RIVER, LAKESIDE, FLOODPLAIN AND WETLAND MANAGEMENT

GROYNES (VEGETATED)

RW6

NATURE-DEMO

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ADDRESSED HAZARDS

PROTECTED CRITICAL INFRASTRUCTURE

Nature-based low (submerged) and mid-water (semi-submerged) groynes, River Glatt (under construction), Örlekon (CH)
Image Credit: [Rosemaria Stangl], [2023]. Used with permission.

Low cost root wad groynes, River Glatt (under construction), Örlekon (CH)
Image Credit: [Rosemaria Stangl], [2023]. Used with permission.

What is it?

Groynes are transverse structures implemented in streams and rivers to divert their flows and to realign wider streams and rivers (> 10m). Groynes are placed perpendicular to the flow direction, helping to protect the riverbanks from flow forces, to perform as deflectors that divert and manage water flow. Groynes highly contribute to sedimentation and ecological upgrade and reduce bank erosion (Hans, 2009; RRC, 2021).

Groynes are designed as structures that extend outward from the bank to the river flow at inclined or declined angles, or with a rectangular position, affecting sedimentation patterns. Low, medium or high water groynes have significant impacts on the discharge and result in varying bedload sedimentation patterns and dynamics. Distances between groynes must be considered with regard to hydraulic effective length (Florineth 2012).

Groynes are often made of only rock or concrete, (Krishna Prasad, 2016; Yossef, 2002), missing the NbS character. However, live groynes based on soil and water bioengineering techniques (see Section 4.6 SWB) include live plant materials in combination with timber structures or stone and rock formations. This can include live stakes, fascines, root stocks, brush mattresses and many more (Florineth 2012), which contribute greatly as nature-based solutions, supporting and protecting the habitat values of the groynes and the groyne fields. Groynes are usually planned in series to control the flow path and change sediment deposition dynamics, and to enhance a zone of lower flow velocity where the tendency for erosion can be mitigated (Hans, 2009; RRC, 2021). Arranging them alternately on the banks at appropriate distances, meandering watercourses can be created at low water. Hydraulic engineers must be consulted in the planning process for safety purposes and guaranteeing targeted effects.

Primary functions and key services

- **Erosion Control:** Groynes reduce the velocity of water near the banks by redirecting flow, reducing and preventing erosion of the streambanks and bank failure.
- **Sediment Control:** Regulation of sediment transport by trapping sediment and reducing downstream sediment deposition that may cause impacts to conventional discharge systems, local streets and neighbourhoods.
- **Flood Protection:** Reducing flood risk by regulating water flow away from vulnerable areas such as buildings for main public service and housing.
- **River Restoration:** The introduction of groynes allows for imitating meandering river courses, upgrading spoilt river landscapes with poor ecological conditions and monotonous flow characteristics. Water level and still water zones can be controlled, and dynamics will improve. Natural recolonisation is triggered.
- **Habitat Creation:** depending on groyne positions different sedimentation patterns result in still water zones with varying water levels. The ecological value is greatly improved when soil and water bioengineered, live groynes are used. Fauna and flora biodiversity is enhanced and protected.

Challenges this NbS addresses

Groynes designed as a NbS for stream restoration have especially been indicated to address hydrological hazards, such as fluvial, pluvial and coastal flood, and bank failure. As a result of its support to river bank stability, this solution has proven to be effective in mitigating, reducing or even preventing stream bank and bed erosion. (Krishna Prasad, 2016; RRC, 2021; Yossef, 2002)

- **Stream bed erosion –** prevention, reduction
- **Floods –** reduction

Site suitability, scale and coverage

Groynes are a restoration technique suitable for a wide range of riverscapes predominantly dealing with riverbank stability and erosion issues, and lacking effective measures that enhance natural processes for fine particle deposition. Downstream sediment deposition decrease, regulation of water flow and habitat quality are increased (Krishna Prasad, 2016; RRC, 2021; Youssef, 2002).

Scale & Coverage:
Groynes are a NbS type defined at specific scale directly implemented in riversides, but normally being evaluated within a broader project restoration action that include different types of stream restoration measures. To raise the NbS scale, live plant materials should be integrated (Florineth 2012, see SWB techniques, Section 5.6). Therefore, most appropriate for assessing scale and coverage is to consider the action integrated to a wider plan with alternative forms of riverbank protection (Hans, 2009; RRC, 2021).

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Ecosystem services

- **Biodiversity and habitat enhancement:** by promoting sediment deposition, creating still water zones and regulating flow, groynes create new habitats for riparian species.
- **Water quality improvement:** by reduction of sediment loads and limiting flow of associated pollutants.
- **Carbon sequestration:** moderate carbon capture in herbaceous vegetation in groyne fields..

Results from groynes installations in river restoration actions indicated that these systems increased marginal emergent and submerged macrophyte diversity, a change in substratum composition (from silt and sand domination to gravel and pebbles), keeping macro invertebrate diversity and improving fish population density and diversity. (Buczyńska et al., 2018; RRC, 2021).

