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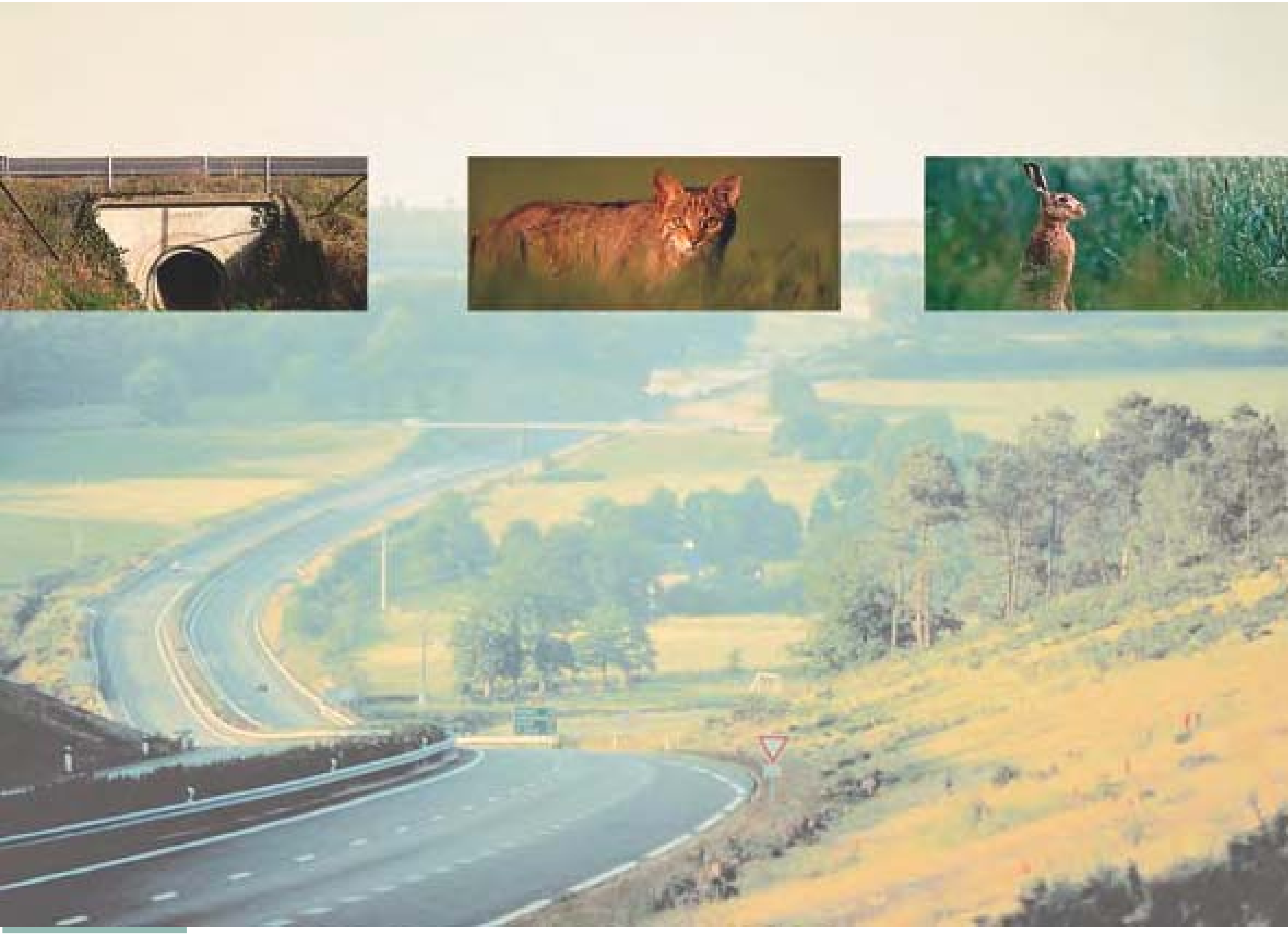
Technical Guide

Facilities and measures for small fauna



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The Sétra supplies State agencies and local communities (counties, large cities and urban communities) with informations, methodologies and tools suited to the specificities of the networks in order to:

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- define, apply and evaluate the public policies;
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Technical Guide

Facilities and measures for small fauna

This document is the translation of the work "Guide technique : Aménagements et mesures pour la petite faune" published in August 2005 under the reference 0527.

This document has been prepared in conjunction with the Direction des Études Économiques et de l'Évaluation Environnementale[1], a division of the French Ministère de l'Écologie et du Développement Durable[2] (MEDD).

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We would especially like to thank François Nowicki for the animal photographs illustrating this guide.

Ministère de l'Ecologie et du Développement Durable

[1] Economic study and environmental assessment division

[2] French ecology and sustainable development ministry

Construction example: access expressway to Strasbourg airport

European variable toad conservation involved a series of operations between 1990 and 1992, including creation of two substitution ponds, construction of 800 m of low concrete wall (height 0.40 m) and installation of 3 km of wire-mesh (6.5 x 6.5 mm) fencing designed to encourage colonisation of new environments.

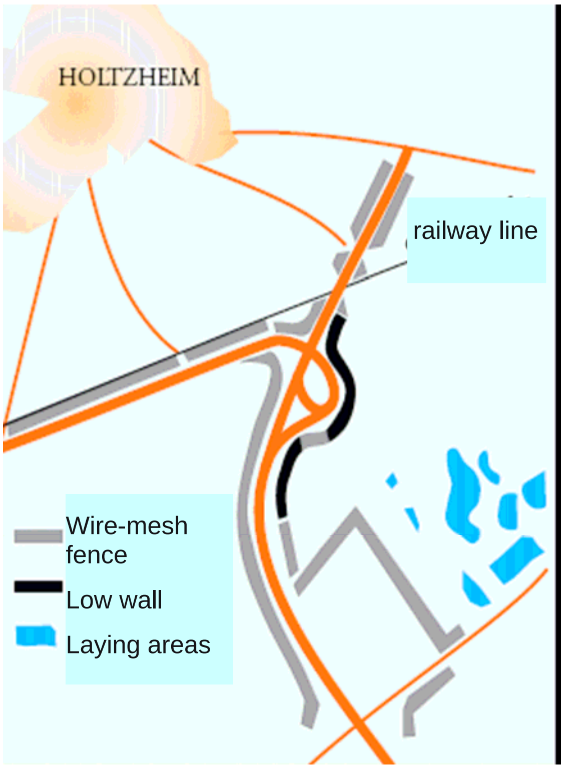


Figure 71 – Access expressway leading to Strasbourg-Entzheim airport. Protection measures in favour of the European variable toad (Bufo viridis)

Amphibian passages are usually placed at major gathering locations (common toad, common frog). However, other more vulnerable, and even threatened, species do not benefit from this type of protection because they are usually discreet and often go unnoticed through lack of careful diagnosis. Yet, these are the very species that should benefit in priority from type II protection installations.

4.1.4.3 – Type III passages: small-scale hydraulic passages

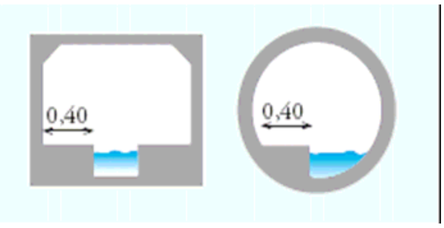
Watercourses, even the smallest, generate biological flows and watercourse banks are as important as a dry bed in ensuring movement of riperian land fauna.

Very many animals follow watercourses and their banks. This is indeed the case not only for mammal taxons such as the shrew, water rat, European mink, otter, beaver, dormouse, hedgehog, but also for bats, which hunt insects flying above watercourses. The same applies for other groups such as reptiles associated with hygromorphic habitats (e.g. the grass snake, the viperine snake, etc.) or amphibians. All can hunt and migrate along watercourses.

Biological flows must therefore be re-established by type II mixed structures, which can be of different forms: ovoid (conduit, arch) or rectangular (culvert). Depending on the case, there are equipped with side ledges, dry-standing areas[53], widened banks and even walkways, which extend watercourse banks beneath a structure.

