RESTORATION OF WATERCOURSES WITH REESTABLISHMENT OF INUNDATED WETLANDS

First draft December 2009 author: B. Kronvang

Description

Improvement of the physical (morphological and substratum) diversity in watercourses (brooks, streams and rivers) that have been straightened and channelized for drainage of agricultural land can be achieved by carrying out different types of stream restoration. Active restoration of streams is a quick and direct way of achieving the required physical improvement of the channel, and restoring the interaction with the adjacent riparian areas through inundation during high flow periods.

Rationale, mechanism of action

During the course of the last century numerous watercourses have been straightened and channelized or otherwise manipulated throughout Europe [1,2,3,4]. As a result there are now only few watercourses that live up to our present-day ideas of a natural watercourse and many watercourses in Europe are mapped as heavily modified water bodies under the EU Water Framework Directive [5]. The outcome of watercourse restorations should preferably resemble the natural conditions of the stream as much as possible and should only require a minimum of future maintenance. The last two decades have shown a growing interest in restoring watercourses and river valley ecosystems for the benefit of wildlife worldwide. Many river restoration projects have already been undertaken achieving wide environmental benefits. Today, biodiversity is given high priority on the political agenda and restoration of rivers and their adjacent areas has been identified as one of the measures to maintain or even improve European biodiversity. At the same time there is increasing awareness that reinstating naturally functioning river-floodplain systems may bring catchment management benefits, particularly by increasing flood-storage capacity, giving increased nutrient retention and ameliorating low flows. Sustainable management and restoration of river and floodplain ecosystems may also reduce river maintenance costs and provide better facilities for amenity and recreation.

A classification system which differentiates between **'Types'** and '**Methods'** has been developed under the European Centre of River Restoration (ECRR). Each restoration project is subdivided in one of three **types** according to the overall objectives of the project. This subdivision is based on the extent of rehabilitation within the watercourse system:

- **Type 1: Rehabilitation of watercourse reaches**, encompasses projects whose objective is local improvement of shorter reaches. The methods used under type 1 will typically result in *better habitats* locally, both in the watercourse and in the 2 meter cultivation-free border zone.
- **Type 2: Restoration of continuity between watercourse reaches**, encompasses projects aimed at ensuring free passage along watercourse systems. The methods employed under type 2 are those that reconnect reaches and restore *free passage* and continuity between a watercourse's component reaches and between the watercourse and its immediate surroundings.
- **Type 3: Rehabilitation of river valleys**, encompasses projects affecting both the watercourse and its whole river valley. The methods employed under type 3 are those that ensure that the watercourse and river valley function as an *ecological and hydrological entity*. The impact reach across the watercourse and its surrounding riparian area.

Each type always has one **Primary Method** and might have a number of **Secondary methods** that have been used to achieve the objective of the restoration project (Table 1).

Table 1. Watercourse rehabilitation - types and example of methods.

Type 1: Rehabilitation of watercourse reaches
51 Reach remeandered
52 Culverted reach opened to create better habitats
53 Two-step cross-sectional profile created
55 Lakes established/re-established in connection with the watercourse
56 Ochre sedimentation basin established in connection with the watercourse
57 Single measures as:

- Stones laid out
- Gravel laid out
- Artificial fish hiding places established
- Other solid objects laid out
- Current concentrators established
- Sand traps constructed
- Artificial bed and/or bank established (fascines, concrete, paving slabs, etc.)
- Artificial bed and/or bank removed (fascines, concrete, paving slabs, etc.)

Type 2: Restoration of continuity between watercourse reaches
26 Obstruction replaced by riffle
27 Obstruction replaced by meanders
28 Bypass riffle established at preserved obstruction
29 Riffle established at preserved obstruction
30 Culverted reach opened to create free passage
31 Culvert falls evened out (drop manhole removed, etc.)
32 Greater water depth and/or current breakers in underpass culverts
33 Falls evened out at culvert outlet/bridge
34 Fish ladder/fish sluice established
35 Fish ladder/fish sluice removed
36 Formerly periodically 'dried-up' stream reach completely/partly restored
38 Water pumped into watercourse to maintain flow in periodically 'dried-up' reach
39 Otter pass established
40 Free passage established for other vertebrates
42 Fish ladder/fish sluice improved
48 Obstruction removed

Type 3: Rehabilitation of river valleys
1-6 Water table and flooding frequency increased by:
1 - remeandering the watercourse
2 - raising the bed
3 - terminating drains in meadows
4 - establishing a dam
5 - meadow trickling
6 - narrowing the watercourse

- Lakes/ponds/wetlands etc. established/re-established in the river valley
- Vegetation management in the river valley

Applicability
The measure of watercourse restoration can be used where the watercourse is mapped to have a low physical quality utilising some sort of physical habitat index [6]. Watercourses being heavily modified due to straightening, channelization, harsh maintenance including regular excavations of the bed and banks, watercourses with a high sediment delivery and transport, river systems with obstructions that are blocking for a free migration for fish such as salmonids. Watercourse restoration includes a long list of possible methods that can be applied (Table 1). The ultimate active restoration method is to remeander a formerly straightened and channelized reach of a stream or river. Such a measure has been widely applied in many North-western European countries [7,8,9]. Other methods are for example to restore a channel by filling in spawning gravel for trout or salmon, removal of all obstructions to re-establish the free passage up and downstream in a river system or where this is not possible re-establish free passage by a riffle or a bypass stream.

Effectiveness, including certainty
The effectiveness of watercourse restoration for improving morphological and substratum conditions is normally high if measured by a kind of physical habitat index. We are, however, still lacking enough evidence on the ecological outcome of a range of projects to be certain in the final ecological outcome being measured from indicator organisms (macrophytes, fish, macroinvertebrates and benthic algae). Short-term experience from Denmark with watercourse restoration shows generally improvements in the channel ecology but with large variations from site to site [10]. We are lacking longer term information about the final outcome and there may in many cases be a need for post management of the restored sites a need that has never been investigated. Type three projects that include reestablishment of the inundation of the adjacent riparian areas and allows them to interact with the river shows positive results regarding an increase in nitrogen and phosphorus retention capacity [11,12]. Moreover, re-meandering of a former channelized channel will create a larger area of stream bed and increase water retention time thus increasing retention of e.g. nutrients [13].

Time frame
Effects of restored watercourses will for some indicators be seen immediately (physical habitat diversity, nutrient retention), whereas it for other indicators will take many years before the final outcome can be documented (macrophyte community).

Environmental side effects
Restored watercourses will in many cases have a first initial disturbance period where higher erosion and sediment loads may be anticipated. A restored river channel may also have a higher in-channel retention capacity, increase the risk for floodings and possible influence emission of greenhouse gases from wetter surrounding riparian areas.

Relevance, potential for targeting, administrative handling, control
Restoration of watercourses can be used in natural water bodies (NBW) and heavily modified water bodies (HMWB) where the survey of the ecological quality shows that it is not sufficiently high (minimum good for natural water bodies and best attainable for HMWBs). Restoration of watercourses is very developed and targeted measure due to the many methods that has been developed and been used in practice. The administrative handling of a project can take time depending on the national and regional regulations and a follow-up control during and after the project is advisable.

Costs: investments, labor

The costs of this option relates to the costs of: (1) establishing the project proposal, (2) getting hold of the land or payment to farmers if the area nearby the watercourse is to become impacted by e.g. poorer drainage conditions, (3) establishing the restored watercourse, and (4) possible maintenance, etc.

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