Environmental impacts
(EU taxonomy)

- ☐ Climate change mitigation
- ☑ Climate change adaptation
- ☑ Sustainable use and protection of water and marine resources
- ☐ Transition to a circular economy
- ☑ Pollution prevention and control
- ☑ Protection and restoration of biodiversity and ecosystems.

Main components

Groynes are conventionally made of wood, concrete, or rock piles. Alternative SWB techniques using live plant material are more effective as NbS eg. Coir geotextiles in the form of cocologs have also been utilised and its effectiveness studied (Krishna Prasad, 2016), but are limited in applicability unless live plant material is incorporated for long-term function.

Studies concentrated on analysing the effects of placing groynes at different angles to find the most effective arrangement for minimising the erosion, some of which demonstrated that maximum protection was delivered with groyne angle (Krishna Prasad, 2016).

Other **technical considerations** for the design:

- **Permeability:** permeable or impermeable design. Permeable groynes, made of wood (e.g. bamboo or timber, or natural material like cocologs) allow water to flow partially through at reduced velocities. Impermeable groynes, made of concrete, using gabions, or rock, blocks deflect water flow.
- **Submergence:** submerged or non-submerged design Low, medium or high water groynes result in different impacts on water deflection, hence functions and sedimentation level.
- **Layout:** single groyne or groyne series design impact the flow deflection, the latter allows for meandering flows.
- **Action on the stream flow:** attracting, deflecting or repelling design impacts the flow characteristic and require cautious considerations.

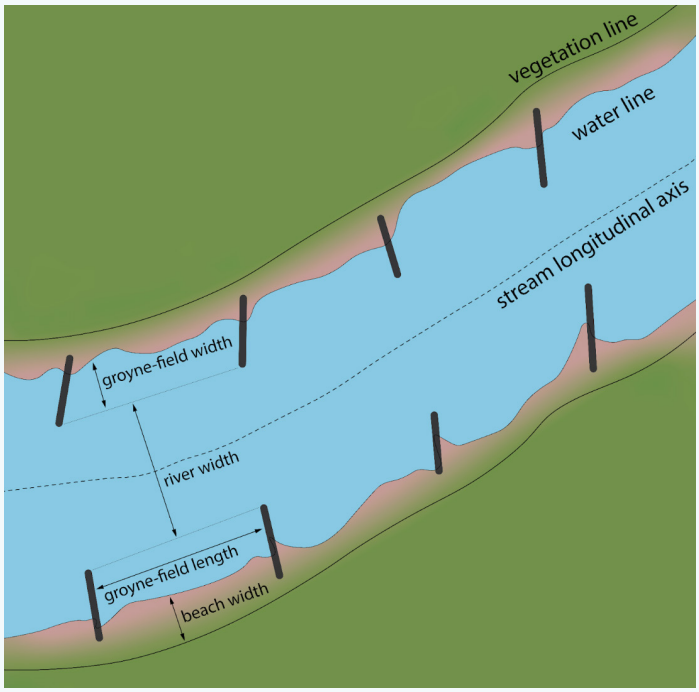
For the design specifics, it is important to consult hydraulic engineers and to define target functions first, then to determine types of groynes, spacing, orientation to the flow, crest elevation and slope, cross-section, construction materials and scour.

With regard to the planview shape, arrangements depend on factors such as the specific type of groyne, angles from the bank, or the use of groynes with a rounded head to provide extra volume and area for scour protection at the outer end (Yossef, 2002).

Cost-benefit profile

Bank erosion is a widespread reported challenge river landscapes, bringing multifarious impacts: social, economic, health, and sometimes political (Krishna Prasad, 2016).

Groynes appear as an NbS alternative to help mitigate bank erosion issues in rivers and streams. The level of habitat diversity is raised by implementing soil and water bioengineering (SWB) versions such as eg. simple ripraps and the integration of willow (Salix spp) stakes, fascine-based designs, or willow brush mattresses. Loose brushwood or faggots may seem attractive as low-cost designs (RRC, 2021) when composed of on-site materials, but may only be applied where appropriate referring to river and flow characteristics.
More costly techniques include concrete or blockstone versions, and more complex timber constructions (RRC, 2021).



Schematic of Groynes, NbS Typology for Stream Restoration with depiction of main design parameters in plan view - definition sketch for the dimensions of an arbitrary Groyne field
Image Credit: [Adapted from Yossef, 2002], [Alchemia-nova Research and Innovation], [2025], Used with permission

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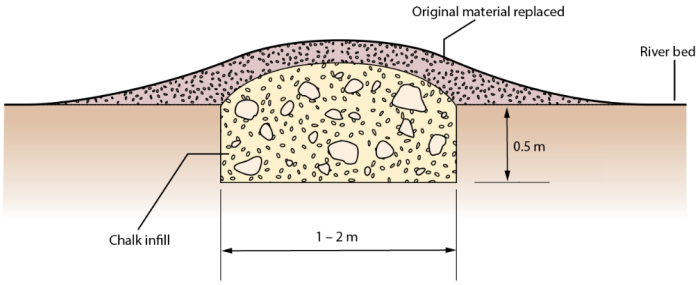


