RINATURALIZZAZIONE

THE BUILDING BLOCK APPROACH TO STREAM RESTORATION: THEORY AND PRACTICE*

Robert C. Petersen Jr.**

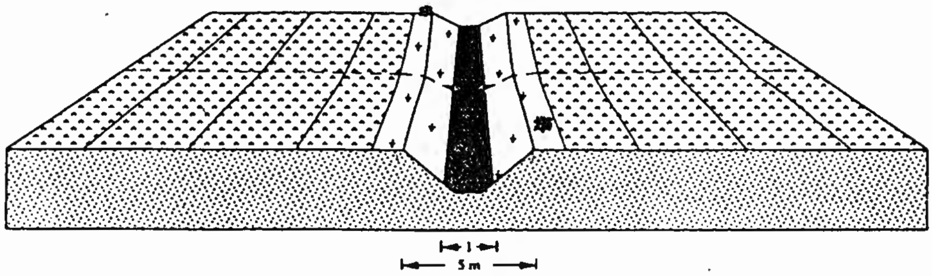
ABSTRACT

In agricultural areas throughout Europe, farmers and governement authorities recognize that something has to be done to reduce the loss of nutrients and to improve the overall quality of inland surface waters. While there may be a general consensus of opinion that something has to bo done there has been little organization of what can be done and how to do. This is in conflict with the rather large data base that exist on the ecology of running waters and the effect of various restoration measures on stream structure and function. This paper identifies eight restoration measures which act to 1) decrease the nutrient load to the sea by reducing nitrogen and phosphorus loss from agricultural lands, and 2) protect and restore the animal and plant life along and within streams by improving fish, small mammal, and bird habitat. Each measure has its own environmental benefit, cost and land use needs and are viewed as building blocks which may be added in various combinations depending on the local resources, existing land use practices and landowners preferences. The first and the most important restoration measure is to set aside a 10-meter wide riparian corridor along the entire stream lenght in each catchment. This is viewed as the foudation for the addition of other measures. On this foundation are added 2) revegetation of the buffer strip, 3) construction of drain tile horseshoe wetlands, 4) reduction of the channel side slope angle, 5) reconstruction of riffle pool sequences, 6) construction of meander loops, 7) creation of small ponds in the headwaters, and 8) the reconstruction of swamp forest and wetlands where possible. Together the 7 restoration measures once placed on the riparian corridor foundation, in various combinations, will restore the stream to it former habitat integrity and self cleaning capacity.

* Invited lecture for presentation at *"Ambiente '91"*, Terme di Comano Trentino, 29 september - 7 october 1990.

** Stream and Benthic Ecology Group, University of Lund, Sweden.

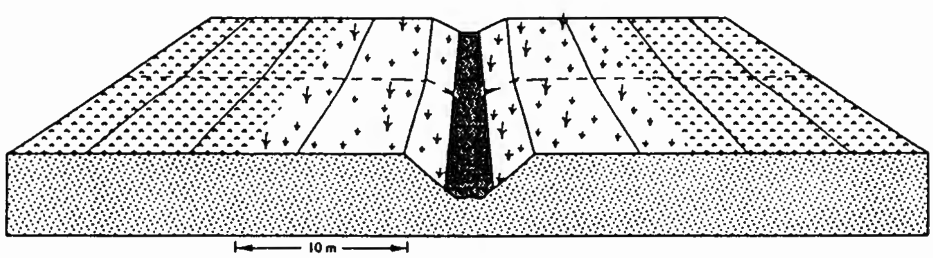
PRESENT CONDITION



The present condition of most streams in southern Sweden has been reduced to a drainage channel with minimal self cleaning capacity and little nature conservation value. Our proposal for lowland stream restoration consist of a series of measures, viewed as building blocks, that can be put together in a variety of ways depending of local conditions, available financial resources and landowner preferences.

This approach is referred to as a building block model since there are many ways that the restoration measures can be used and as with building blocks there are certain "assembly rules", in this case rules of biological organization that should be followed.

