Annex 7. Ecological Indicators

Water Resources Pressures in Rivers

This section provides details of the ecological damage indicators that are likely to be observed in rivers as a consequence of water resource pressures. Separate tables are provided for Physical Indicators, Fish, Macro-invertebrates, Macrophytes, Bryophytes, Diatoms, Amphibians & Riparian Vegetation.

UKTAG is currently undertaking further work to identify the application and the most appropriate sub-sets of the ecological indicators for use in different circumstances (e.g. depending on the characteristics of the pressure, river type, etc.). This will clarify issues associated the use of subjective terminology in this Annex. This work is due to report in March and will help each of the UK environment agencies decide when and where to apply the indicators in place of, or in addition to 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 absence 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

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
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 submerged substrate disturbed	Steady abstraction; spray irrigation; direct supply reservoir (water and HEP).	Gravel and cobble bed rivers	Excessive inputs of fine sediment from the catchment
1f	Absence of gravel from bed surface	Direct supply reservoir (water & HEP)	Gravel and cobble bed rivers, potentially also cascades and bedrock channels.	

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
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	

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
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	
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	

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
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,	

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
			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	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 >0.914 using RIVPACS III+ or RICT and family LIFE	Steady abstraction, regulating reservoir (HEP), spray irrigation, direct supply reservoir (water & HEP), regulating reservoir (water)	LIFE not tested in Scotland or Northern Ireland	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.

Indicator number	Indicator description	Driver application	River type specificity	Potential confounding factors
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. LIFE not tested in Scotland or Northern Ireland	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. LIFE not tested in Scotland or Northern Ireland	Water pollution. Artificial physical modification of the channel
3f	Presence of species described as winterbourne specialists in normally permanently flowing reaches near abstractions or downstream of impoundments	Steady abstraction, spray irrigation	Chalk streams	Natural sinks (e.g. karstic streams) and winterbournes
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

Indicator number	Indicator description	Driver application	River type specificity	Potential confounding factors
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

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
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.
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

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
4h	Dominance of *R. peltatus* relative to *Ranunculus penicillatus* subsp. *psuedofluitans*	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 (*Lemna 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

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
4k	Dominance of rooted species that are usually confined to still backwaters in main river channel (e.g. starwort *Callitriche*, milfoil *Myriophyllum*and crowfoot *Ranunculus*)	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
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

Indicator number	Indicator description	Driver application from Conceptual Model	River type specificity	Potential confounding factors
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.

Morphological Ecological Indicators- Rivers & Lakes

This section provides a list of physical damage indicators that are consistent with the pressures outlined below:

Rivers

- Channel Realignment
- Embankments
- Impoundments
- Culverts
- Dredging
- Bank Protection
- Riparian Vegetation Modification

Lakes

- Water level modification
- Bank Protection

Rivers

Impacts can be observed upstream and/or down stream of the works and within the pressure footprint, and these are denoted by the following codes.

W-F= Within Pressure Footprint

US=Upstream

DS=Downstream

Where boxes are greyed out the indicators are unlikely to be recorded within these impact zones.

UKTAG is currently undertaking further work to identify the most appropriate sub-sets of the ecological indicators for use in different circumstances (e.g. depending on the characteristics of the pressure, river type, etc.). This work is due to report in the spring and will help each of the UK environment agencies decide when and where to apply the indicators in place of, or in addition to their existing approaches.