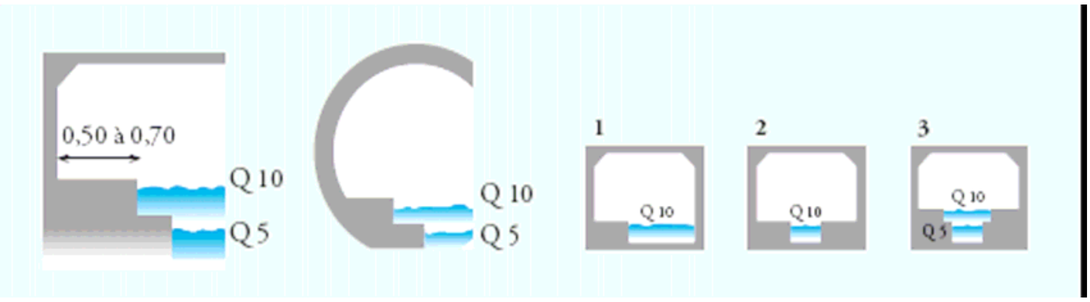
[53] *dry-standing = dry bench, riverside footpath*

Sheet III – Different forms of type III passage



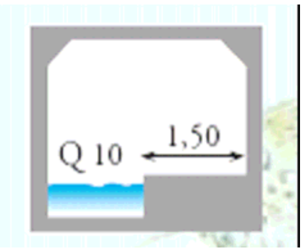
Type IIIa

l or Ø δ 2 m Small-scale hydraulic structure with narrow submersible bench



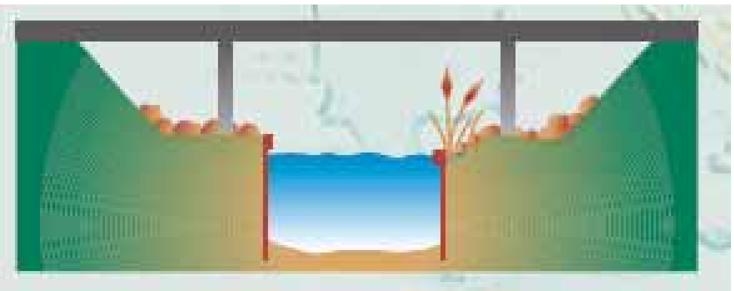
Type IIIb

Hydraulic structure with narrow side ledge (50 to 70 cm) - single (1), double (2) or tiered (3)



Type IIIc

2 < l < 7 m Medium-scale hydraulic structure with 1.50 m wide dry-standing



Type IIId

l > 7m Large-scale functional hydraulic structure for both large and small fauna with extra widening of one (ε 3 m) or two (ε 2 x 3 m) banks.

Type IIIe

Dry pipe (Ø ε 600) placed near the hydraulic structure and above water for a 10-year flood.

Source: J. Carsignol (CETSource CETE de l'Est) – European Commission / COST341(2003)

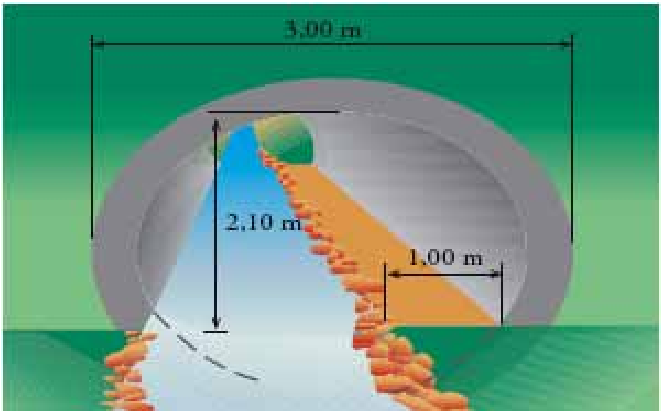


Figure 72 - Type IIIa passage: steel pipe with 1 m wide bench

Source: E. Rillardon (Sétra)

Photo 40 - Type IIIa passage: steel pipe with 1 m wide ledge

Source: photo M. Gigleux (CETE de l'Est)

Type IIIa passage

These passages are small structures (pipe, ovoid conduit, open or closed frame) less than 2 m high, incorporating one or two submersible ledges. These stuctures restore small, occasional or permanent, natural watercourses (streams, ditches), but can also be associated with drainage, when this involves run-off from the catchment basin and not from the road (pollution risk).

Ledge installation is delicate in small-scale conduits, but it can be done in the factory during unit production. Resorting to systems featuring an arch placed on a foundation raft (cf. figure 74) or a precast device (cf. figure 75) can facilitate ledge integration during construction.

Type IIIb passage

These permanent hydraulic structures incorporate narrow 0.50 to 0.70 m wide ledges. Headroom between the dry-standing and the deck is 0.70 m. There are several possible ledge layouts: on one of both banks, single or "stepped" (tiered) ledges. Tiered ledges (0.50 m minimum width) allow animals to advance as near as possible to the water, whatever its depth, without reducing the flow cross section too much. This system requires no extra width and is successfully used for the otter. Weekly recording of presence indices and night photographic trapping also indicate regular usage of this facility by the marten, the stone marten, the water rat, the fox, the short-tailed rat, the garden dormouse and the muskrat for structures up to 180 m long.

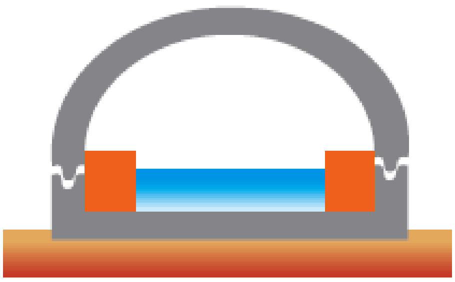


Figure 74 – Arch connected to foundation raft. Dry-standing areas can be cast on the raft in the factory or during construction, before installing the arch

Source: J. Carsignol (CETE de l'Est) - L. Lafontaine (1991)

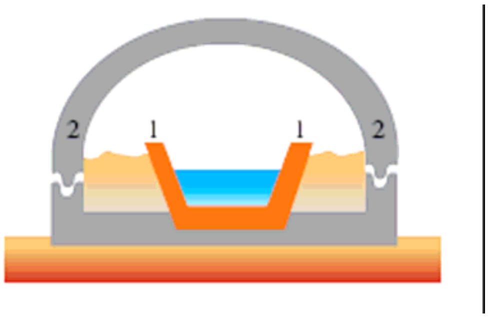


Figure 75 – Precast unit allowing ledges and dry-standing areas to be built. Void between (1) and (2) is backfilled or concreted to restore bank continuity.

Source: J. Carsignol (CETE de l'Est) - L. Lafontaine (1991)

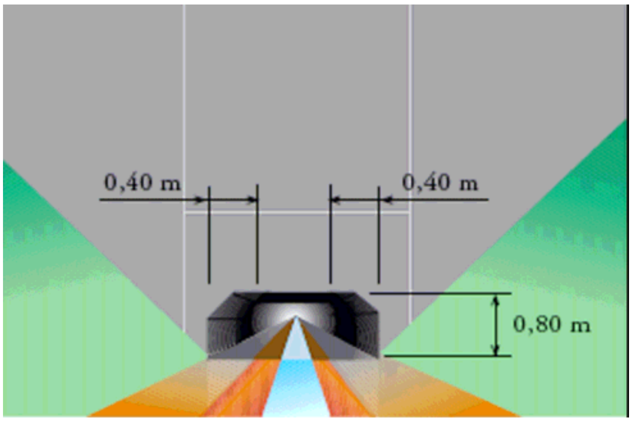


Figure 73 – 1.20 m wide culvert with two 0.40 m wide ledges (headroom: 0.80 m)

Source: E. Rillardon (Sétra)

Photo 41 - RD 18 Sizun by-pass (Finistère department): type IIIb passage with ledge (l = 0.75 m) on each bank.

Headroom 0.80 m. Structure is used by the otter, the hedgehog, micromammals, batrachians, the fox and the badger.

Source: J. Carsignol (CETE de l'Est)

ASF motorway concessionary operator installed 22 hydraulic passages beneath the A 89 motorway specifically for otters. Two of these, Clidane (Puy de Dôme) and Dogon (Corrèze) rivers were subject to patronage monitoring by recording presence indices and photographic surveillance.

Year	Duration	Results of passage monitoring
2001	3 months	3 photos, including 1 female with its baby Signs of presence each month
2002	12 months	5 photos Signs of presence 10/12 months
2003	2 months	1 photo Signs of presence each month

Table 23 - A 89 motorway - ASF (Puy de Dôme – Corrèze department). Otter patronage of hydraulic structures on Clidane Dognon rivers.
Source: Catiche Production (2002-2003)

No protection can be provided against ledge submersion in small-scale type IIIa structures. On the other hand, ledges, dry-standing areas and extra widths are designed for a 10-year flood flow in type IIIb, c and d structures. The advantage of tiered ledges (cf. sheet III) is that they maintain crossing possibilities for riperean fauna at 5-year and 10-year flood levels. This is an important factor for consideration because underdesign would mean that the structure will often be unusable for land fauna; the latter could then move away from the watercourse and cross at road level with all the ensuing risks for both animal and road user.

