LES SYNTHÈSES
de l'Office International de l'Eau

Good status headwater streams : what issues and which non-degradation actions ?

Roland KAGAN

February 2017

Office International de l'Eau

EAUDOC

www.oieau.org/documentation

In partnership with higher education institutions, IOW offers states of art on various topics related to water. These synthesis are written by students as part of their study program.

This synthesis « **Good status headwater streams: what issues and which non-degradation actions?** » was performed by **Roland KAGAN,** student in the AgroParisTech-ENGREF specialized master "Water Management" (post-master degree) in Montpellier.

SYNTHESIS

Good status headwater streams:

What issues and which non-degradation actions?

Roland KAGAN
roland.kagan@agroparistech.fr

February 2017

AgroParisTech
Centre de Montpellier
648 rue Jean-François Breton – BP 44494
34093 MONTPELLIER CEDEX 5
Tél. : (33) 4 67 04 71 00
Fax : (33) 4 67 04 71 01
www.agroparistech.fr

Office International de l'Eau
Service gestion et valorisation de l'information et des données
15 rue Edouard Chamberland
87 065 LIMOGES CEDEX
Tél : (33) 5 55 11 47 47
www.oieau.org

Table of contents

List of figures

List of tables

Glossary

AESN = Agence de l'Eau Seine-Normandie

AERMC= Agence de l'Eau Rhône-Méditerranée-Corse

ART = Association of Rivers Trust

DAAF = Direction de l'Alimentation de l'Agriculture et de la Forêt

DREAL = Direction Régionale Environnement Aménagement Logement

DDT = Direction Départementale du Territoire

DCE = Directive Cadre européenne sur l'Eau

ENR = European Rivers Network

ERT = Eden Rivers Trust

ONF = Office National des Forêts

ONG = Organisations Non Gouvernementales

PNR = Parc Naturel Régional

SAGE = Schéma d'Aménagement et de Gestion des Eaux

SDAGE = Schéma Directeur d'Aménagement et de Gestion des Eaux

TBV = Tête de Bassin Versant

WSC = Wild Salmon Center

WWF = World Wild Fund

ABSTRACT

Rivers located in upstream watershed represent a strategic issue in relation to the goal of quality of surface water required by the European Framework Directive in 2027. Because of their position away from anthropogenic pressures it is in these places that are found most often rivers in good or excellent status as defined in the European Directive. These rivers have a significant importance in the functioning of a basin. First, they take part in flood control by wetlands that accompany them. Then they have a physicochemical treatment role thanks to the riparian vegetation. Finally, their rich habitats enable them to host a great biodiversity either in the water or on the shore. However, the fragility of these environments makes it necessary to put in place preservation actions in order to maintain or improve their condition. These actions are categorized according to the type of pressure (agriculture, forestry, tourism). Different types of protection projects can be distinguished according to their issues: biodiversity, ecology, agriculture. However, these projects are not yet sustainable due to the absence of defined management rules and the lack of recognition of the upstream channels.

Key words: headwater streams, water bodies status, European Framework Directive, LIFE Program, European Rivers Network, Wild Rivers Label, rivers quality, biodiversity.

RESUMÉ

Les cours d'eau se trouvant en tête de bassin versant représentent un enjeu stratégique par rapport à l'objectif de qualité des masses d'eau de surface imposé par la Directive Cadre européenne sur l'Eau (DCE) à l'horizon 2027. En raison de leur position éloignée des pressions anthropiques, c'est dans ces lieux que l'on trouve le plus souvent les rivières en bon état au sens de la Directive européenne. Ces cours d'eau ont une importance fondamentale dans le bon fonctionnement d'un bassin versant. D'abord, ils participent à la régulation des crues grâce aux zones humides qui les accompagnent. Ensuite, ils jouent un rôle d'épuration physico-chimique grâce notamment à la végétation rivulaire. Enfin, leurs richesses en habitats leur permettent d'abriter une grande biodiversité aussi bien dans l'eau que sur les berges. Cependant, la fragilité de ces milieux rend nécessaire la mise en place d'actions de préservation afin de maintenir ou d'améliorer leur état. Ces actions sont catégorisées en fonction du type de pression (agriculture, sylviculture, tourisme). On peut distinguer différents types de projets de protection de ces zones en fonction de leur enjeu : biodiversité, écologie, agriculture. Cependant, ces projets ne sont pas encore pérennes en raison du défaut de règles de gestion clairement définies et du manque de reconnaissance des têtes de bassin versant.