1. CHANNEL REALIGNMENTS					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
Channel mechanically over-widened	W-F	Increase in channel width where realignment starts.			
		Water surface devoid of features (e.g. ripples, white water).			
		Shallow, slow moving water			
		Fine sediment dominating the channel bed and /or deposition of berms of fine sediment at the channel margins.			
		Vegetated berms of silty material at channel margins resulting from reduced flow velocities.			
Channel mechanically over-deepened	W-F	Increase in bank height where realignment starts.			
		Exposed vegetation roots in lower bank.			
		High flow level (marked by trashline, flattened vegetation or fluvial scour) is well below bank top.			
		Exposures of original bed sediments (e.g., bar or bed) in the bank, indicating lowering of channel bed.			
		Obvious floodplain present but entirely disconnected (this indicator should not be used in isolation as floodplains can become disconnected due to natural vertical incision).			
		Exposure of underlying geology, *e.g.* bedrock, till, at base of bank.			
		Absence or damage to wetlands due to lowering of the water table and desiccation or disconnection between water and wetland due to the deposit of material from channel			
Excessive bank erosion	W-F US DS[1]	Bank erosion in places where it would not normally be expected, e.g. the inside of bends or long stretches of both banks along the same section of channel.			
Fluvial erosion of channel bed	W-F US DS[1]	Increase in bank height where realignment starts.			
		Exposed vegetation roots on lower bank face below vegetated upper bank surface.			
		Exposure of underlying geology, *e.g.* bedrock, till, at base of bank.			
		Bed sediment coarser and more homogenous than in adjacent reaches.			
		High flow level (marked by trashline, flattened vegetation or fluvial scour) is well below bank top.			

1. CHANNEL REALIGNMENTS					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
		Exposures of original bed sediments (e.g., bar or bed) in the bank, indicating lowering of channel bed.			
		Presence of vertical or near vertical bank toe below more gently sloping bank faces			
		Complete, or near complete, absence of aquatic plants from channel bed			
Change to channel length	W-F	Change in channel length calculated/estimated from comparisons of historical and contemporary mapping.			
		Evidence of old channels on floodplain adjacent to current channel.			
		Eroded bed.			
		Floodplain disconnected.			
Floodplain disconnected	W-F US DS[1]	Absence of high flow trash lines on riparian vegetation or bank top fencing.			
		Absence of flattened bank top vegetation following high flows.			
		Wetland vegetation changed / absent due to disconnection between channel and wetland			
		Wetland ecologically fossilized; e.g. significantly reduced out of bank impacts on for example wet woodland (no keeling over)			
		Wetland starved from sediment;			
Reduction in morphological diversity of channel bed	W-F US DS	Absence of the bed forms that would normally be expected for the unmodified channel type due either to scour or burial by excessive levels of sediment deposition.			
Reduction in morphological diversity of channel banks	W-F	Banks re-profiled: Lack of variation in or uniform bank face angles			
Aggradation of channel bed	W-F[2] DS	Deposition of coarse sediment that is clearly in excess of the volume that would accumulate naturally.			
		Bank erosion in places where it would not normally be expected, e.g. the inside of bends.			

[1] May occur where sediments have been trapped in an over-widened reach upstream, thus triggering bed and bank erosion downstream.

2. EMBANKMENTS					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
Floodplain disconnected	W-F US DS[1]	Embankment present on only one bank			
		Embankments present on both banks along the same stretch of channel			
		Presence of high flow lines above the level of the floodplain but below the embankment crest			
		Absence of high flow trash lines on riparian vegetation or bank top fencing.			
		Absence of flattened bank top vegetation following high flows.			
		wetland vegetation changed / absent due to disconnection between channel and wetland			
		Wetland ecologically fossilized; e.g. significantly reduced out of back impacts on for example wet woodland (no keeling over)			
		wetland changed (either drier due to less flood water reaching the wetland or wetter because of less chance for rain water to enter the channel / or flood water to return to the river; thus ponding on landward side of embankment			
		wetland starved from sediment;			
Fluvial erosion of channel bed	W-F US DS[1]	Increase in bank height where embankment starts.			
		Exposed vegetation roots on lower bank face below vegetated upper bank surface.			
		Exposure of underlying geology, *e.g.* bedrock or till, at base of bank.			
		Bed sediment coarser and more homogenous than in unmodified reaches.			
		Presence of vertical or near vertical bank toe below more gently sloping bank faces			
		Complete, or near complete, absence of aquatic plants from channel bed			
		Absence or damage to wetlands due to lowering of the water table and desiccation.			
Excessive bank erosion	W-F US DS[1]	Bank erosion in places where it would not normally be expected, e.g. the inside of bends.			
		Erosion of both banks along the same stretch of channel			

2. EMBANKMENTS					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
Reduction in morphological diversity of channel bed	W-F US DS	Absence of the bed forms that would normally be expected for the unmodified channel type due either to scour or burial by excessive levels of sediment deposition.			
Reduction in morphological diversity of channel banks	W-F	Banks re-profiled: Lack of variation in or uniform bank face angles			
Aggradation of channel bed	DS	Deposition of coarse sediment that is clearly in excess of the volume that would accumulate naturally.			
		Bank erosion in places where it would not normally be expected, e.g. the inside of bends.			

