

Restoration of side channels of the Loire and its tributaries

The operation

Category	Restoration
Type of operation	reconnection of side arms or ancient meanders
Type of environment	Intermediate zone and lowland river
Issues at stake (water, biodiversity, climate):	Good status of habitats
Start of operation	1995
End of operation	2005
Scale of the works	80 restored side channels

The river in the restored section

Name	The Loire
Distance to source	-
Mean width	> 50 m
Mean gradient	-
Mean flow rate	342 m ³ /s in Orléans, 650 m ³ /s in Saumur

Aims of the project owners

- Restore the flow capacity of the bed to limit the impact of large floods
- Redeploy the energy of the river into the secondary channels to stop the incision process
- Restore ecological diversity of the river environment

Environment and pressures

The Loire, measuring 1,013 km long, is the longest river in France. It takes its source at Mont Gerbier des Jons, in the *Département* of Ardèche. Its river catchment is close to 115,000 km².

Embanked since the twelfth century to protect the populations from its irregular hydrological features, the Loire has long been a significant trade route until the mid-nineteenth century. This activity resulted in straightening of the riverbed with channelling structures that still exist despite their obsolescence. From the late nineteenth century, large hydroelectric complexes were built on the main tributaries of the Loire (Vienne, Creuse, Allier, etc.). Thereafter, the low-flow channel of the Loire and its tributaries experienced strong sediment extraction

The location

Country	France
River basin	Loire-Bretagne
Region(s)	Centre-Pays de Loire
<i>Département(s)</i>	Allier, Cher, Indre-et-Loire, Loir-et-Cher, Loire-Atlantique, Loiret, Maine-et-Loire,



activity between the end of World War II and the 1990s.

Despite the embankment of its bed, the Loire, in its middle section, has a fairly wide mobility area (embanked bed width compared to the low-flow channel).

Gravel extraction combined with channelling works have caused widespread deepening of the bed and of its tributaries - around 1 m at low water in the middle Loire - particularly pronounced in the vicinity of large urban areas. This depression can reach 3 m in the lower Loire or on certain sections of the Allier. It impacts the balance of the river and leads to accelerated vegetation growth in secondary channels and side channels. In other words, side channels that used to be year-round under water are now dry for six months of the year.

Regulatory context:	Classified watercourse under the French Water Act
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European directive references

Water body ref.:	Middle Loire: RGR007a to RGR007d Downstream Loire: RGR007e to RGR007f
Natura 2000 site ref.:	308 Natura 2000 sites on the Loire basin



Le Gros Ormeau side channel before reconnection work. August 1999.

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Reconnection of Le Gros Ormeau side channel with the Loire. September 1999.

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■ Opportunities to act

Awareness of this river imbalance was raised following the spectacular collapse of the Wilson Bridge in Tours in 1978, indicative of the hydromorphological impacts of gravel extraction on the bed of the Loire and on other rivers. The definitive end to extractions and start of restoration operations on the bed of the Loire took place during the first phase of the "Plan Loire Grandeur Nature" (PLGN) launched by the Interministerial Committee on Planning and Development (CIADT) on 4 January 1994.

The plan initiated by the State, Etablissement public Loire, the Regions and Loire-Bretagne water agency covers the implementation "of an overall development plan for the Loire in order to ensure the safety of the population, protection of the environment and economic development".

In line with the River Basin Management Plan of the Loire/ Brittany catchment (SDAGE Loire Bretagne) guidelines, the first phase of the Plan Loire apportioned an important role to the restoration of side channels to reconcile the objectives of restoring the flood flow capacity inside the embanked river bed with those of restoring functional natural habitats in an environmentally diverse area.