Photo 42 - RN 89 national road (Puy de Dôme department): type IIIb passage crossing the Clidane . Arched hydraulic structure (Ø 5000 mm, length 75 m). Tiered river-banks (2 x 0.40 m wide ledges) are regularly used by the otter – Source : M. Owaller

Photo 43 - A 89 motorway- ASF (Corrèze department): Dognon river crossing. Tiers (4) allow otters to cross in the dry, throughout the year, whilst remaining close to the water (on left of photo, control unit) – Source: Ch. Bouchardy

Type IIIc passage

The size of these structures permits the use of small construction machinery, facilitating “internal” equipment of the passage. A 1.50 m high step is recommended for both wild fauna and anglers to maintain free access to the fishing stretches.

Photo 44 - A 35 motorway - DDE 67 (Bas-Rhin department): type IIIc passage. Width 3 m (incl. 1.20 m wide dry-standing), height 3 m.

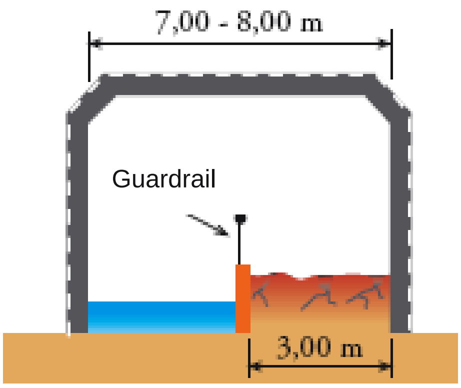
Source: J. Carsignol (CETE de l'Est)

Photo 45 - LGV Méditerranée '52FF high-speed rail line (Bouches du Rhône department): type IIIc passage for beavers in the Durance river valley.

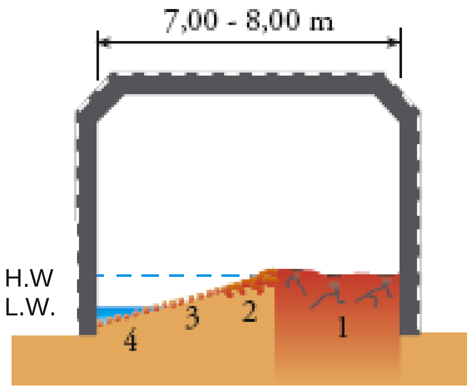
Source: J. Carsignol (CETE de l'Est)

Type IIId passage

This passage is embodied by mixed hydraulic and large fauna structures providing an opening larger than 7 m. Depending on circumstances, bank widening restores one or both riverbanks. These frame and arch structures should be designed such that land fauna usage can be maintained even during river flood periods (Q 10, 10-year flood flow). However, this requirement is unnecessary if the structure is located in a flood area (valley submerged during 10-year floods).



To be avoided



Recommended

1 – Compacted material: the step is built to the level reached by the watercourse during a 10-year flood
2 – Rockfill protects the passage from erosion. It must not form and obstruction to animal movement in the exposed riverbed.
3 – Paving of the exposed riverbed, laid like an old ford, prevents formation of waterholes, into which fauna does not venture.
4 – a crossfall creates a narrow low-water stream against the structure wall, freeing extensivef space accessible to land fauna.

Figure 76 – Dry standing development principle.

Source : Sétra and French ministry of the environment (1993)

Type III passage size enables a gently sloping extra width (15 to 25°) to be provided. This measure offers the following twin advantages:

- Animals strictly associated with the watercourse can always advance in contact with it, whatever the water level;

- A larger free movement area is available to animals, which use the river corridor as a preferred route, when low-water conditions prevail.

Sheet IV – Different forms of type IIId passages

Photo 46 - A 43 motorway - SFTRF (Maurienne valley): St Bernard type IIId canal bridge.

The PS overpass structure re-establishes a stream and a passage for deer. The fauna reserved area is 8.20 m wide. This area is used by small fauna.

Source: J. Carsignol (Cete de l'Est)

Photo 47 - A 89 motorway- Asf (Gironde department): mixed PI (hydraulic + fauna) underpass crossing the "Cholette" . L = 30 m, l = 8 m, h = 4.3 m.

Source : Ph. Thievent (Scetauroute)

Photo 48 - LGV Méditerranée high-speed rail line. Type IIId structure in the Durance river valley with extra width on both banks.

Source: J. Carsignol (Cete de l'Est)

Photo 49 - A 89 motorway - Asf (Dordogne department): slab bridge crossing of "Boutouyre" stream. Deck width: 25 m.

Source: Ph. Thievent (Scetauroute)

Photos 50 and 51 - A 71 motorway - Cofiroute (Sologne department): structure with extra width on right bank.

Left: during construction; right: after revegetation.

Source: J. Carsignol (Cete de l'Est)

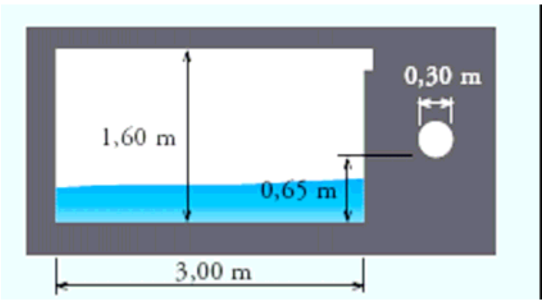
Type IIIe passage

Another option involves installing a dry pipe or frame near the hydraulic structure, when its structural characteristics do not allow incorporation of a ledge or dry standing. This possibility is therefore helpful, when hydraulic structure cross section cannot be increased or a remedial or retrofit measure cannot be implemented.

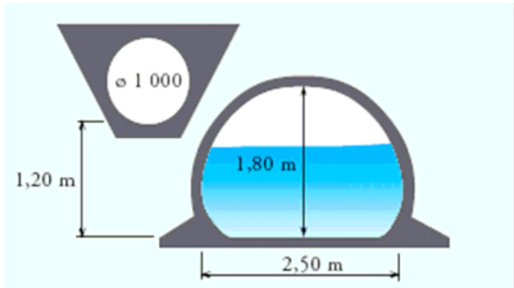
Dry pipes or frames can be installed by jacking or trench excavation.

In all cases, ledges and dry standing facilities must be connected to (merge with) the natural banks upstream and downstream of the structure. Gently sloping accesses must be wide enough, made safe by a few shrubs and helophytes over a radius of about 12 m around each entrance. Entrances must not be obstructed by concrete drainage channels or water treatment ponds, which curtail passage accessibility.

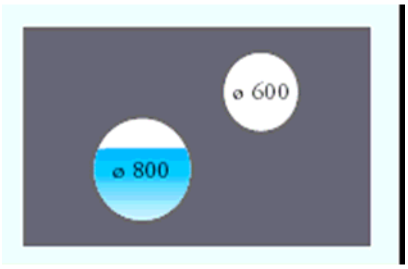
RD 86 departmental road (Côtes d'Armor department): Ø 300 mm dry pipe Not used by the otter, Mustelidae passages



RD 8 departmental road (Côtes d'Armor department): Ø 1000 mm dry pipe (l = 16 m) Used for otter, fox, Mustelidae



RD 8 departmental road (Côtes d'Armor department): Ø 600 mm dry pipe (l = 12 m) Not used by the otter, Mustelidae and fox passage



RD 780 departmental road (Morbihan department): Ø 600 dry pipe (l = 12 m) Used by the otter

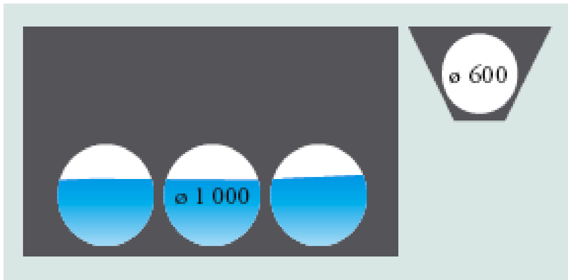


Figure 77 – A few type IIIe passages

Source: Réseau SOS loutres [otter SOS network] and French environment ministry (1993)

Corbels may be envisaged, either built into the structure or retrofitted beneath existing small-size bridges (cf. figure 78).

Walkways must be butt-jointed to be effective. Similarly, steel gratings should be prohibited because they behave like a cattle grid (cf. photo 59).

