Streams are ecological corridors

Streams provide ecological corridors in the landscape. Species-rich environments that differ from the surrounding areas are found there. Apart from the extensive biodiversity completely connected to the aquatic environment itself, the nearby environments are used as migratory paths for insects, birds, and game animals. Most aquatic animals need open migration routes to be able to propagate and reproduce.

Fish migrate between breeding, spawning, and feeding grounds. They also move to overwinter or to temporarily avoid unfavourable conditions. Certain species, especially small individuals, find it difficult to swim against strong water currents.

Like fish, bottom-dwelling animals are dependent on being able to move along the stream. The species that lack a flying stage, such as crustaceans, snails, and freshwater barnacles, are especially dependent on open waterways. Bottom-dwellers that crawl along the riverbeds and that lack the ability to swim are naturally dependent on there being no fall from culvert outlets. A corrugated culvert bottom can be good to crawl on, but even at moderate water velocity there can be a lot of turbulence, which makes migration for smaller animals difficult.

Even those land animals that move along the stream – like otters, beavers, and the northern water shrew – need to pass road crossings so that their migratory needs are not disrupted. At culverts with high water velocities and which lack natural shores, many land animals choose to cross the road and risk being run over.

ENVIRONMENTAL OBJECTIVE 8

Flourishing lakes and streams

"Lakes and watercourses must be ecologically sustainable and their variety of habitats must be preserved. Natural productive capacity, biological diversity, cultural heritage assets and the ecological and water-conserving function of the landscape must be preserved, at the same time as recreational assets are safeguarded."

In this brochure, we describe the features of crossings that block migration, propose measures concerning how to correct this, and how new stream crossings can be designed to minimise their impact on streams. Recommendations have been produced by the Norrbotten and Västerbotten county administrative boards, the Northern Region of the Swedish Forest Agency and the Northern Region of the Swedish Transport Administration.

In Sweden, on average, there is a road crossing every two kilometres along a stream.

Through inventories, we know that every third stream crossing can constitute a block to migration for fish migrating upstream. If other aquatic animals, and species that live on both land and water are taken into consideration, the situation is even worse.

To achieve the Swedish Environmental objective for lakes and streams, and for all our streams to achieve good ecological status in accordance with the EU Water Framework Directive, we must stop building new obstacles to migration in the form of poorly adapted road crossings. In addition, we must take effective and long-term care of the existing stream crossings that are blocks to migration.

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SKOGSSTYRELSEN

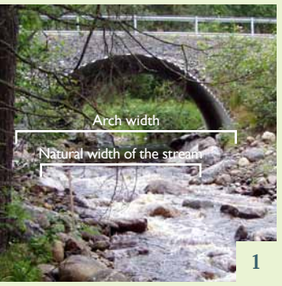
TRAFIKVERKET

Länsstyrelsen Norrbotten

Länsstyrelsen Västerbotten

Design of Ecologically adapted stream crossings

Advice for when new stream crossings are to be constructed and obstacles to migration are to be corrected



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! Changing out or constructing new culverts or bridges are water operations that have a notification or permit requirement in accordance with Chapter 11 of the Swedish Environmental Code, which can be found summarised in "Har du koll? Arbeten i vatten - vad gäller?". It can be downloaded from the Västerbotten county council website.

! The recommendations here also apply in principle to the ecological design of railway crossings.

The best way of making sure that streams are not impacted by a new road is, of course, to give it another route. If, despite all this, a road is to be built over a stream, the greatest care should be observed. Here we'll demonstrate a few principles that should be followed, just as when culverts that are blocks to migration are to be corrected.

1 To achieve proper environmental adaptation, a bridge or arch should be chosen – one that is wide enough to accommodate at least one riverbank. A rule of thumb is that the opening should equal at least the natural width of the stream at normal water levels multiplied by 1.2. Note that certain streams may require greater width to ensure the strength of the construction during high flows.

2 When building a crossing over a stream, as much of the water area as possible should be left untouched. Water area means the area covered by the water at the highest predictable water level.

3 Maintain the existing stream bed and the original slope, width, breadth and current velocity of the stream.

4 Choosing a bridge results in an open solution that minimises the impact on flying insects.

5 Marking stones – large stones or blocks that otters, for example, often use to mark their territory with their droppings – at the entrances to the bridge or arch increase the chances of land animals being led under the stream crossing.