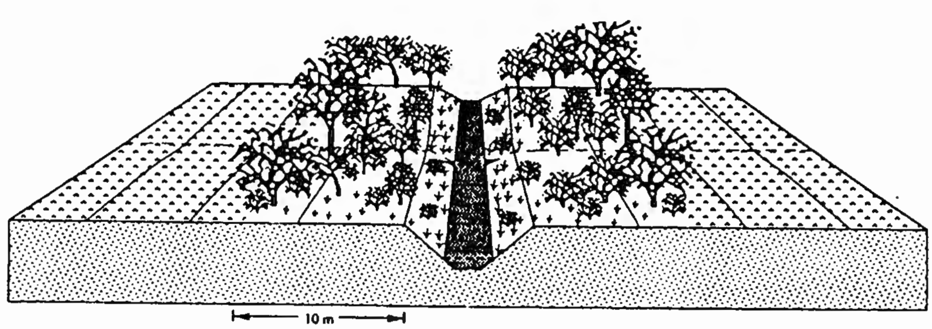
1- BUFFER STRIPS



The first assembly rule is that the first goal of a restoration programme is to set aside at least 10-m wide buffer strips along the entire length of the stream.

Buffer strips are important since they form the basis for other restoration measures that can come after. They provide habitat for many birds and plants in an otherwise monoculture landscape and can trap nutrients leaking from the agricultural landscape.

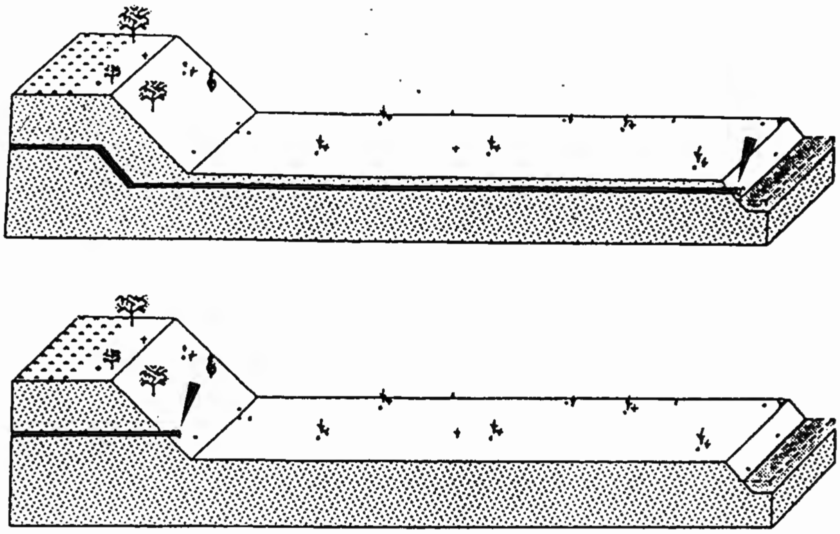
2- REVEGETATION



After buffer strips are in place they should be planted with a fast growing woody shrub. This can be alder, willow or hybrid aspen.

Broader buffer strips could be used for growing energy forests. Without planting, the buffer strips will re-seed naturally with annual plants, and could take up to 7 years for the complete effect to be seen.

3- RIPARIAN WETLANDS



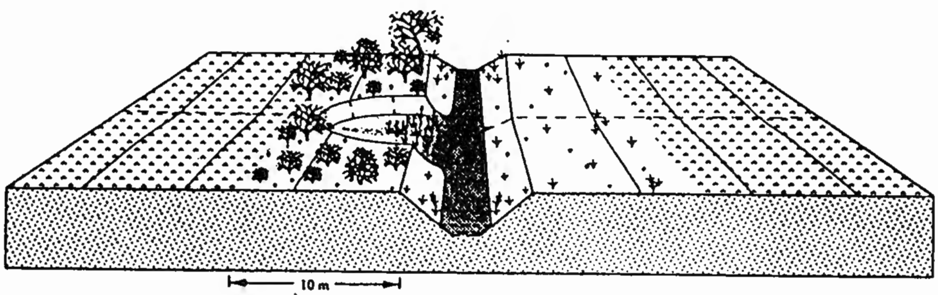
Historically, Scania streams were surrounded by extensive wetlands. These wetlands were drained by lowering the stream channel to allow the wetlands to be used for agriculture. To aid drainage, most of the agricultural land of southern Sweden has been underlain by drainage tiles(*). These carry drain water directly to the stream, and bypass soil processes which would reduce and retain nitrogen.