Existing structures can sometimes be adapted. For example, the pipe in figure 79 had originally a purely hydraulic function. With use, very low drainage flows allowed installation of a Ø 400 mm drainage conduit and laying of crushed aggregate and sand bedding on the bottom of the main Ø 2600 mm pipe; this being both more attractive to fauna and suitable for patronage monitoring (footprint recorder). Facility effectiveness monitoring operations give interesting results in south-western France (cf. table 24).

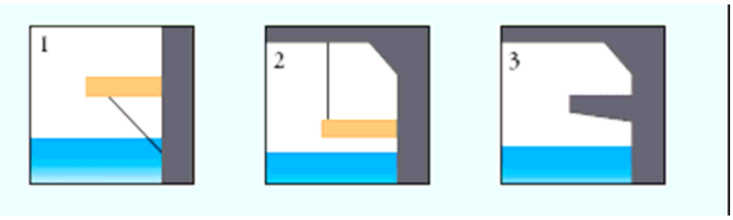


Figure 78 – Corbels made of wood (1 and 2) or built into the structure (3)

Source: J. Carsignol – European Commission / COST 341 (2003)

Photo 52 - A 5 motorway - APRR (Haute Marne department): timber walkway

Source: J. Carsignol (CETE de l'Est)

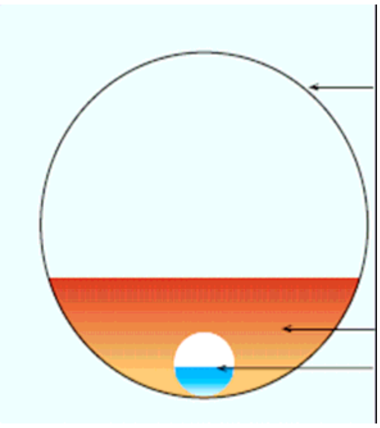


Figure 79 – Restored type III passage

Source: J. Carsignol (CETE de l'Est)

Hydraulic structures offer defragmentation opportunities (cf. photo 53), which are not always developed. However, recurrent design mistakes often prohibit land fauna access to these facilities (cf. sheet V).

Photo 53 - A 26 motorway - SANEF Marne river valley

Small hydraulic discharge structures represent interesting type IIIa passages. They are functional for small fauna most of the year outside flood periods and require no specific adaptation

Source : J. Carsignol (CETE de l'Est)

Observation weeks												
Structure n°	1	2	3	4	5	6	7	8	9	10	11	12
n°6 h = 2.59 m	Badger Genet	Badger Genet Stone marten	Badger Genet	Badger Stone marten	Badger Genet	Badger Genet	Badger Genet	Badger Genet	-	Badger Genet Roe-deer	Badger Genet Roe-deer	Badger
n°8 h =2.59 m	Badger	Badger Wildboar	Badger	Badger Stone marten	Badger Genet	Badger Genet Stone marten	Badger Genet	Badger Genet	-	Badger Genet Roe-deer Stone marten (?)	Badger Genet Roe-deer	Badger

Table 24 - A 62 motorway: weekly records of fauna through passing converted steel pipes
Source: Sétra (1992)

Sheet V – Different designs unsuitable for fauna

Photos 54 and 55 – Overdesigned hydraulic structure, often dry (Mediterranean regime) but unusable to fauna.

The upstream opening (left-hand photo) does not cause an accessibility problem, but the downstream opening (right-hand photo), equipped with a stone-filled pit, operates as a land fauna trap

Source: J. Carsignol (CETE de l'Est)

Photos 56 and 57 – Hydraulic passages unsuitable for land and fish fauna

Source M. Gigleux (CETE de l'Est)

Photo 58 – Hydraulic discharge structure

Funnel inlet pits recommended by hydraulic engineers for reducing the hydraulic cross section of discharge structures are obstructions to free movement of land fauna and traps for fish, which die in these water holes when flood levels drop. These pits contain water because they are in contact with the groundwater table all year (offering an important environment for amphibians, but representing a barrier for land fauna)

Source : J. Carsignol (CETE de l'Est)

Photo 59 – Grating prevents fauna access to the passage

Source : J. Carsignol (CETE de l'Est)

4.1.4.4 - Type IV passages: agricultural or forestry underpasses or overpasses

The function of type IV passages is essentially to allow mobile machinery to cross the infrastructure on unsurfaced roads. These passages had originally no biological vocation (they were not combined structures) but, following a number of adaptations, their characteristics (7 to 8 m wide) offer possibilities of regular crossing by both microfauna and mesofauna. These passages are particularly effective for nocturnal animals living readily below ground or in cavities, such as foxes, badgers, stone martens, martens, polecats, stoats, hedgehogs, rabbits, voles, shrews, etc. On the other hand, they contribute only very marginally to large fauna biological exchanges (occasional crossings).

Type IV structures should be considered during overall assessment of traffic route permeability. Their relatively low adaptation cost offers an attractive cost/effectiveness ratio for small fauna.

The narrowness of these passages restricts their deck adaptation potential. However, installation of revegetated or swath strips can facilitate passage usage by fauna (cf. technical datasheet n°10 entitled “Passage facilities”).

But, most of the passage development effort must be applied to the direct surroundings of the passage (cf. technical datasheet n°10 entitled “Passage facilities”). Direct outlet onto a road carrying heavy traffic, or onto drainage devices likely to trap small fauna or prevent it crossing, must be avoided at design stage.

The opportunities offered by these structures remain underdeveloped. Development of agricultural or forestry passages with a double grassed strip and, if possible, a few shrubs represents effectively a low-cost solution, prompting a reduction in barrier and isolation effects on common species. These contribute to the faunistic diversity of our common species. In major faunistic areas, type IV passages do not replace type VI, VII or VIII fauna-specific structures. However, they do constitute additional displacement structures.

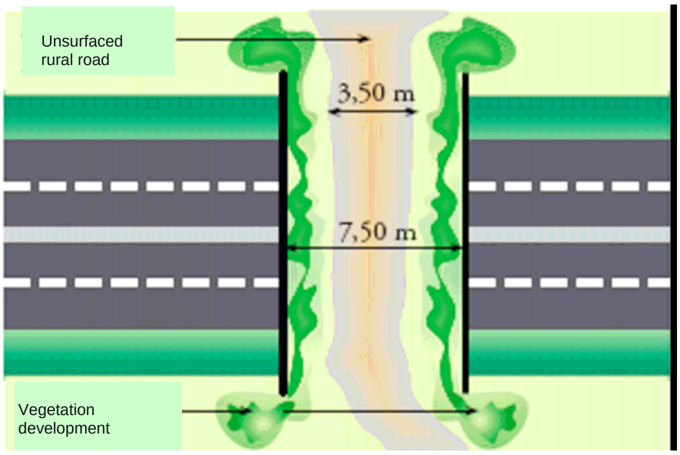


Figure 80 – Development principle for an agricultural (or forestry) overpass: 2 vegetated strips on each side of the unsurfaced stabilised road.

Source: J. Carsignol (CETE de l'Est)

Photo 60 - A 39 motorway / APRR: 8.5 m wide passage over the Blanay (Jura department). Unsurfaced road, stabilised with natural material and bordered by two revegetated, tree-planted strips (2.5 m x 2) (single row planting)

Source: T. Cagniant (APRR)

4.1.4.5 - Type V to VIII passages: large structures

If properly laid out and developed, these passages (cf. technical datasheet n°10 entitled “Passage facilities”) enable the biodiversity of infrastructure-crossed environments to be maintained in a state of conservation (sustainable development).

The large dimensions of type V and VI structures, developed mainly for large ungulates or corridors of regional and supraregional importance, ensure sufficient clearance to avoid a tunnel effect and transparency favourable to many medium and small fauna species.

Remark: type VI passages are relatively expensive and should therefore be reserved for equipping fauna-rich habitats and for re-establishing corridors of regional and supraregional importance.

As for type VII and VIII passages, on the biological level, these ensure full habitat connectivity and restore immediate possibilities of movements for all local and regional fauna.

All these passages are included in technical datasheet n°9 entitled “Major structure (type V to VIII) design and management recommendations”.

Photo 61 - A 26 motorway / Sanef (Marne department): agricultural passage (width 8 m). Clearance (perception of other side of structure) and surfacing (stabilised natural materials) favour local fauna

Source: J. Carsignol (Cete de l’Est)

4.1.5 – Structure development

In addition to its positioning and characteristics, the effectiveness of a passage also depends on development of either its deck or its surroundings. The passage attractiveness for many small and medium fauna species can be enhanced by implementing special measures, such as choice of plants and their positions, swath creation, facility adaptation to different areas, etc.