[1] May occur where sediments have been trapped in an over-widened reach upstream, thus triggering bed and bank erosion downstream

3. IMPOUNDMENTS				
Impact	Zones of impact	Indicators of damage	Length of damage (m)	
			US	DS
Pooling upstream from impounding structure	US	Flat or nearly flat water surface.		
		No appreciable flow velocity		
		Bed elevation significantly elevated relative to downstream bed and banks		
Fluvial erosion of channel bed	DS	Exposed vegetation roots on lower bank face below vegetated upper bank surface.		
		Exposure of underlying geology, *e.g.* bedrock, till, at base of bank.		
		Exposure of original bed sediments (e.g., bar or bed) in the bank, indicating lowering of channel bed.		
		Bed sediment coarser and more homogenous than in unmodified reaches.		
		Absence or damage to wetlands due to lowering of the water table and desiccation.		
Excessive bank erosion	DS[1]	Bank erosion where it would not normally be expected, e.g. the inside of bends.		
		Erosion of both banks along the same stretch of channel		
Floodplain disconnected	DS[1]	Absence of high flow trash lines on riparian vegetation or bank top fencing.		
		High flow level (marked by trashline, flattened vegetation or fluvial scour) is well below bank top.		
		reduced flooding (through storage in impoundment) results in less out of back flows and thus much drier wetlands which will change character		
		increased water tables (level and frequency) in the pool will change the water levels in the wetlands associated with these, to much wetter, more swamp. Increased sediment deposition in pool section will also often enrich the wetlands around the pool		
		Nettles / thistles in the riparian vegetation show enrichment		
		wet woodland shows often stable but high water tables		
		Absence of flattened bank top vegetation following high flows.		
Reduction in morphological diversity of channel bed	DS	Absence of the bed forms that would normally be expected for the unmodified channel type due either to scour or burial by excessive levels of sediment deposition.		

3. IMPOUNDMENTS				
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**	
			US	**DS**
Aggradation of channel bed[2]	DS	Deposition of coarse sediment that is clearly in excess of the volume that would accumulate naturally.		
		Bank erosion in places where it would not normally be expected, e.g. the inside of bends.		

[1] May occur where sediments have been trapped in pool upstream from structure, thus triggering bed and bank erosion downstream.
[2] This zone of aggradation would be located downstream from the degradation zone immediately downstream from the structure.
It might be present as a result of the sediment that has been eroded from the degradation zone being deposited in channel reaches with a lower transport capacity.

4. CULVERTS					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
Modified channel geometry and morphological features	W-F	Culvert completely enclosed and used to claim land for urban or rural activities.			
		Culvert closed and used as bridging structure.			
		Culvert open.			
		Culvert banks are artificial.			
		Culvert bed is artificial.			
		Culvert is undersized, i.e. culvert width and height are less than upstream and downstream channel bankfull width and depth respectively.			
		wetland that were present and affected by original channel will likely disappear (less water) or get wetter due to lack of pathway for rain water to enter channel Culvert bed slope appears significantly different to that of channel bed upstream and downstream.			
Aggradation upstream from culvert	US	Culvert entrance partially or completely blocked by sediment, woody material or debris.			
		Bed elevation elevated relative to downstream bank top and bed elevation (signifying deposition in pool)			
		Water is pooling upstream from culvert.			
		Flow velocities are reduced or negligible upstream from culvert.			
Fluvial erosion of channel bed	DS	Drop exists between culvert bed and bed of channel immediately downstream			
		Exposed vegetation roots on lower bank face below vegetated upper bank surface.			
		Exposure of underlying geology, *e.g.* bedrock, till, at base of bank.			
		Exposure of original bed sediments (e.g., bar or bed) in the bank, indicating lowering of channel bed.			
		Bed sediment coarser and more homogenous (armoured) than in adjacent reaches.			
Excessive bank erosion	DS[1]	Bank erosion where it would not normally be expected, e.g. the inside of bends.			
		Erosion of both banks along the same stretch of channel			

