Asiantaeth yr Amgylchedd Cymru
Environment Agency Wales

River basin management guide to hydromorphology no. 6

Ecological potential classification mitigation measures

Hydromorphology is used in river basin management to describe the hydrological and geomorphological processes and attributes of rivers, lakes, estuaries and coastal waters. The Water Framework Directive (WFD) dictates that the ecology of surface waters is protected by correctly managing their hydrology and geomorphology. The WFD recognises the key role water resources and habitats play in river basin management to support a healthy environment. This document deals with the morphology aspects of hydromorphology.

The following tables provide a reference guide to hydromorphological mitigation measures. We use these mitigation measures to assess ecological potential in artificial and heavily modified water bodies (AWB/HMWB). They are reported in the water body tables shown in Annex B of the River Basin Management Plans. This document accompanies *River basin management guide to hydromorphology no. 2 - assessment of ecological potential*. Please refer to this for details of how we've used the mitigation measures to determine ecological potential, and how they were identified in water bodies.

The measures are grouped into seven broad categories. For each mitigation measure a table shows the associated:

- **uses** (i.e. the socio-economic reason behind the designation as AWB/HMWB)
- **hydromorphological pressures**
- **ecological and hydromorphological impact.**

For example**, re-opening of existing culverts**.

The **impact(s)** to the ecosystem, which will be mitigated against by the measure

Mitigation measure	Use	Pressure	Impact
Re-opening existing culverts	flood protection, land drainage, urbanisation	Culverts	Loss of morphological diversity and habitat; continuity

This is the **measure** that can be taken to reduce adverse impacts on ecosystems

The **use**(s) present in a water body that results in the presence of the pressure

The **pressure** that requires management as it causes an impact

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1. WORKING WITH FORM AND FUNCTION

Mitigation measure	Use	Pressure	Impact
Modify channel (e.g. deepen; realign channel)	Ports and harbours	Vessel movement	Physical disturbance of sea bed habitats; ship wash (leading to erosion); indirect impacts on habitats.
Remove obsolete structure	Ports and harbours	Existing modifications, including structures, reclamation and capital dredging	Change in flows; sediment transport; wave energy or direction; direct or indirect habitat loss; disruption of habitat continuity or connectivity.
	Estuary or coastal flood/erosion protection	Locks, sluices and tidal barrages; Installation of beach control structures	Alteration of bathymetry; disruption of tidal flow and interaction; alteration of natural sediment dynamics - loss of continuity; destruction and alteration of benthic habitats; mobilisation of contaminants; increased turbidity; loss of faunal nursery, refuge and feeding areas; Disruption of habitat connectivity/continuity - interference with fish population movements; alteration of estuarine processes; direct / indirect habitat loss
	Flood protection, land drainage, urbanisation	Dams, sluices, weirs and gravel traps	Loss of sediment continuity (longitudinal) - build up of sediment upstream, reduced bed load downstream
Re-engineering of the river where the flow regime cannot be modified	Water storage and supply	Managed flows (including: compensation flows, regulation of flow, strategic water transfer)	Adverse impacts on the downstream river flows necessary to maintain river habitats and their associated aquatic plants or animals
Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution	Recreation inland navigation flood protection, land drainage, urbanisation	Hard bank protection e.g. steel piling, vertical walls. Includes hard bank protection in a state of disrepair.	Loss of riparian zone / marginal habitat / loss of connectivity / loss of sediment input / loss of wave energy absorption; Loss of sediment continuity (lateral) - build up of sediment in the channel (flood protection, land drainage, urbanisation only)
	Estuary or coastal flood/erosion protection	Bank reinforcement	Coastal squeeze; Disruption of tidal flow and channel interaction; disruption / alteration of estuarine process dynamics; modification of sediment dynamics; disruption of natural habitats; loss of faunal nursery, refuge and feeding areas
Preserve and, where possible, restore historic aquatic habitats	Recreation inland navigation flood protection, land drainage, urbanisation	Hard bank protection e.g. Steel piling, vertical walls. Includes hard bank protection in a state of disrepair	Loss of riparian zone / marginal habitat / loss of connectivity / loss of sediment input / loss of wave energy absorption; Loss of sediment continuity (lateral) - build up of sediment in the channel (flood protection, land drainage, urbanisation only)