Mots-clés : têtes de bassin, état des masses d'eaux, DCE, programme LIFE, European Rivers Network, label Rivières Sauvages, qualité des rivières, biodiversité.

INTRODUCTION

Since 2000, the European Water Framework Directive (WFD) defines a framework for the management and the protection of the resource in the European Union. This directive emphasizes the preventive character and sets an environmental goal, i.e. good status of water bodies to be reached by 2021, except for dispensation 2027 concerning the most degraded water bodies.

The status of a surface water body is assessed through two aspects. The first is characterized by the chemical quality defined by the concentration in water of a list of 41 substances identified by the European directive (pesticides and metals). The second is defined by the ecological status which covers all the biological quality elements (macro-invertebrates, diatoms, fish and macrophytes), which are themselves directly impacted by the physico-chemical elements (oxygen concentration, temperature, nutrients, acidification) and the concentration in water of certain specific pollutants (metals, pesticides). To be declared in good condition, a body of water must have a chemical state and an ecological state of at least “good”. To this must be added the hydromorphological state which is capable of downgrading a very good ecological state in good ecological state

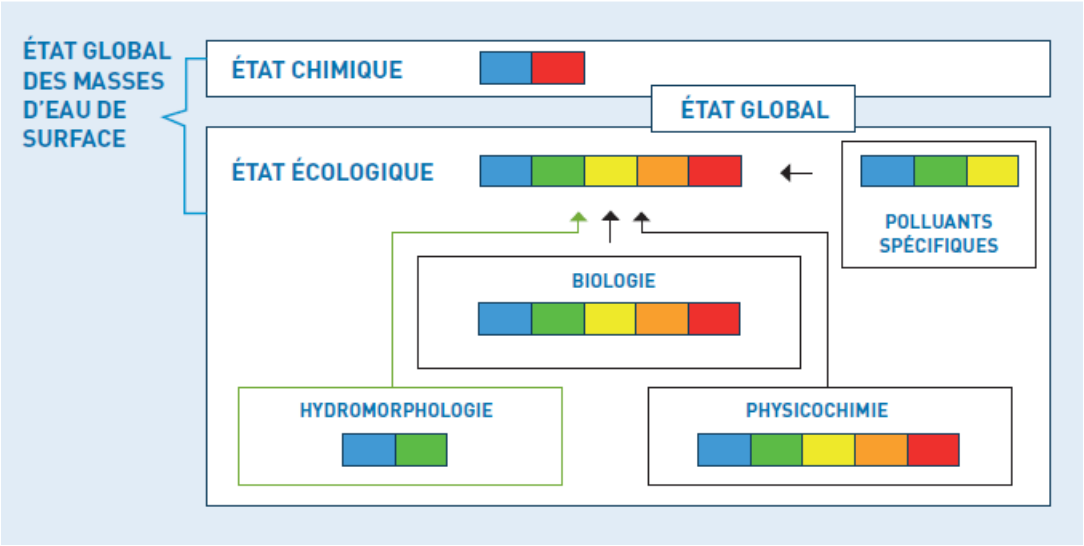


Figure 1 : Assessment of the state of a surface water body (AESN SDAGE, 2016)

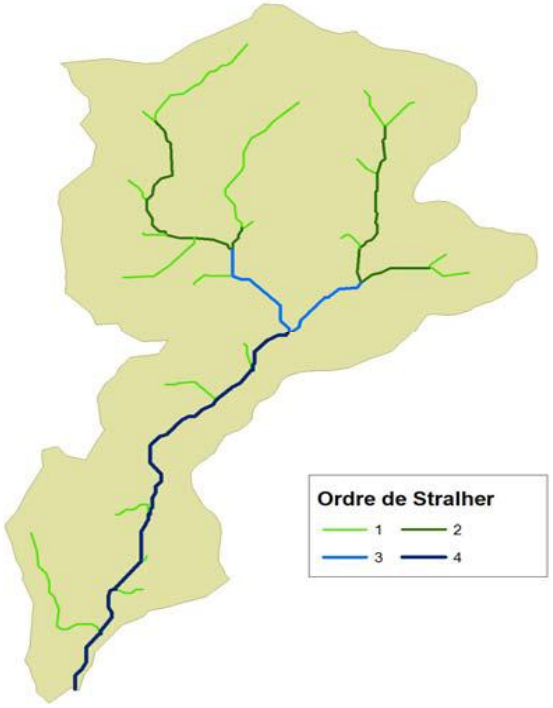
Headwater streams are frequently found in areas that are protected from pollution or other anthropogenic pressures. Thus, it is often in these territories that rivers can be found in good condition or even in very good condition. We will see first that basin heads have a fundamental role in physical, water and ecological regulation of watersheds. Despite these many features, the headwater streams are not at the center of the management orientations. In the past, they have often been altered due to their lack of knowledge and intensive farming practices. However, over the past ten years or so research findings on the subject have made it possible to define a number of means of protection in order to preserve them. In order to illustrate this awareness, we will detail some projects based on different approaches (heritage species, biodiversity, agriculture).