Passage development for small fauna can be differently envisaged according to whether type I, II or even III passages, type IV, V and VI passages or type VII or VIII major structures are envisaged. cf. technical datasheet n°10 entitled “Passage facilities”.

Datasheet D | Otter (Lutra lutra)

The otter is mainly nocturnal in France and rarely leaves the waterside, its living area. It patronises every type of aquatic environment from the seashore to mountain lakes at altitudes of more than 2,000 m. For otters to live and reproduce in a precise location, it is absolutely essential that the following three conditions are met.

- High quality water with abundant, varied food.

- Multiple shelters along rivers and areas of water with very quiet sectors for the its reproduction holt.

- Total freedom of movement not only for territorialized individuals, but also for erratic young seeking a free area.

Photo 132 - Lutra lutra. Source: D. Chevalier (Sétra)

The otter is a very mobile animal, especially during winter flood periods (up to 40 linear km of watercourse for a single reproducing male). Territory size ranges between 2 and 40 km (bank length). Daily displacements vary between 2 and 10 km per night, i.e. ¼ to 1/3 of its territory in one night. Holts used for reproduction require maximum security, good view of the surroundings, presence of fresh water, camouflaged passages leading to fresh water, flood protection and availability or prey.

Nowadays, the otter has virtually disappeared from Western Europe's most industrialised regions (aquatic environment destruction and degradation, direct destruction, etc.).

Population with satisfactory numbers, even abundant; continuous distribution.

Population with low numbers; discontinuous distribution.

Species disappeared; possibly a few isolated individuals.

Situation unknown.

Species absent.

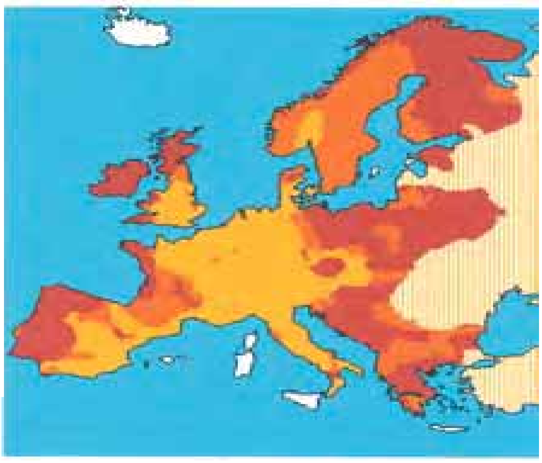


Figure 161 – European otter Lutra lutra distribution area in Western and Central Europe.

Sources: C. Bouchardy (2001) from Foster/Turley (1990) and Reuther et al. (2000)

Present everywhere in 19th century France, the otter was most thinly distributed in 1980, when only 10 departments signalled its obvious presence (Atlantic coastline and Massif-Central). Between 1980 and 2000, 23 departments indicated obvious otter presence in the wake of a natural recolonisation movement. Strictly protected by order of 17th April 1981, the species' general situation prompts increasingly environmental action to encourage its return. Otter protection has be extended to European scale and it is included in both appendices 2 and 4 of the "Habitats" directive.

Road impacts

Some experts consider that collision-based road mortality ranks first amongst otter main accidental mortality factors. This would be followed by accidental drowning, hunting, etc.

"Between 27th December 1993 and 10th February 1994, 6 European otters were killed by road traffic on the RD123 departmental road between Saint-Agnant à Marennes and Brouage marsh". (Le courrier de la Nature n° 144 March - April 1994).

Photo 133 – Otter run over

Source: X. Moyon - PRNB

Examples of facilities

Otter conservation facilities on roads involve creating bank continuity within hydraulic structures, which restore watercourses beneath the road (cf. case n°1 and 2). When a suitable passage along the watercourse cannot be designed, a dry underground structure with a diameter of at least 1 m can then be created next to the hydraulic structure (cf. case n°3). Wire netting forming a funnel on both sides of the facility prevents otters from climbing onto the road and directs them towards the underground passage.

Several types of structure can be envisaged, depending on the breach opened up by the hydraulic structure.

Case n°1: large-scale hydraulic structures

At a viaduct passage (large-scale hydraulic structure), terraced lateral rockfill areas with top levels permanently above water, are recommended. Depending on the altimetric, hydraulic and, above all, financial constraints, effective construction of such structures, whilst it should be encouraged, can only be foreseen for certain road developments or large scale projects justifying exceptional means in terms of impact reduction measures.

Figure 162 – Large-scale hydraulic structure facility

Source: L. Lafontaine and the SOS Loutres [SOS otter] network (2001)

Datasheet D	Otter (Lutra lutra)

Case n°2: medium-scale hydraulic structures

For medium-scale hydraulic structures (portal frames or arched conduits with spans exceeding 3 m), the best solution involves building side benches along the internal walls of the structure.

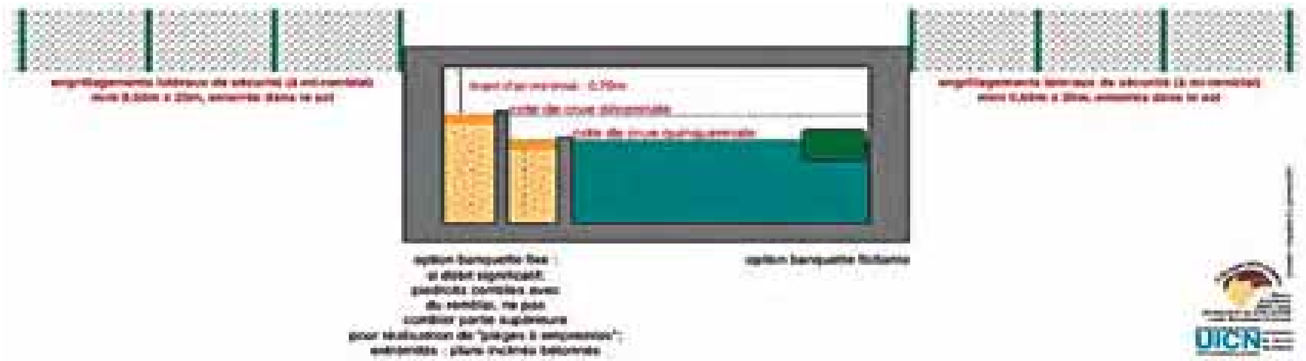


Figure 163 – Medium-scale hydraulic structure facility.

Source: L. Lafontaine and the SOS Loutres [SOS otter] network (2001)

Photo 134 - RN 89 national road: otter passage on the Clidane river at the Pont du Fraisse locality (St-Jullien-Puy-Lavèze commune).

Source: V. Billon (CETE de Lyon)

Case n°3: small-scale hydraulic structures

For small-scale hydraulic structures (pipes or frame bridges with spans less than 3 m), the insufficiently large cross section does not allow artificial bank reconstitution within the structure itself. The solution involves doubling up the structure with a parallel pipe passage positioned vertically at least 20 cm and not more than 40 cm above maximum flood level. This pipe passage must extend the watercourse natural banks.

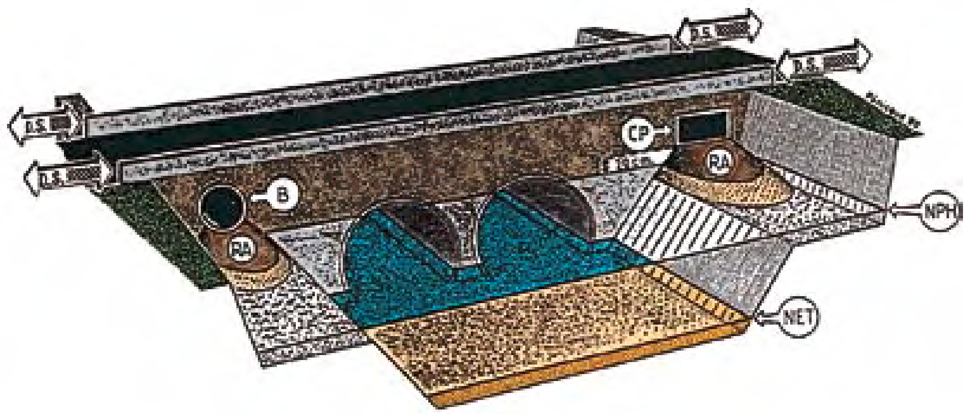


Figure 164 – Small-scale hydraulic structure facility.