In some areas even the flood-plain has been underlain by drainage tiles.

To counteract this the drain tiles should be opened up at the head of the floodplain. This will allow the nutrient laden drain water to flow over a small wetland area, thus reducing nitrogen and fertilizing flood-plain grasses.

(*) Canali di drenaggio sotterranei *(n.d.r.)*.

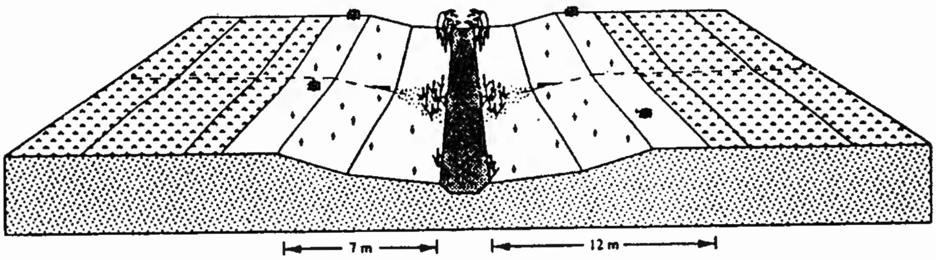
4- HORSESHOE WETLANDS



For drain tiles that do not go under a floodplain but instead drain directly from agricultural land, the tiles should be exposed as they enter the buffer strip. This will serve several purposes. One problem with allowing the buffer strip to revegetate is that the roots will grow down and start to clog the tiles. A second problem is that the drain water empties directly into the stream bypassing any possible hyporheic processes.

To counteract this bypass, mini-wetlands at the mouth of each drain tile should be created. This are semicircular, horseshoe (hästsko) shaped escavations dug into the stream bank to expose each drainage tile and allow the water it is carrying to flow over an 8-m stretch of wetland.

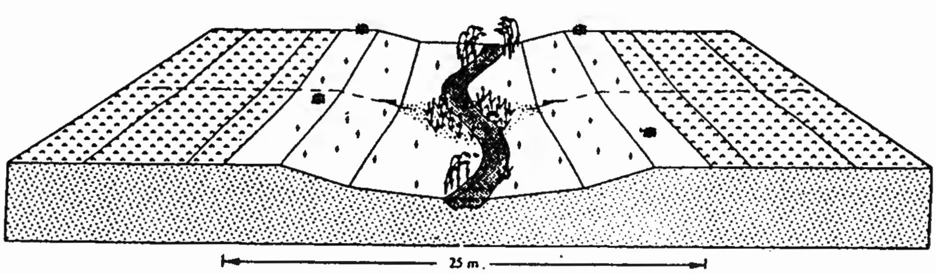
5- SIDE SLOPE REDUCTION



One of the major sources of sediment and phosphorus to streams, is the small scale land failures that periodically occur along the length of the channel. This requires that the channel be cleaned every 1 to 10 years depending on the soil and discharge character of the stream. A simple recommendation to limit this, is to reduce the stream channel side slope from the present 50% (*i.e.* 1:2) slope to a minimum of 25% (1:4) slope as shown in the figure.

There will be several effects of this. First, it will increase the width of the stream channel allowing it to dissipate its energy by meandering instead of undercutting the side banks which leads to slope failure. Second, it will reduce the frequency of channel maintenance saving both money in the long run, and the integrity of the stream.