ROLE OF HEADWATER STREAMS

DEFINITION

According to the approach and regions of the world, the definition of headwater streams is variable. The water agency Loire-Bretagne defines it in its Master Plan for Water Management and Management 2016-2021 (SDAGE).

Figure 2 : Strahler's method of ordination (Henner, 2013)



«Headwater streams are defined as the watersheds of streams with a Stralher rank of 2 or less and a slope greater than 1%. This slope criterion can be adapted locally for low-specific rivers with a risk of not achieving environmental objectives. "Stralher's mapping of rivers shows that basin are not necessarily located upstream of a bassin.

This is why the slope criterion is questionable. Thus, some rivulet and moat would be excluded as they play the role of small river sources. Moreover, the limit to the use of this criterion rests on the accuracy of the maps and on the fact that it is necessary to know the entire hydrographic network in order to assign the right number to the watercourse.

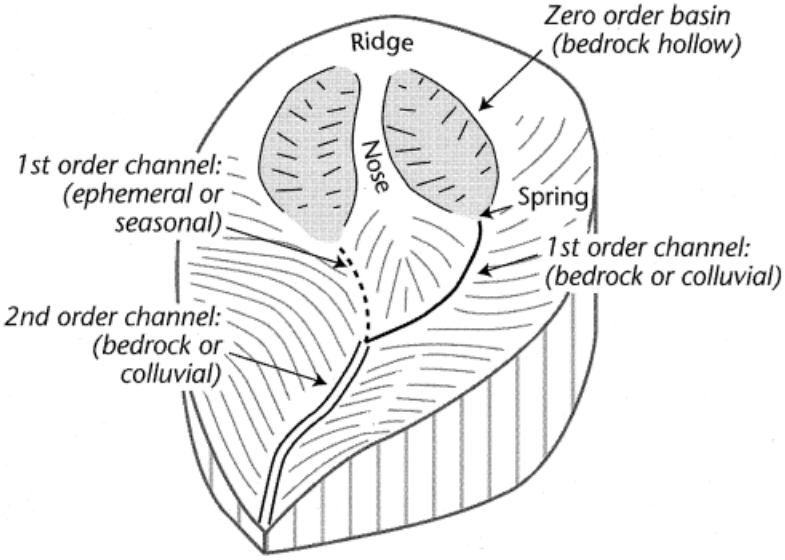


Figure 3 : Classification of a watershed from rank n ° 0 (Bendal et al., 2005).

In order to cover all the areas concerned, some authors define a rank 0 which corresponds to the source and feeding areas of the rivers. Finally, definitions may vary by country. In the United States, some authors consider that a watershed head should not exceed 2 km² (Adams et Spotila, 2005). Other studies show that the width of the minor bed is usually less than 1 meter (Wipfi et al., 2007). In Japan, TBV are characterized by upstream areas of the dominant sedimentation zone (Uchida et al., 2005)

Headwater streams, rich in small streams, ponds and wetlands, are essential territories in the functioning of the water cycle. These territories, whose boundaries are sometimes difficult to find, represent almost 75% of the line of the hydrographic network (Onema, 2015). The water quality objective imposed by the WFD by 2027 depends naturally on the state of the rivers upstream of a watershed. One understands intuitively that if the upstream rivers are in poor condition, they may have a negative impact on the condition of the rivers downstream. The state of these rivers is therefore crucial in the state of a whole basin. Thus, four essential functions can be distinguished by rivers and wetlands at the head of the basin.

REGULATION OF WATER FLOWS

Headwater streams receive, store and restore precipitation and runoff like a sponge. These areas are indeed essential in low-water support, flood control and groundwater recharge (Onema, 2015). Because of their narrowness and slope, these rivers constitute a water transfer zone. TBV are estimated to account for 50-70% of the feeding of higher-order streams (Alexander et al., 2007). The multitude of small streams and wetlands that originate in these territories also presents "a dynamics of hydraulic gradient which oscillates all the year according to the events of seasonality and regime of the rains. This reflects the ability of the slope to produce water for downstream watercourses "(Chantal Gascuel, Research Director at INRA) (Onema, 2015). Moreover, because of the slope, erosion processes are important and therefore the transport of sediments downstream is another characteristic of these rivers. Thus, basin heads play a predominant role in the hydromorphology of streams throughout the catchment.