Source: L. Lafontaine (1991)

Photo 135 – Facility on Duchée bridge (Loire-Atlantique department): structure provided with a bench extending the river-banks and a pipe passage forming an emergency exit in the event of a flood – *Source: X. Moyon - PRNB*

Datasheet D	Otter (Lutra lutra)

Developments complementing crossing structures can also enhance the situation. To curtail human-related disturbance in some sectors, bank accessibility can be restricted (after very extensive consultation with resident owners). Fencing or planting (*Rubus sp, Prunus spinosa, Hippophae sp*) can also contribute. Within these otter–reserved areas, a few simple facilities (woodpile near the water) provide the animal with holts (dropping, rest sites) or potential daytime refuges.

In the early 1990s, the Côtes d'Armor department offered 6 "otter tunnels or otter routes" embodied by Ø 50 cm pipes installed beneath the Guimgamp to Rosetrenen road (contract value 100,000 FF) (Le Point n° 964 – 11th March 1991).

Translated extract from article entitled "Des tunnels pour les loutres" [tunnels for otters]

"Several thousand otters still lived in Brittany at the start of the century; today, they are scarcely more than 250…. And as if pollution wasn't enough, the motor car has also become a deadly predator…

At the initiative of "SOS Loutres" network set up within the Breton mammalogical group, the Conseil Général des Côtes-d'Armor [departmental council] has decided to provide the otter with means of ceasing its exposure to the deadly impacts of cars and lorries by building "otter tunnels", underground passages beneath the roads, which split in two the areas they visit. In consultation with the local public works division, 6 otter routes have now been built of are under construction over 15 or so km to Western Côtes-d'Armor between Kerien and Plounévez-Quintin.

There are many other examples in operation not only on national or departmental roads, but also on motorways. The case of the A 89 motorway (between Clermont-Ferrand and Bordeaux) is exemplary; over 20 rivers and underground passages beneath the motorway have been provided with specific facilities, enabling the otter to remain at the waterside, despite underground sections of 80 m and sometimes more (ASF / SCETAUROUTE / CATICHE PRODUCTIONS developments).

Photo 136 – First otter photographed in a specific passage beneath the A 89 motorway on 23rd November 2001 at 0012 h.

Source : CATICHE PRODUCTIONS / ASF

A database is currently being developed, covering so-called "otter passages" developed within the scope of road infrastructure construction, to compare respective situations and experiences of facilities installed with the intention of reducing otter mortality. The aim is to draw up an inventory of existing facilities taking into account biological, technical and financial parameters.

Should the reader possess data, which would contribute to this database, (e.g. participation in building or monitoring an "otter passage", knowledge of the "otter passage" existence, etc.), please consult the website www.reseau-loutres.org

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Le Télégramme – 11 janvier 1991 – « Des tunnels pour les loutres », article

Figure 165 – Use of steps depending on water level.

Source: N. Gouilloux / Catiche Productions (2001)

Photo 137 – Passage developed specifically for the otter.

Source: C. Bouchardy / Catiche Productions (2001)

Datasheet E	Badger (Meles meles)

Frequently located in deciduous forests with clearings, badger earths can also be found in open or semi-open environments such as bocage enclosures, heathland or grassland. The badger lives in a family or clan comprising up to 12 individuals of both sexes.

This nocturnal animal spends several hours each day looking for food on its territory (50 to 200 ha), it usually uses the same paths and searches the same sectors. Its nocturnal movements can lead it several kilometres away from its main earth. Females readily change social group, which allows genetic mixing.

In Europe, the species is sometimes protected and sometimes considered harmful or as game.

Since the early 1990s, the badger is in a relatively good state although poaching remains widespread in some European countries.

Photo 138 - Badger (Meles meles).

Source: H. Bekker

The badger is not threatened in France, even though it can be locally rare. It has few predators and, despite its cohabitation with the fox, it is little affected by rabies. Badger hunting is authorised in France.

Causes of badger mortality

A departmental survey conducted by the Moselle hunting federation in 1990 showed that badger removals were divided between:

- 154 hunting killings,
- 39 accidental trappings,
- 57 trappings and releases,
- 149 road traffic casualties.

The badger was strongly threatened in the Netherlands, so the species has been covered by special protection measures since the 1980s. In the road sector, badger pipes were installed on all existing or new roads; 110 structures had been built by 1995. Preferred road crossing structures (Ø 30 - 40 cm) are made of concrete, invariably located in potentially favourable environments (hedges, woodland strips, wood edges) and accompanied by fencing. Fences must be buried and must provide an underground return route to prevent the animal burrowing beneath the fence (cf. figure 167 at right).

The distance between two badger crossings is usually 250 m, but structures can be closer, especially when they can also be used by other animals (polecat, fox, stone marten, stoat). Thick hedges guide badgers towards entrances at each end of these passages. These facilities have turned out to be very effective in the Netherlands.

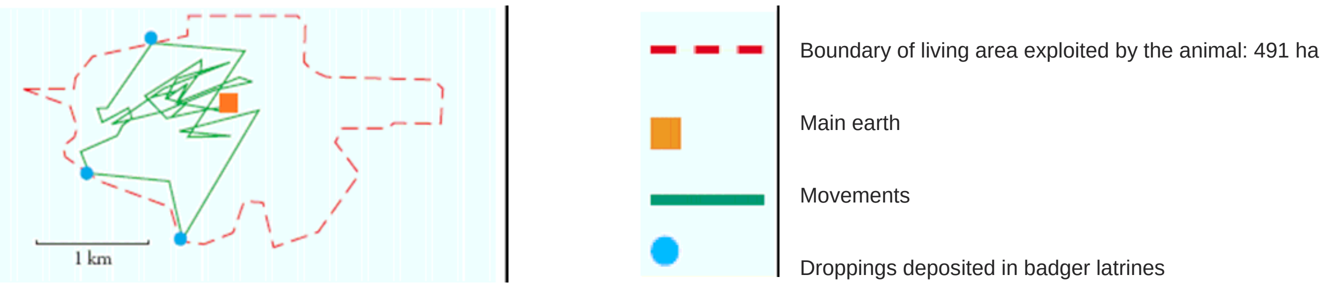

Figure 166 – Territorial-type displacement observed for a male badger during one February night.

Source: C. Henry, L. Lafontaine and A. Mouches (1988)

Photo 139 – Specific badger structure (approx. 3 x 2 m) – Source: V. Billon (CETE de Lyon)

In France, a structure installed specifically for the badger beneath the A 39 motorway is also frequently used (cf. photo 139)

Additional facilities, fauna exits or gates, are helpful complements to structures and fences because they enable animals enclosed within infrastructure coverages to return to the natural environment. Two or three fauna exits, positioned at intersections of main badger displacement routes and fences, are sufficient. They should be solidly built in hardwood and should feature a transparent window. Initially and to help badgers to become familiar with these facilities, movements in both directions should be allowed; a single passing direction can later be established to prohibit access to the road, when the animals are used to using the facilities (cf. figure 168).

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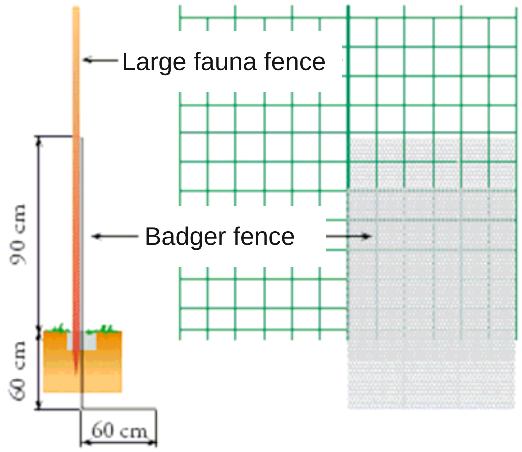

Figure 167 – Badger fence for motorways or high-speed railways – Source: E. Rillardon (Sétra)

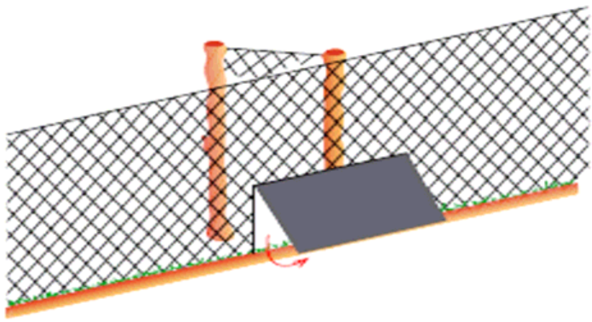

Figure 168 – Layout diagram for a badger trapdoor. Source: D. Chevalier (Sétra) and E. Rillardon (Sétra) 244

Datasheet F	European mink[82] (Mustela lutreola)

The distribution area of the European mink shrank dramatically between the end of the 19th century and the present day. It is now only present in 7 French departments (the 5 Aquitaine departments, Charente and Charente-Maritime).