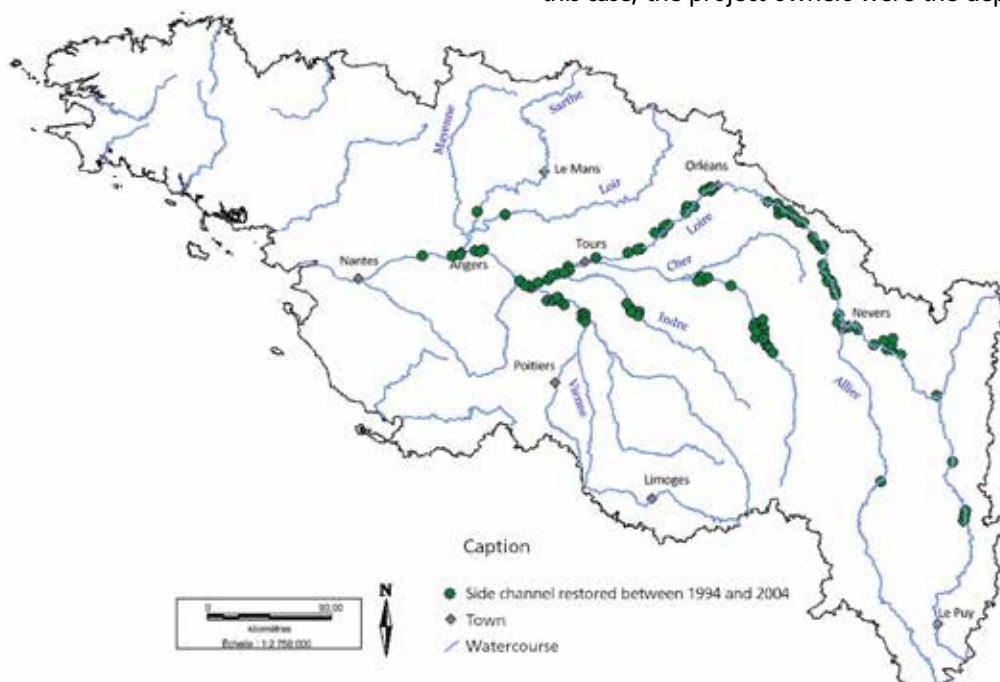
These operations were covered by two different programmes:

- For sites within the Public River Domain of the Loire and the Allier, operations were primarily carried out as part of the river bed restoration programme, under the guidance and project management of the State;
- For the other tributaries or private land on the banks of the Loire and the Allier, operations were carried out under another chapter of the Plan Loire: the natural environment restoration programme. In this case, the project owners were the departmental

Perched above average levels, marshes and side channels do not remain flooded long enough to allow fish reproduction. Spawning grounds, even if they maintain valuable flooding conditions, are frequently isolated due to building up of gravel shoal downstream of the side channels and also due to the incision of the main river bed.

Side arms are more often likely to be dry during low-flow periods. They thus lose their nursery function. Poorly activated in medium water level, they provide a fertile ground for tree growth. The development of willow-poplar plantations promotes siltation and this process accelerates through to the total closure of the side arms.

The filling in of side channels is a natural phenomenon, but is greatly amplified, indirectly, through the incision in the main channel of the Loire and of its tributaries.



Federations for fishing and the protection of the aquatic environment (FDPPMA) or local authorities.

■ Works and developments

A multidisciplinary "Plan-Loire" team and a "Plan-Loire" unit of the Conseil supérieur de la pêche, CSP, (National Agency for Water and Aquatic Environments - Onema since 2007) were created to help and advise owners in restoring side channels of the Loire and its tributaries.

The operations consist in readjusting downstream connecting weirs between the main channel and side channel at the water level exceeded in the spring for 45 days, every fifth year. For pike spawning grounds of the middle Loire, re-connection projects are often positioned near to the water level of the average inter-annual rate. Given the lowering of the groundwater and lack of maintenance, it is usually necessary to thin the plant cover over old channels to restore sunlight conditions favourable to the development of the herbaceous layer and biological production. The works consist of carefully treating riverside vegetation, while respecting its overall balance, but also its role in the composition of water habitats. The techniques recommended are set out in the methodological guide developed for maintenance of the bed of the Loire and the Allier (DIREN Centre / IMACOF).

■ Regulatory approach

In addition to the regulations under the 1992 Water Act, special attention has been taken to identify protected species in the sites requiring the granting of a dispensation (displacement and / or destruction of protected species) from the relevant State departments.

■ Post-restoration Management

The project owners or managers of the restored sites are encouraged to do some maintenance on the sites after restoration. This maintenance may be part of a territorial agreement for the aquatic environment.

In general, maintenance of side channels involves removing trees having fallen across the river, extracting trees growing in the area, removing clutter that can accumulate or re-leveling certain connections with the main river which have been closed by sedimentary deposits.