4. CULVERTS					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
Floodplain disconnected	W-F DS[1]	Culvert completely enclosed.			
		Absence of high flow trash lines on riparian vegetation or bank top fencing.			
		High flow level (marked by trashline, flattened vegetation or fluvial scour) is well below bank top.			
		Absence of flattened bank top vegetation following high flows.			
Reduction in morphological diversity of channel bed	W-F DS	Absence of the bed forms that would normally be expected for the unmodified channel type			
		Coarsening of channel bed.			
		Complete, or near complete, absence of aquatic plants from channel bed			
Aggradation of channel bed[2]	DS	Excessive amounts of sediment deposition			
		Bank erosion in places where it would not normally be expected, e.g. the inside of bends.			

[1] May occur where sediments have been trapped upstream from culvert entrance, thus triggering bed and bank erosion downstream.
[2] This zone of aggradation would be located downstream from the degradation zone immediately downstream from the structure.
It might be present as a result of the sediment that has been eroded from the degradation zone being deposited in channel reaches with a lower transport capacity.

5. DREDGING					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
Channel mechanically over-widened	W-F	Increase in channel width where dredging has occurred			
		Water surface devoid of features (e.g. ripples, white water).			
		Shallow, slow moving water			
		Fine sediment dominating the channel bed and /or deposition of berms of fine sediment at the channel margins.			
		Vegetated berms of silty material at channel margins resulting from reduced flow velocities			
Channel mechanically over-deepened	W-F	Increase in bank height where realignment starts.			
		Exposed vegetation roots in lower bank.			
		High flow level (marked by trashline, flattened vegetation or fluvial scour) is well below bank top.			
		Exposure of original bed sediments (e.g., bar or bed) in the bank, indicating lowering of channel bed.			
		Obvious floodplain present but entirely disconnected (this indicator should not be used in isolation as floodplains can become disconnected due to natural vertical incision).			
		Exposure of underlying geology, *e.g.* bedrock, till, at base of bank.			
		Absence or damage to wetlands due to lowering of the water table and desiccation.			
Excessive bank erosion	W-F US DS[1]	Bank erosion in places where it would not normally be expected, e.g. the inside of bends.			
		Erosion of both banks along the same stretch of channel			
Fluvial erosion of channel bed	W-F US DS[1]	Increase in bank height where dredging has occurred.			
		Exposed vegetation roots in lower bank.			
		Fresh exposure of underlying geology, *e.g.* bedrock, till, at base of bank.			
		Bed sediment coarser and more homogenous than in adjacent reaches.			
Floodplain disconnected	W-F US DS[1]	Absence of high flow trash lines on riparian vegetation or bank top fencing.			

5. DREDGING					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
		Absence of flattened bank top vegetation following high flows.			
Reduction in morphological diversity of channel bed	W-F US DS	Absence of the bed forms that would normally be expected for the unmodified channel type			
		Excessive amounts of sediment deposition			
		Complete, or near complete, absence of aquatic plants from channel bed			
Aggradation of channel bed	W-F[2] DS	Excessive amounts of sediment deposition			
		Bank erosion in places where it would not normally be expected, e.g. the inside of bends.			

[1] May occur where sediments have been trapped in an over-widened reach upstream, thus triggering bed and bank erosion downstream.
[2] May occur if realigned section of channel has been mechanically over-widened.

7. HARD BANK PROTECTION (RIVER)					
Impact	**Zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			W-F	**US**	**DS**
Reduction in morphological diversity of channel banks	W-F	Protection present on only one bank.			
		Protection present on both banks along the same stretch of channel.			
		Composition and geometry of affected bank face modified.			
		natural exchange of water and energy between wetland and channel interrupted resulting in normally drier wetlands.			
		Composition and geometry of affected bank toe modified.			
Fluvial erosion of channel bed	W-F US DS	Undermining of protection as evidenced by partial or complete collapse of the protection.			
		Exposure of underlying geology, *e.g.* bedrock or till, at base of bank / beneath the bank protection.			
		Exposed vegetation roots on lower bank face.			
		High flow level (marked by trashline, flattened vegetation or fluvial scour) is well below bank top.			
		Exposures of original bed sediments (e.g., bar or bed) in the bank, indicating lowering of channel bed.			
		Bed sediment coarser and more homogenous than in adjacent reaches.			
		Absence or damage to wetlands due to lowering of the water table and desiccation.			
Excessive bank erosion	W-F US DS	Excessive bank erosion on opposite bank to the protection.			
		Excessive bank erosion of the protected bank due to interference from the protection.			
Reduction in morphological diversity of channel bed	W-F US DS	Absence of the bed forms that would normally be expected for the unmodified channel type due either to scour or burial by excessive levels of sediment deposition.			