This species is the subject of a national restoration plan in 11 departments of SW France in view of a possible re-appropriation of environments from which it has disappeared in recent years.

It appears strictly associated with wetland environments and only very occasionally moves away from marshes and watercourse banks, habitats to which it is most partial. Here, it finds abundant food throughout the year with easy prey for capturing and refuges capable of offering it shelter from predators (reed, sedge and rush beds).

This species occupies a large territory (from 1.6 to over 15 km^2).

Probable causes of its decline result from a combination of unfavourable conditions associated with following factors.

1. Habitat deterioration: strong wetland decline over several decades, re-grading or dyking of very many watercourses, improper bank maintenance, water pollution (fewer prey, poisoning, reduced reproduction capacity, etc.).

2. Direct destruction: trapping for its fur, accidental trapping instead of the American mink (Brittany) or polecat (classified as harmful), poisoning instead of water rats or muskrats, killing by predators (dogs) and running over on roads: representing a major proportion, which can have a significant impact on local population dynamics.

3. American mink expansion.

4. Pathogenic agents.

Photo 140 – European mink (Mustela lutreola).

Source: Pascal Fournier

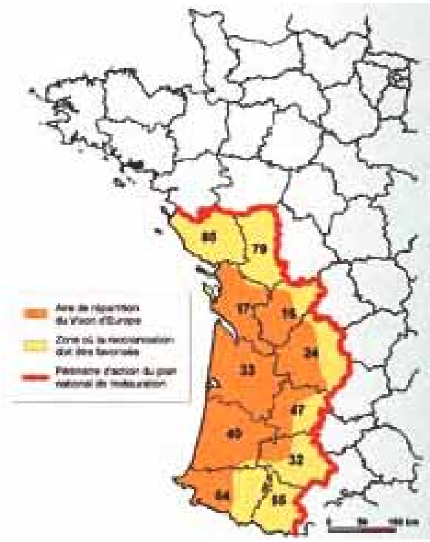

Figure 169 – European mink distribution area in France

Source: GREGE (2003)

Photo 141 – European mink (Mustela lutreola)

Source: Pascal Fournier

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[82] *This datasheet summarises the guide entitled "La gestion des habitats du vison d'Europe / Recommandations techniques" [management of European minik habitats / technical recommendations] GREGE (2003).*

Remark. These results are insufficient to provide an accurate idea of mortality for the whole population, but they nevertheless allow us to note that certain factors, such as road collisions or predation, can have a significant impact on species dynamics.

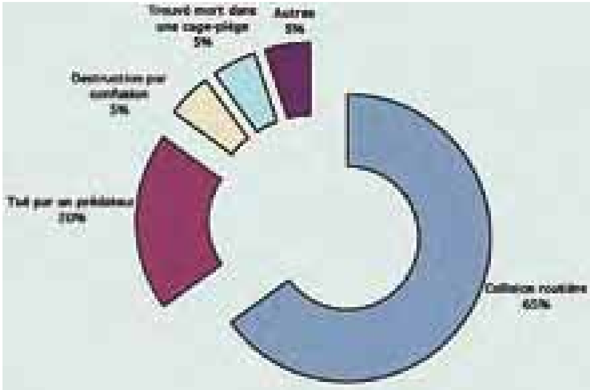

Figure 170 – Analysis of mortality causes for 59 European minks found dead

Source: Grege (2003)

Amongst the objectives of the European mink restoration plan, we find “to combat direct causes of mortality” which, for transport infrastructures, must include amongst other things ecological engineering work on roads conveying heavy traffic, which pass through sectors patronised by the European mink.

Naturally, wetland protection and management, adequate development and maintenance of watercourses or control of animal pests are all saving methods, which are essential but are not dealt with here.

On the other hand, preliminary studies including this species and existing or new transport infrastructure-based facilities will contribute greatly to the restoration plan aim of curtailing potential impacts (habitat destruction or damage due directly to the road coverage or indirectly to land reallocation operations, isolation of population cores and vehicle collision mortality).

“Over the last two years, the '69l has picked up 20 or so animals killed by vehicles. This figure does not allow us to assess the real significant of road mortality, but it is nevertheless worrying because the population has not enough reserve numbers to compensate these losses”.

Studies or facilities

Principles which must prevail in upstream studies:

- seek routes avoiding wetlands,

- seek least penalising watercourse crossing areas (narrowest valley sectors); avoid preferred habitats.

Reduction measures:

- give priority to viaduct construction (population operation, avoidance of preferred habitats),

- adapt hydraulic structures: provide extra widths or benches always located above highest water level in the case of type 3 facilities. Frame bridges will be developed by means of artificial banks or gently sloping (25°) rockfill areas. “Otter” type structures with several staircases appear perfectly suitable.

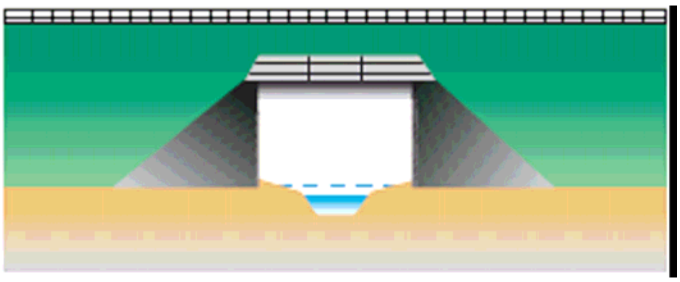

Figure 171 - Principle of extra width or a bench installed in a type III passage.

Source: E. Rillardon (Sétra)

Datasheet F

All road crossing structures should be provided with fencing (2 – 3 cm mesh) or systems preventing access to the road (GBA concrete barriers, galvanised sheeting (amphibians) throughout the linear length affected by mink preferred habitat.

Structure connections must be designed with the greatest possible care and must aim at maximum fauna imperviousness.

Given the ease with which animals climb fences (higher than 2 m), wire netting top sections must be fitted with metal shutters or more simply vertical metal plates: under these circumstances, fence height can be limited to 1 m. it goes without saying that fences must be controlled to ensure regular repairs.

Ground connection must be perfect, the netting must therefore be buried to a depth of approximately 30 cm.

The special case of rainwater drainage ditches must be specifically managed: minks must be prevented from passing, whilst ensuring a good flow of water.

A system, in which road runoff water discharges into an approximately 1 m deep concrete tank can also be used. The fence is installed above the tank, which does not prevent water flow but prohibits mink access to the road because they cannot climb up the walls (cf. photo 142).

Special construction stage recommendations

- Avoid stripping vegetation from the right of way using a bulldozer to limit mortality of minks lodging in hollow trees, stumps or earths and favour chainsaw tree felling.

- Build mink protection systems and structures as early as possible so that animals can learn to use them as quickly as possible.

- Set up site supervision to ensure application of technical requirements and provide operator guidance during construction through a specialist technician.

Concerning the existing network

Road resurfacing or widening operations can represent opportunities for curtailing collisions with vehicles.

If structural dimensioning permits, benches or, more realistically, concrete slabs suspended from the wall (cf. photo 143) can be built. The latter system enables the cross section available for water flow to be maintained.

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Photo 143 – Corbelling, but with the defect of not being connected to the watercourse bank – Source: Pascal Fournier

Photo 142 – Overspill from a road formation water treatment pond

Source: Pascal Fournier

Datasheet G	Beaver (Castor fiber)

Castor fi ber is the largest European rodent. It was present almost throughout Gaul until the 7th century, but was close to eradication 12 centuries later. Today, the beaver is present in over 40 metropolitan departments (mainly in south-western, central and north-eastern France).

This territorial "re-appropriation" is mainly due to the legal statuses of both the species itself and its habitat at European[83] and national[84] levels, but it also results from multiple reintroduction programmes. Today, beaver numbers total 8,000 to 10,000 individuals.

Associated with plain and hill stage alluvial ecosystems, the beaver can establish itself not only in rivers and streams, but also in areas of water linked to the hydrographical network.

Its activity takes place mainly at the interface between aquatic (2/3 of its time) and land (1/3 of its time) environments. Its requirements in terms of habitat are very specific and its presence therefore depends on several conditions.