PHYSICAL AND BIOGEOCHEMICAL PURIFICATION

The heads of the basin make it possible to fight the erosion of the banks thanks to the specific vegetation of the wetlands. This vegetation also ensures a first degree of purification of phosphates and nitrates by absorbing these compounds at the level of their roots. Nitrate purification is also carried out by microorganisms which consume nitrogen (heterotrophic denitrification). Phosphorus, phytosanitary products and some heavy metals are more or less retained by vegetation and sediments. These receptacle and sediment emitting areas also play a significant role in the degradation and transformation of organic matter by microbial activity (especially fungi), coupled with the action of shredding invertebrates. These steps make available nutrients that can be assimilated by other organisms (Onema, 2015).

ECOLOGICAL FUNCTION

The headwater streams have an ecological function by serving as habitat for a fauna and a flora specific to these environments: sculpin, droseras, white-clawed crayfish, pearl mussel, brook lamprey, macrophytes, helophytes, willows. Biodiversity is also promoted throughout the surrounding ecosystem through naturally developing riparian vegetation that serves as habitat and food reserves for a diverse wildlife:

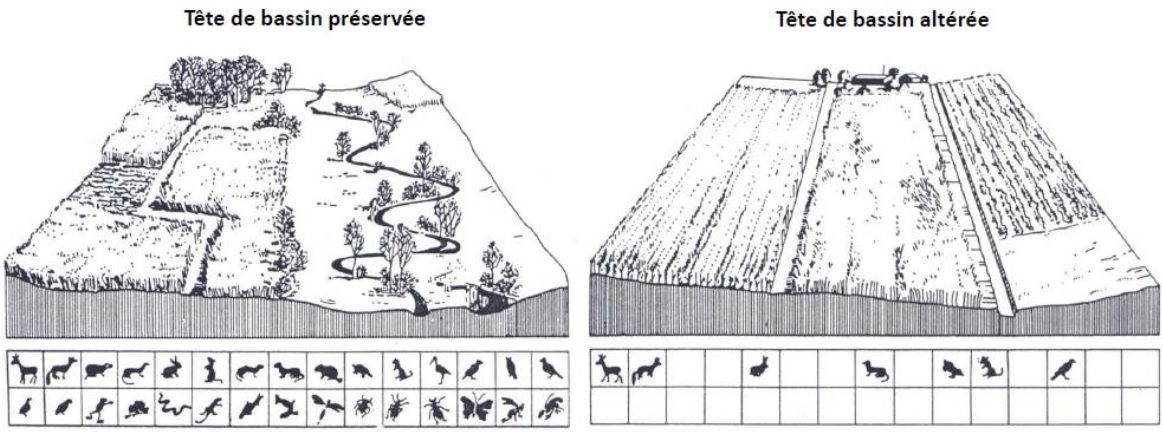


Figure 4 : Preserved biodiversity of a TBV (Le Bihan, 2016)

First and second order rivers have high biological diversity. Sometimes, endemic species are discovered and developed in conditions that are ideal for them. For example, the Lez sculpin (Hérault) which was recently discovered in the upstream part of the river. This biodiversity is often more important in lower order rivers (Godreau et al., 2010). The riparian vegetation offers areas of shade which allow to maintain a temperature of the fresh waters, which is favorable to a good oxygenation of the stream and therefore to the requirements of particular fish such as trout. This shade also reduces the amount of light entering the watercourse, limiting eutrophication phenomena that are detrimental to biodiversity (Adam et al., 2008). They are also the preferred breeding ground for some fish species. Some protected species are infectious to streams such as pearl mussels or white-clawed crayfish. The importance of preserving and restoring these very small rivers is a major challenge for the fishery resource (Lhéritier, 2012). The riparian cords of small rivers will allow the production of organic matter that will be stored and trapped according to the energy of the flows, the roughness of the bed, the jams, the root system of the banks. The allochthonous organic matter is then decomposed by the various bacteria, macro invertebrates and other decomposers which will then constitute the first links of the trophic network (Baudoin, 2007). This process will therefore makes it possible the existence of fauna and flora downstream and in the surrounding area.