8. RIPARIAN VEGETATION MODIFICATION (RIVERS)					
			Length of damage (m)		
Impact	Zones of impact	Indicators of damage	W-F	US	DS
Excessive bank erosion	W-F DS	Excessive and extensive erosion of bank whose riparian zone is significantly devoid of woody vegetation or well developed wetland communities.			
		Significant modification of bank profile, vegetation cover or stability due to livestock poaching.			
		Excessive deposition of coarse and/or fine sediment on channel bed.			
Reduction in morphological diversity of channel bed and banks	W-F DS	Absence of alluvial sediment accumulations, scour pools and locally eroded banks normally associated with in-channel large woody material.			
		Excessive sediment deposition from eroding banks.			
Modified tree cover	W-F	Complete absence of tree cover where it might be expected to occur naturally.			
		Reduced density of tree cover			
		Uniform age of tree cover			
Modified wetland cover	W-F	Complete absence of wetland cover where it might be expected to occur naturally.			
		mowing signs / uniform vegetation height shows mowing			
		Damage to wetlands due to lowering of the water table and desiccation.			
Presence of INNS	W-F	Giant Hogweed <1% 1-10% 10-40% 40-75% >75%			
		Himalayan Balsam <1% 1-10% 10-40% 40-75% >75%			
		Japanese Knotweed <1% 1-10% 10-40% 40-75% >75%			
		Rhododendron <1% 1-10% 10-40% 40-75% >75%			

Morphological Ecological Indicators- Lakes

1. WATER LEVEL FLUCTUATIONS CAUSED BY ACTIVE & PASSIVE OUTLFOW CONTROL STRUCTURES ASSOCIATED WITH WATER STORAGE AND HYDROPOWER GENERATION					
Impact	**Lake shore zones of impact**	**Indicators of damage**	**Length of damage (m)**		
			Riparian zone	**Exposed shore zone**	**Littoral zone**
Distortion of the natural water level fluctuation regime	RZ ESZ LZ	Lake-ward encroachment of terrestrial vegetation into the exposed shore zone and littoral zone.			
		Landward encroachment of aquatic vegetation into the exposed shore zone and riparian zone.			
Excessive erosion of the lake shore	RZ ESZ LZ	Excessive and extensive erosion of bank, beach and littoral sediments leaving behind a predominantly coarse sediment (gravel, cobble & boulder) matrix.			
		Erosion scars and failure blocks indicating the slumping of hillslopes caused by bank erosion and undermining.			

2. HARD SHORE PROTECTION (LAKES)						
				Length of damage (m)		
Impact	**Lake shore zones of impact**	**Indicators of damage**	**Spatial extent of impact**	**Riparian zone**	**Exposed shore zone**	**Littoral zone**
Reduction in morphological diversity	ESZ LZ	Protection covers the entire ESZ and extends into littoral zone.	W-F			
		Protection covers the entire ESZ only.	W-F			
		Protection covers the whole bank face only.	W-F			
		Protection covers the bank toe only.	W-F			
Lacustrine erosion of lake shore	ESZ LZ	Undermining of protection as evidenced by partial or complete collapse of the protection resulting in excessive scour.	W-F			
		Fresh exposure of underlying geology, *e.g.* bedrock or till, at base of bank / beneath the bank protection.	W-F			
			DSh			
		Exposed vegetation roots on lower bank face.	W-F			
			DSh			
		Sediments coarser and more homogenous than in similar but unimpacted sections of the lake shore.	W-F			
			DSh			
		Excessive sediment deposition from 'upshore' erosion.	W-F			
			DSh			