Mitigation measure	Use	Pressure	Impact
Increase in-channel morphological diversity, e.g. install in stream features; 2 stage channels	Inland navigation flood protection, land drainage, urbanisation	Realignment / Re-profiling / Re-grading	Loss of morphological diversity and habitat
	Estuary or coastal flood/erosion protection	Tidal river alteration e.g. channelisation / realignment / straightening	Disruption of tidal flow and interaction; Alteration of estuarine processes; Alteration of natural sediment dynamics; Alteration of bathymetry; Loss of morphological diversity and habitat
Bank rehabilitation / reprofiling	Recreation inland navigation	Boat movement; surface water disturbance and turbulence created by passage of hull	Bank Erosion / loss of marginal, riparian vegetation (boat wash)
	Estuary or coastal flood/erosion protection	Shoreline reinforcement / elevation: Bank reinforcement	Coastal squeeze; disruption of tidal flow and channel interaction; disruption / alteration of estuarine process dynamics; modification of sediment dynamics; disruption of natural habitats; Loss of faunal nursery, refuge and feeding areas
Re-opening existing culverts & Alteration of channel bed (within culvert)	Flood protection, land drainage, urbanisation	Culverts	Loss of morphological diversity and habitat; continuity
Flood bunds (earth banks) (in place of floodwalls);Set-back embankments; Improve floodplain connectivity	Flood protection, land drainage, urbanisation	Flood banks and flood walls	Loss of riparian zone / marginal habitat / loss of lateral connectivity / loss of sediment input
Managed realignment of flood defence	Estuary or coastal flood/erosion protection	Shoreline reinforcement / elevation: Bank reinforcement	Coastal squeeze; disruption of tidal flow and channel interaction; disruption / alteration of estuarine process dynamics; modification of sediment dynamics; disruption of natural habitats; Loss of faunal nursery, refuge and feeding areas

2. STRUCTURAL MODIFICATION

Mitigation measure	Use	Pressure	Impact
Modify structure or reclamation and **Flow manipulation**	Ports and harbours	Existing modifications, including structures, reclamation and capital dredging	Change in flows; changes in sediment transport; change in wave energy or direction; change in water quality resulting from changes in flows; direct or indirect habitat loss; disruption of habitat continuity or connectivity.
Enable fish to access waters upstream and downstream of impoundment	Water storage and supply, inland navigation, flood protection, land drainage, urbanisation, estuary or coastal flood/erosion protection	Impoundments / Locks and weirs/ Dams, sluices and gravel traps/ tidal barrages	Loss of biological continuity; disruption of habitat connectivity/continuity - interference with fish population movements
Volume and timing of flow releases from impoundments are sufficient for fish migration.	water storage and supply	Impoundment	Interference with fish population movements
Management of fish entrainment in intakes	Water storage and supply	Impoundment	Interference with fish population movements
	Flood protection, land drainage, urbanisation	Pumping station operations	Fish entrapment
Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone	Recreation, inland navigation, flood protection, land drainage, urbanisation	Hard bank protection e.g. steel piling, vertical walls. Includes hard bank protection in a state of disrepair; trampling and erosion of riparian zone	Loss of riparian zone / marginal habitat / loss of connectivity / loss of sediment input / loss of wave energy absorption; Loss of sediment continuity (lateral) - build up of sediment in the channel (flood protection, land drainage, urbanisation only)
	Estuary or coastal flood/erosion protection	Bank reinforcement; installation of beach control structures	Coastal squeeze; Disruption of tidal flow and channel interaction; disruption / alteration of estuarine process dynamics; modification of sediment dynamics; disruption of natural habitats; loss of faunal nursery, refuge and feeding areas; alteration of bathymetry; direct / indirect habitat loss
Operational and structural changes to locks, sluices, weirs, beach control, etc	Inland navigation , flood protection, land drainage, urbanisation	Impoundments / Locks and weirs/ Dams, sluices and gravel traps/ tidal barrages	Loss of sediment continuity - build up of sediment upstream, reduced bed load downstream; loss of biological continuity - interference with fish population movements
	Estuary or coastal flood/erosion protection	Installation of beach control structures	Disruption of tidal flow and interaction; alteration of estuarine processes; alteration of natural sediment dynamics; alteration of bathymetry; direct / indirect habitat loss