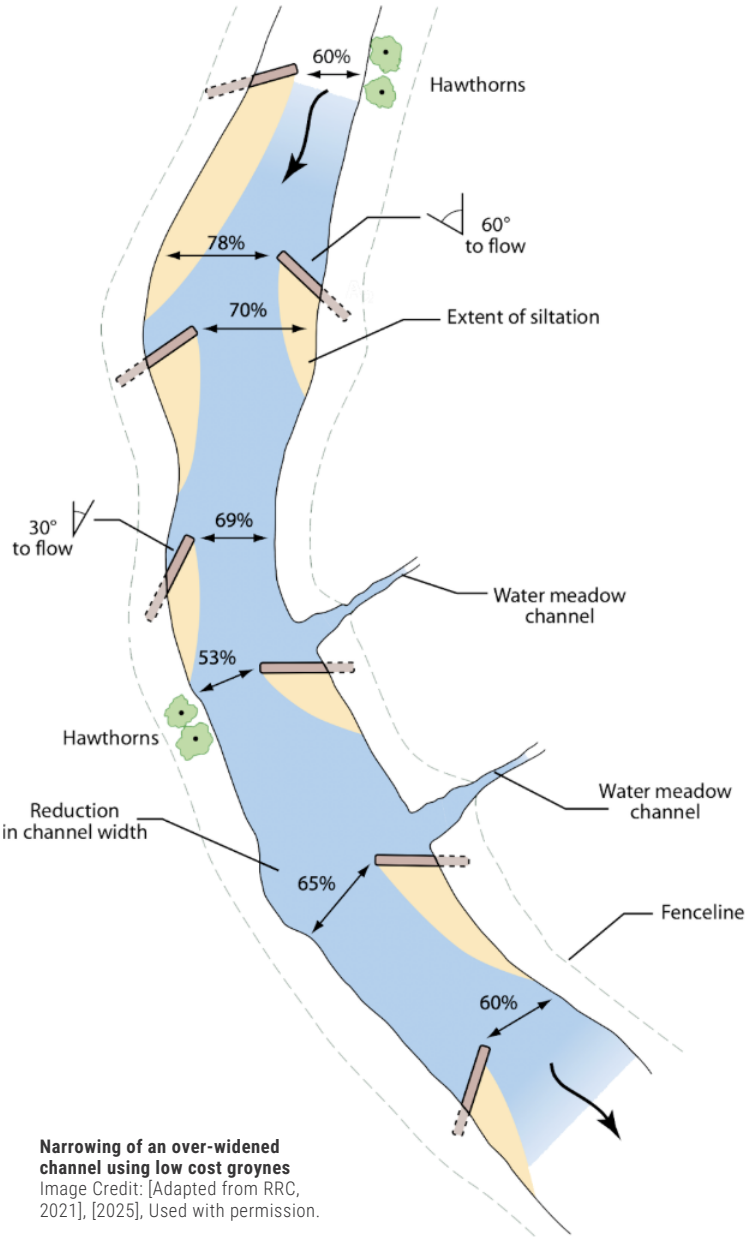
Schematic of River Restoration
Image Credit: [Adapted from RRC, 2021], [alchemia-nova Research and Innovation], [2025], Used with permission

Example of installation

- **Narrowing of an over-widened channel using low cost groynes**
- **Location:** measure executed on the River Avon, at Stratford-Sub -Castle, Salisbury, Wiltshire, in South-West England
- **Implemented by:** Wessex Chalk Stream Project, in collaboration with Wiltshire Wildlife Trust, Environment Agency, Natural England, Wessex Water, Wiltshire Fishery Association project partners.
- **Description and results:** the Hampshire Avon has historically been dredged, over-widened and impounded in several locations, compromising the natural geomorphological processes that support habitat quality and water balance regulation. Despite the unsuccessful results from the above mentioned river management practices, further actions of channel form and flow variation continued being implemented.

  The overall River Avon restoration project extended on two 750m reaches of the Hampshire Avon at Figheldean and West Amesbury, identified in the Strategic Framework for the Restoration of the River Avon. Main target of the restoration program was to return a more natural flow regime at the two sites, enhancing natural bed scouring and riparian habitat, with specific measures such as the narrowing of over-widened channels, re-meandering of channelised sections, introduction of woody debris, rifles and tree planting.

  The narrowing of the over-widened channel was executed in 1997 on a 125 m longitudinal section of the river using low cost groynes, with a total cost of £2,000. The implementation of groynes as an alternative technique to the historical anthropogenic river management practices resulted in the increase of habitat diversity following direct consequence of the flow characteristics, with sediment being accumulated both upstream and downstream of the groyne to enhance a "natural" narrowing of the channel (RRC, 2021).



Narrowing of an over-widened channel using low cost groynes
Image Credit: [Adapted from RRC, 2021], [2025], Used with permission.

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