6 At crossings with very low current velocities, burying a whole culvert may be a good choice. In choosing a whole culvert, the same dimension calculations should be used as with arches and bridges – that is, the opening should be calculated based on the width of the stream at normal water levels. The culvert is buried at least 0.3 m into the stream bed so that a natural stream bed substrate can flow in, or alternatively it can be brought in by machine or by hand.

Minimise turbidity

By moving as little of the existing stream bed as possible, turbidity can be minimised and the risk of erosion-related problems in the future can be countered. The work should be carried out during periods of low flow, which then minimises the risk of heavy turbidity. The deadline for construction should be adapted according to the species that live in the stream. Keep the reproductive migration of fish in mind, when fish eggs and young can be found in the stream bed gravel; which other sensitive life forms can be found in the stream, and so on. In certain cases particular protection measures may be necessary to avoid turbidity. In the event there are freshwater pearl mussels in the stream, they may need to be lifted up and temporarily stored at a location further upstream. This, however, requires permission from the County Administrative Board.

Prioritise the measures

Before correcting a culvert that is blocking migration, it must be decided whether this is a prioritised measure. Keep the following points in mind:

- Are there any natural obstacles to migration in the vicinity of the road crossing? In that case, a measure of this kind may be judged to be of no use.
- Where is the stream crossing located on the stream? Obstacles nearer to the mouth close off larger parts of a water system and should normally be corrected before those lying further upstream.
- Which fish species or other animal species are there in the stream? Species particularly worth protecting are a strong motive for measures.
- Does the culvert lie in a stream that has been singled out as being particularly valuable? Have other restoration measures been carried out there, or will they be carried out there? If the answer to any of these questions is 'yes', this could be an argument that contributes to the decision on a measure.
- Is the measure locally supported by landowners' groups, fish conservation areas, municipalities and water councils? This is a fundamental condition for successful remedial measures.

Temporary solutions

High costs, perhaps even technical problems, are sometimes associated with changing a culvert, however. There are two ways of temporarily reducing the water velocity in a culvert. One is to raise the water level downstream from the culvert with the help of stone sills at the outlet. The slope is thus reduced, thereby also reducing the water velocity. Keep the following in mind:

- Make the construction stable enough that it can handle high water flows and the break-up of ice.
- Make sure the sills are compact enough that water runs over them and not through them, so that new obstacles to migration are not created.

The other way of effecting a temporary solution is to create structures in the culvert that curbs the water velocity. One such example is "wings" of steel on the culvert bottom and which alternate on the right and left sides with approximately a metre between them. The wings interrupt the current and create a somewhat less strenuous migration for fish upstream through the culvert. In the event the culvert does not bear on the stream bed, stone sills downstream from the culvert should be considered in addition to wings or similar solutions.

Common problems with stream crossings

Presumably, the more stream crossings hindering migration in a water system, the greater the problems they pose for the fauna. By fauna, we mean fish and other aquatic animals, as well as land animals that often move along the stream. Every individual crossing does not need to be impossible to pass, but the cumulative effect of several obstacles can make migration impossible or severely delay it.

Culverts can cause problems of various kinds. This applies in particular if the culverts do not contain a natural stream bed substrate.

The most important problems are summarised in points 1-7:

1. Free fall from the culvert's outlet results in a stop to migration for fish and many other species. Certain species cannot pass if the culvert does not bear on the stream bed.

2. High water velocities and turbulence in the culverts and at the respective intakes and outlets hinder animals' passage. When water velocities exceed 0.2 m/sec in connected parts, for example along the bottom of a corrugated sheet metal culvert, small animals will experience difficulty passing. Migration problems can also occur if the velocity in the main mass of the water exceeds 0.4 m/sec.

3. Culverts that are long and lack areas for rest result in animals not having the strength to pass. Culverts with a slope exceeding 0.5% can hinder migration if they are longer than 30 metres.

4. The water in the culverts is too shallow for migration. Nowhere should the depth of the water fall below 20 cm in the "middle segment" of the culvert under normal low river flows, provided that the natural depth of the stream exceeds 20 cm at the culvert's position.

5. Stoppages from debris at the intake and outlet, or of the culverts themselves.

6. Long culverts with high water velocities result in land animals that depend on the water course – otters, beavers, and water shrews, for example – being forced to cross over the road or choose to deviate from the stream.

7. The culverts are designed so that erosion of the shore and stream bed increases. Common causes are the culvert being underdimensioned and incorrectly placed.