3. OPERATIONS AND MAINTENANCE

Mitigation measure	Use	Pressure	Impact
Avoid the need to dredge, Reduce impact of dredging, Reduce sediment re suspension, Alter timing of dredging / disposal, Prepare a dredging / disposal strategy	Ports and harbours	Removal of sediment or re-deposition of disturbed sediment; Increased suspended sediment in water column; change in flows; change in wave propagation; change in sediment transport; direct or indirect habitat loss or change; reduced water quality; Smothering due to deposition of sediment; direct habitat loss or change due to disposal.	Maintenance dredging; dredged material disposal; reclamation and capital dredging
Prepare a dredging / disposal strategy	Inland navigation	Direct loss of / impact to aquatic habitats / hydromorphology; Transfer of fine sediment downstream; bankside erosion and impacts to riparian habitats;	Sediment management
	Estuary or coastal flood/erosion protection	Alteration of bathymetry; disruption / alteration of natural tidal and sediment dynamics; destruction and alteration of benthic habitats; mobilisation of contaminants; Increased turbidity (periodically)	Channel dredging
Sediment management, Site selection (dredged material disposal) Manage disturbance (dredge/disposal)	Ports and harbours	Dredged material disposal	Smothering due to deposition of sediment; disturbance due to deposition of re-suspended sediment; increased suspended sediment in water column; direct habitat loss or change due to disposal.
	Inland navigation	Sediment management	Source of fine sediment (disposal of dredgings on banks)
	estuary or coastal flood/erosion protection	Deposition of material	Smothering of existing floral and faunal and habitats; Alteration of estuarine processes; Alteration of natural sediment dynamics; Alteration of bathymetry
Appropriate vegetation control regime	Inland navigation flood protection, land drainage, urbanisation	Vegetation control	Physical disturbance of bed and or bank- increased sediment input; sediment mobilisation and loss of marginal / riparian vegetation

Mitigation measure	Use	Pressure	Impact
Appropriate techniques to prevent transfer of invasive species	Inland navigation flood protection, land drainage, urbanisation	Vegetation control	Transfer and establishment of alien invasive species
Retain marginal aquatic and riparian habitats	Estuary or coastal flood/erosion protection	Tidal river alteration e.g. channelisation / realignment / straightening	Disruption of tidal flow and interaction; alteration of estuarine processes; alteration of natural sediment dynamics; alteration of bathymetry; loss of morphological diversity and habitat
	Flood protection, land drainage, urbanisation	Realignment / re-profiling / regrading	Loss of morphological diversity and habitat
Sediment management strategies (develop and revise)	Flood protection, land drainage, urbanisation	Sediment management (including dredging)	Direct loss of / impact to aquatic habitats / hydromorphology; transfer of fine sediment downstream; bankside erosion and impacts to riparian habitats;
Appropriate channel maintenance strategies and techniques minimise disturbance to channel bed and margins; remove woody debris only where needed.	Flood protection, land drainage, urbanisation	Removal/clearance of urban trash and woody debris	Loss of aquatic habitats; transfer of fine sediment downstream