6- MEANDER VALLEY

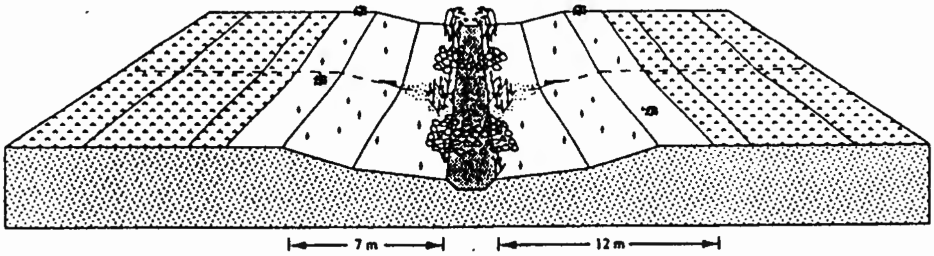


Meanders are an effective restoration measure, since there are the most stable and most natural physical state for a stream that was formally meandering. They are also able to reduce nutrient loads by increasing the physical complexity and length of the channel.

A meandering channel by definition is one that has a channel length that is at least 1.5 times the length of the down valley distance(*). Since many stream processes can be quantified on a length basis, the longer channel has greater purification properties.

(*) Distanza realmente percorsa dal corso d'acqua ≥ 1,5 volte della distanza in linea d'aria*(n.d.r.)*.

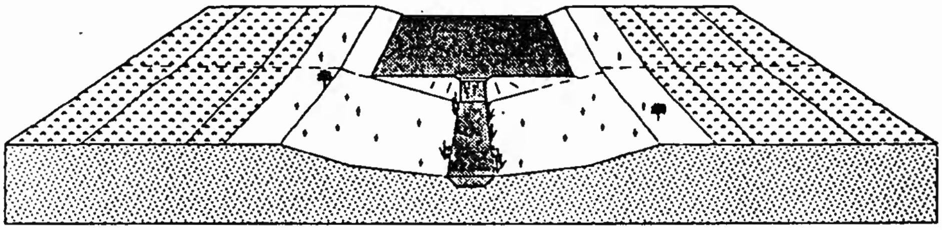
7- RIFFLE-POOLS



Where a slightly higher gradient is available and to increase the physical complexity of the stream bottom, rooks can be placed at intervals to create riffle areas. These should be followed by a pool area. The natural physical dimensions of riffle pool associations should be set so to have one pair, a riffle and a pool, at a downstream distance of 5-7 times the stream width.

For a stream 1-meter wide a riffle pool pair should occur ever 5-7 meters. The riffle should be about 3 meters long followed by a 2 meter long pool. Actual spacing is not critical since the stream will readjust the rocky sediments itself during the first flood.

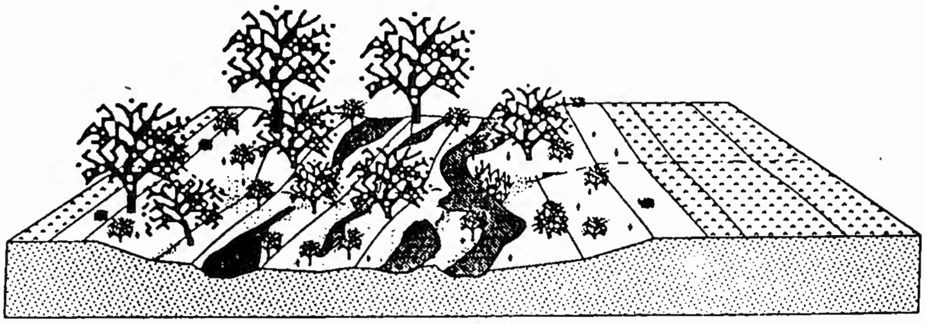
8- PONDS



Small ponds created within the meander valley or created as an extension of the horseshoe wetland are an economical and multiuse restoration measure. The cost of impoundment for most small streams is well under 100,00 SEK.

The uses include water retention for later use for irrigation. Ponds can be used for crayfish growing or as a fish pond. Ponds also retain organic material and nitrogen, and with sediment processes nitrogen reduction can be achieved.

9- SWAMP FOREST



Where possible, the riparian ecotone should be reconstructed back to its former status as a swamp forest. These are freshwater woody communities, which are flooded frequently by the stream and contain water throughout most or all of the growing season.

In Sweden, swamp forests tend to be dominated by European Black alder and while remnants of these forests can still be found today, most have been eliminated.