1. Watercourses with weak currents (or at least no permanently high current), which are sufficiently deep (more than 0.6 m, allowing installation of the holt, whose access is submerged, amongst other things) and clean.

2. Low watercourse gradient, usually less than 1%.

3. Along several metres of watercourse bank[85], presence of a low river-based tree stratum comprising several herbaceous species, thickets of willow and other softwoods (poplars, elms, aspens, alders, etc.).

4. Possibility of emigrating and communicating with other watercourses.

5. In some cases, earth banks (no rockfill) allowing it to excavate its holt.

All these conditions make the beaver a good indicator of watercourse overall ecological state.

Photo 144 - Castor fiber.

Source: Ph. Desbiolles

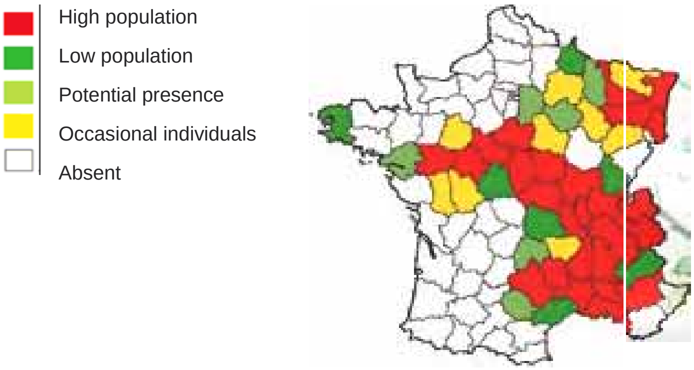


Figure 172 – Qualitative status of the beaver in France: 2001 situation

Source: ONCFS "Castor" [beaver] network (2001) – Drawing: N. Gouilloux

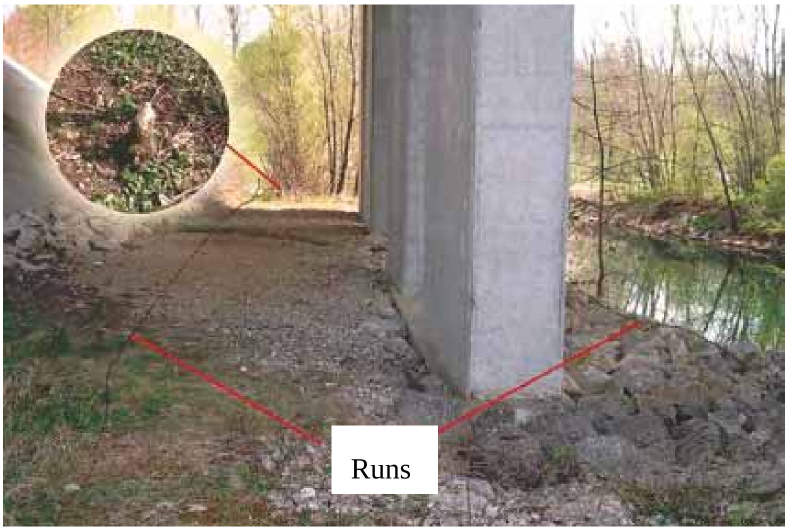
Datasheet G	Beaver (Castor fiber)

Beavers live in family groups comprising 2 to 6 individuals. Mainly nocturnal, they never move far away from water. They are very poor walkers and venture only very occasionally more than a few metres on a watercourse bank to ensure escape in the event of danger. Each group occupies a clearly delimited territory extending over approximately 3 km of watercourse.

[83] *Berne Convention, Addendum 3; "Habitats" directive, appendices 2 and 4.*

[84] *French national order of 17.04.1981 and Art.L.211.1 of French rural and forestry code.*

[85] *A 4 m wide, 3 km long dense strip of vegetation comprising Salicaceae would appear to suffice sustainable conservation of a beaver population at a site*



Photos 145 and 146 – Combined passage on A 40 motorway: structure patronised by the beaver. Two clues to presence indicate this usage: runs and felled trees.

Source: T. Cagniant APRR

Causes of mortality

Direct measures (conservation, maintenance of surviving numbers, natural re-appropriation) have enabled the beaver to be saved from extinction. However, beaver presence could be called into question in certain places due to disturbance factors (development work: rockfill placement, bank straightening, wetland destruction; watercourse modification) and direct mortality factors (car traffic, strong discharges from hydroelectric dams, heavy fishing nets (drowning), poisoning campaigns aimed at other aquatic species, “accidental shooting” by a hunter).

A 1997 survey conducted in south-eastern France (15 departments) thus revealed that structures, which are impassable and difficult to skirt, prevent not only colonisation of pond headwaters, but also cause accidental mortality resulting from collisions with cars. Out of 109 mortality cases recorded between 1989 and 1996, 50% were due to collisions.

A 2001 survey provided the same conclusions: out of 34 individuals found dead, 18 had suffered a collision.

Transport infrastructures (road developments and car traffic) are therefore responsible for a significant proportion of deaths amongst beaver populations.

Facilities

The beaver needs to move around in search of food and to colonise new territories, but its migration routes are cut off by a number of obstructions. During road developments therefore (on the existing network or performing new work), it is essential to keep in mind that beavers have a very specific requirement concerning their aquatic environment, which must be taken into account, namely hydraulic continuity. Acceleration of the water current, lowering of its depth, presence of control sills higher than 20 cm (e.g. a weir) may effectively impede beavers or, in some cases, force them into trying to by-pass the obstruction by crossing either a road or a railway, on which they may be run over.

Examples: during re-grading of a river or stream, during placement of a pipe or trap beneath the road, etc.

Studies or facilities

Principles, which must prevail during upstream studies:

- seeking of routes avoiding wetlands,
- seeking of least penalising watercourse crossing areas, avoiding of preferred habitat areas.

Reduction, attenuation and compensation measures:

- give priority to viaduct construction (population operation, avoidance of preferred habitats),
- develop watercourses during re-grading, pipe installation, etc.: ensure hydraulic continuity and that it allows beavers to pass (flow, depth),
- recreate a habitat suitable for beaver recolonisation.

If establishment of hydraulic continuity turns out to be difficult, two development options are available.

1 – *Develop watercourse banks in the case of large structures:* favour by-passing of the structure by developing adjacent banks. These by-pass ramps should be located very close to the water with their downstream ends beneath the water level. They can be built using compacted earth (or at least recovered with slip-resistant material (rubber matting)), they should not slope more than 45° and their width must be 60 cm minimum.

2 – *Adapt hydraulic structures, when they are smaller:* provide beaver passes or ramps, when the structure cannot be crossed by the aquatic environment (e.g. presence of control sills).

Example of a beaver pass built in Switzerland.

Beaver ramp built at the Hauptkanal (BE) beneath a canton road. Five beavers were run over on this road between 1992 and 1996, including 2 in the same week. No other collision has occurred since implementation of this measure.

Photo 147 – Hauptkanal beaver pass.

Source: Philippe Desbiolles

The beaver will always prefer an aquatic environment for crossing a structure but all road crossing structures should be equipped to optimise its protection.

=> 120 cm high, interlinked diamond mesh-type fences with a 20 cm 90° return on the beaver arrival side. These fences should be regularly checked to ensure possible repairs.

Special construction stage recommendations

- Avoid passage of mobile machinery and earthworks in a 5 m wide strip along the waterside (a little less if the bank is sloping) to curtail mortality due to running over of beavers lodging in earths excavated within watercourse banks.

- If possible, avoid destroying the riverside vegetation strip, which is essential to beaver survival.

Concerning the existing network

With watercourse recolonisation by the beaver, some structures can now curb this territorial re-appropriation and form veritable mortality “black spots”. “Simple” facilities can overcome such problems.

- Installation of beaver passes or ramps allowing animals to cross the structure (cf. above).

- Creation of a rockfill ramp to reduce watercourse flow. Example at the Vaugris dam (Isère department):

“For many years, beavers were regularly run over, when crossing the road passing over the Vaugris dam along the River Rhône. The headrace channel rejoined the Rhône through a large diameter pipe, whose gradient created a violent current unsuitable for beaver movement within the structure. Beavers were therefore forced to by-pass the obstruction on land by crossing a very busy road. […...]. It was decided to build a rockfill weir ensuring a major reduction in current velocity within the aqueduct, thereby allowing the beaver to swim across the obstruction. This solution appears to be effective because no beaver mortality has been recorded at the site since the facility was built.” (H Laydier and P. Rouland (1998)).

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