4. WATER MANAGEMENT

Mitigation measure	Use	Pressure	Impact
Maintain sediment management regime to avoid degradation of the habitat of the downstream river.	Water storage and supply	Managed flows (including: compensation flows, regulation of flow, strategic water transfer)	Adverse impacts on the downstream river flows necessary to maintain river habitats and their associated aquatic plants or animals
Manage drawdown to maintain shore zones, Manage the seasonal pattern of water levels	Water storage and supply	Impoundment	Adverse impacts on the level regime necessary to maintain lake habitats and their associated aquatic plants and animals in the impounded water body
Phased de-watering and other techniques	Inland navigation	De-watering (for maintenance of navigable channel)	Loss / impact to aquatic flora and fauna
Appropriate water level management strategies, including timing and volume of water moved	Flood protection, land drainage, urbanisation	Artificial water level management	Manipulation of water levels resulting in loss of habitats and access to habitats, increased erosion and impacts on riparian habitats and vegetation (at low water level), drowning of riparian habitats and vegetation (at high water level)
Enable access to feeder-streams draining into the reservoir at appropriate times	Water storage and supply	Impoundment	Adverse impact on the movement of salmonids between habitats important in their life cycles, that are **upstream and downstream** of the impoundment.
Ensure an appropriate baseline flow regime downstream of the impoundment.	Water storage and supply	Managed flows (including: compensation flows, regulation of flow, strategic water transfer)	Adverse impacts on the **downstream river flows** necessary to maintain river habitats and their associated aquatic plants or animals
Provide flows to move sediment downstream	Water storage and supply	Managed flows (including: compensation flows, regulation of flow, strategic water transfer)	Adverse impacts on the morphological characteristics of the downstream river
Ensure that good status of dissolved oxygen downstream of the impounding works/ Ensure god status of the thermal downstream of the impounding works	Water storage and supply	Managed flows (including: compensation flows, regulation of flow, strategic water transfer)	Adverse impacts on the water quality of the downstream river
Appropriate techniques to align and attenuate flow to limit detrimental effects of pipes, inlets, outlets and off-takes	Flood protection, land drainage, urbanisation	Pipes, inlets, outlets and off-takes	Hydromorphological alterations of water and sediment inputs through artificial means

5. HABITAT CREATION

Mitigation measure	Use	Pressure	Impact
Indirect / offsite mitigation (offsetting measures)	Estuary or coastal flood/erosion protection	Bank reinforcement; channel dredging; tidal river alteration e.g. channelisation / realignment / straightening; locks, sluices and tidal barrages; installation of beach control structures	Coastal squeeze; disruption of tidal flow and channel interaction; disruption / alteration of estuarine process dynamics; modification of sediment dynamics; disruption of natural habitats; loss of faunal nursery, refuge and feeding areas

6. NAVIGATION

Mitigation measure	Use	Pressure	Impact
Modify vessel design e.g. Encourage use of environmentally friendly vessel design **Vessel Management** e.g. traffic management; speed limits	Recreation, inland navigation	Boat movement, surface water disturbance and turbulence created by passage of hull	Bank erosion / loss of marginal, riparian vegetation (boat wash)
	Ports and harbours	Vessel movement	Physical disturbance of sea bed habitats; ship wash (leading to erosion); indirect impacts and habitats.
Lateral zoning to concentrate boats within a central track	Recreation, inland navigation	Boat Movement, surface water disturbance and turbulence created by passage of hull	Bed scour / sediment mobilisation / macrophyte disturbance (propeller action)

7. EDUCATION

Mitigation measure	Use	Pressure	Impact
Awareness raising / information boards	Recreation, inland navigation	Other navigation structures, maintenance areas/docks/ marinas/slipways/rowing steps	Invasive species transfer
			Source of fine sediment / deposition of fine sediment
Educate landowners on sensitive management practices	Flood protection, land drainage, urbanisation	Urbanisation	Changes to vegetation, hydrology and sediment supply
Education and awareness raising	Recreation	Trampling and erosion of riparian zone	Loss of riparian zone / marginal habitat / loss of connectivity