■ Monitoring

Twenty-three side channels underwent a plant and/or fish diagnostic in 1998 to identify intervention to be conducted. In accordance with the current situation and constraints, this preliminary study resulted in the identification and localisation of objectives as well as hydraulic requirements of each intervention.

More comprehensively, multidisciplinary monitoring was carried out on five restored river side channels on the middle Loire.



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Le Gros Ormeau side channel after reconnection with the Loire. October 1999.



© FDPPMA d'Indre-et-Loire
Reconnection of Le Gros Ormeau side channel with the Loire. August 2000.

The physical and chemical features of water were analysed five times a year; the hydraulic operation of each site (floodability / connectivity), and biological factors (invertebrates, zooplankton, fish and vegetation) were monitored and analysed for each area during the 2002 campaign. The monitoring of side channels by the CSP (now Onema), was completed in 2007. Since then, the monitoring measures are taken care by different project owners involved in restoration projects.

■ Outcome of the project and outlook

Water quality monitoring in the side channels showed the reconnection of some of these areas.

Overall, benthic macrofauna is high (138 taxa) and vegetation is fairly homogeneous, dominated by red canarygrass (*Phalaris arundinacea*).

As far as fish populations are concerned, reproduction has been observed in each of the monitored side channels, but the water deficit in 2002 caused large functional differences between the restored areas, due to their morphological heterogeneity.

In most of the restored sites, egg spawning and the presence of young pike have been highlighted by netting and electrofishing during the breeding season, before the period of migration of juveniles to the main channel.

The balance between the cost of the restoration and the result of long-term operations is highly dependent on the geomorphological evolution of the environment. The morphological stability of the

Costs

Cost of studies	-
Cost of acquisitions	-
Cost of operations and developments	€ 20,000 * Excl. VAT i.e. € 2.5 ex. VAT per m * on average
	<i>per site:</i>
Cost of promotion	-
Total cost of the action	€ 1,600,000 ex. VAT

Financial Partners and funding:

Water agency Loire - Bretagne (AELB), regional councils, general councils, unions of rivers, departmental Federations for fishing and the protection of the aquatic environment (FDPPMA)

Technical partners of the project:

AELB, FDPPMA, Onema (National Agency for Water and Aquatic Environments), regional councils, general councils, associations, regional conservatories of natural areas (CREN), regional conservatory of the banks of the Loire and its tributaries (Corela), departmental territorial directorates (DDTs), regional directorates of the environment, agriculture and housing (DREALs)

given side channel and incision processes or siltation of the bed and its active strip phenomena must be taken into account before defining interventions. Besides stopping the extraction of materials, rehabilitation of side channels is closely related to "substantive" actions devoted to the restoration of river dynamics. Inside the low-flow channel, the restoration of side arms contributes to this as they facilitate remobilisation of sediment for the main course. Further upstream, conservation of the free-space area for the Loire and the Allier is also included in this systematic approach. This is to provide an economical alternative to bank protection in order to safeguard erodible areas, especially upstream to the Bec d'Allier where the main sources of re-aggradation are found.

The restoration of side channels continues, particularly within the framework of PLGN III (2007-2013) often under environmental territorial agreements consisting of one or more components and signed between water agencies, local authorities (regional and general councils) and owners (local authorities, fishing federations) within a specified time frame (about 5 years).

Promotion of the project

As part of the restoration of side channels of environmental territorial agreements between water agencies, regional and general councils and project owners, completed operations are presented to several institutions (communities, chambers of agriculture, etc.). These presentations usually consist of slide shows and a visit to a restored site, to which the press and television media are invited.

Information boards and brochures are also produced and disseminated to a wide audience to raise awareness of the challenges of the restoration of side channels.

Many stakeholders involved in the restoration of these aquatic environments attend regularly organised events. For example, the FDPPMA of Indre-et-Loire presented its environmental territorial agreement for the restoration and maintenance of side channels of the Loire and the Vienne, at the 9th "rencontres Val de Loire" held in Tours in December 2010.

These actions were also promoted for the 10th anniversary of the inclusion of the Loire on the Unesco World Heritage in October 2012.

Project owners Regional Directorate for the Environment (DIREN now DREAL) and departmental Federations for fishing and the protection of the aquatic environment (FDPPMA), local AAPPMAs, river associations

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