h	Dominance or monopoly of Gammarus spp. Downstream of impoundments	Regulating reservoir (HEP), Direct supply reservoir (water & HEP), regulating reservoir (water)	Not base poor catchments or newly wetted winterbourne channels	To be used as an indicator of Poor and Bad status only downstream of impoundments. Other factors can cause Gammarus spp. To dominate in other rivers (excessive allochthonous inputs, moderate organic enrichment, newly wetted winterbourne channels)

Table 4 Macrophyte, Bryophyte and Diatom Indicators

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
4a	Exposed cobbles, pebbles and small boulders in river channels covered by mosses and/or liverworts indicates chronically stable flows and greatly reduced frequency of erosive, inundation events	Regulating reservoir (HEP), direct supply reservoir (water & HEP), regulating reservoir (water)	Gravel and cobble bed rivers	A simple, reliable indicator of chronic low and stable flows in stony rivers. Might be developed in the future to include key species that are easily identifiable in the field and indicate degrees of wetting and drying.
4b	Dominance of emergent plants in relation to submerged plants across the river channel	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	CB1, CB2, CB4 and CB6a (Hatton-Ellis & Grieve, 2003)	Do not include if present only in natural backwaters or vegetated margins of rivers
4c	Dominance of terrestrial plant species in relation to submerged and emergent aquatic species across the river channel	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	All rivers	Do not include if present only in natural backwaters or vegetated margins of rivers
4d	Dominance of perennial terrestrial plant species in river margins in relation to aquatic species and annual species	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	CB3, CB4, CB5 and CB6b (Hatton-Ellis & Grieve, 2003)	Do not include if present only in natural backwaters or vegetated margins of rivers
4e	>10% cover of perennial terrestrial vegetation colonising bars (e.g. perennial herbs, mosses, ferns, trees, bushes)	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	Alluvial or semi-alluvial channels	Potentially useful and reliable indicator of chronic low and stable flows. >10% cover is a proposed starter value and not supported by literature.
4f	>10% cover of perennial terrestrial vegetation colonising channel banks (e.g. perennial herbs, mosses, ferns, trees, bushes)	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	Alluvial or semi-alluvial channels	Potentially useful and reliable indicator of chronic low and stable flows. >10% cover is a proposed starter value and not supported by literature.

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
4g	Filamentous algae covering all submerged macrophytes or channel bed.	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	All rivers	Do not include if present only in natural backwaters or vegetated margins of rivers
4h	Dominance of <i>R. peltatus</i> relative to <i>Ranunculus penicillatus</i> subsp. <i>psuedofluitans</i>	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	CB1, CB2, CB4 and CB6a.(Hatton-Ellis & Grieve, 2003)	Natural sinks (e.g. karstic streams) and winterbournes
4i	Absence of submerged aquatic macrophytes in river types CB4, CB5 and CB6b (Hatton-Ellis & Grieve, 2003)	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	All rivers	Has been cited as an important indicator of excessive abstraction and low flows in chalk streams such as the River Kennet. To be used with caution at most sites and only in combination with other key indicators (1d, 1e, 4g)
4j	Presence of non-rooted, free-floating species such as duckweed (<i>Lemna</i> spp) and floating filamentous algae in river channel	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	Not in naturally very slow flowing lowland rivers	Washout from local still waters during floods. Do not include if present only in natural backwaters or vegetated margins of rivers
4k	Dominance of rooted species that are usually confined to still backwaters in main river channel (e.g. starwort <i>Callitriche</i> , milfoil <i>Myriophyllum</i> and crowfoot <i>Ranunculus</i>)	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	Not in naturally very slow flowing lowland rivers	Do not include if present only in natural backwaters or vegetated margins of rivers
4l	Dominance of aerophilic diatom taxa	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	All rivers	Do not include if present only in natural backwaters or vegetated margins of rivers. A potentially useful and previously underexploited indicator of severe low flows

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
4m	Occurrence of long filamentous diatomaceous biofilms	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	All rivers	Do not include if present only in natural backwaters or vegetated margins of rivers. A potentially useful and previously underexploited indicator of severe low flows
4n	Increased relative abundance of motile diatom taxa	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	All rivers	Do not include if present only in natural backwaters or vegetated margins of rivers. A potentially useful and previously underexploited indicator of severe low flows

Table 5 Amphibian Indicators

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
5a	Presence of frog or toad tadpoles in river channel, especially in late spring – summer indicates long-term and severe low flows from abstraction and/or impoundment of water	Steady abstraction, direct supply reservoir (water & HEP)	Not natural winterbournes	Washout from local still waters during floods. Do not include if present only in natural backwaters or vegetated margins of rivers. Frogs and toads will breed in slow flowing lowland rivers with extensive vegetated and/or shallow margins. Tadpoles need to be present in abundance and all over the river channel for this indicator.
5b	Presence of newts in river channels indicates long-term still water conditions due to the severe effects of abstraction and/or impoundment of water	Steady abstraction, direct supply reservoir (water & HEP)	Not natural winterbournes	Washout from local still waters during floods. Do not include if present only in natural backwaters or vegetated margins of rivers

Table 6 Riparian Vegetation Indicators

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
6a	Loss of more aquatic Sphagna and perhaps transition to a different NVC community (e.g. M4 to M6).	Direct supply, regulating and pumped storage reservoirs for water supply and HEP.	Any	Morphological alteration, land management.
6b	Loss of wetland species and increased representation of more terrestrial species.	Direct supply, regulating and pumped storage reservoirs for water supply and HEP.	Any	Morphological alteration, land management.
6c	Depth and extent of water in the wetland during wet months	Direct supply, regulating and pumped storage reservoirs for water supply and HEP.	Any	Morphological alteration, land management.