SOCIO-CULTURAL FUNCTION

When heads of basin are in good status, they are frequently used for recreational purposes by fishermen, water sports fans or simply by hikers seduced by the beauty of the places. Tourist authorities can also communicate on these areas in order to attract tourists who enjoy "natural" spaces.

This description highlights the many ecosystem services provided by the basin heads. However, these small hydrosystems are very vulnerable because of their small size and their isolation which increase their degree of exposure to alterations. Their abundance, large feeding area and low flow rate expose them to high risks of transfer or pollution (Choucard, 2011).

EXAMPLES OF NON-DEGRADATION ACTIONS

A non-degradation action can be defined as an approach, a rule or an arrangement that does not modify the hydromorphology of a watercourse. Restoration work is excluded here, which

involves the use of substantial material means such as earthmoving equipment. The subject of the study is about aquatic ecosystems already in good status, so we will only describe the actions to conserve or even improve this state. These actions can be categorized according to the type of pressure that can alter the state of the system. This is why we will see the actions to be carried out according to the nature of the anthropogenic activities.

AGRICULTURAL PRESSURES

Intensive farming

Pollution from agricultural sources strongly affects the first concentric flows. "Arable land occupies 25% of the head of French watersheds" (Lhéritier, 2012). From the source, the concentration of nitrates is observed. 60% of the nitrate load found in order 3 streams coming from first-order streams (Alexander et al., 2007). The practice of reasoned agriculture with a less systematic use of fertilizers and phytosanitary products remains the basis of any action to reduce diffuse pollution. Technical and financial aid for conversion to organic farming are an important lever for action. Several socio-economic studies on the control of diffuse pollution, such as the Demonstration Test Catchment study in the United Kingdom, have highlighted the fact that farmers' motivation was inevitably through financial support for changes in practices that are requested. The development of economic tools is therefore often indispensable and funding must be sustainable over time, as it is now recognized that the response of aquatic systems to the implementation of these measures can be long (sometimes several decades). Another motivating factor for farmers is their desire to change the too often widely held perception of the "farmer-polluter". Their desire to be an environmentally friendly farmer who produces food that is safe and non-hazardous to human health is very strong (Siauve et al., 2016).

The purifying power of wetlands should be considered when TBV have a preserved riparian zone. It is estimated that an alluvial forest 30 meters wide along a watercourse is capable of cutting up to 80% of the nitrate contents in surface runoff (Le Bihan M., 2016). Experience in the United Kingdom has clearly demonstrated the predominant role of wetlands in retaining pollutants. The study was conducted on 10 sites ranging from 1 to 50 ha. At each site, a sediment trap was constructed to estimate the quantity and quality of the components selected. Annual surveys of sediment and nutrient accumulation in 2010, 2011 and 2012 indicated that most were trapped on a sandy site (70 tons over 3 years) compared to silt (40 tons over 3 years) or clayey (2 tons over 3 years) (Ockenden et al., 2014).

Breeding

In livestock areas, one of the main environmental changes is caused by the trampling of livestock that drinks or crosses rivers. The installation of watering troughs or adapted crossing areas makes it possible to simply solve this type of problem.

FORESTRY PRESSURES

Some plantations of trees made a few decades ago are not adapted to the requirements of the heads of basin. Thus, poplar cultivars of North American origin, which have superficial rooting and a strong production of dead branches. There has also been an anarchic development of coniferous plantations (notably of spruce) along the rivers, to the detriment of native riparian species and riverine forest. These trees form acid litter affecting aquatic life because they have negative impact on the physico-chemistry of water. They can also profoundly alter the morphology of small rivers (Schneider, 2007). A study in Alsace showed an increase in the bed width from 33 to 166% under conifers, compared with 2 to 12% under deciduous trees

(Adam et al., 2008). In the Haut-Jura Regional Nature Park (PNR), a plan to convert conifers to rivers has been put in place to replace them with hardwoods that are more favorable to riverbank preservation (Liferuisseaux.org, 2009).

Concerning logging, several solutions make it possible to limit the impact of the work on the rivers. One of the disadvantages of this type of exploitation is the regular passage of wood transport equipment on the rivers. A low-cost solution consists in optimizing and pooling the crossings between the different operators. Another economical solution is the use of crossing kits consisting of wooden logs (Pereira V., 2009). Experiments carried out in the Morvan PNR have demonstrated the effectiveness of new skidding techniques allowing to respect watercourses: High Density Polyethylene (HDPE) pipes, cableway cable. Nevertheless, these techniques present technical or economic constraints and are not the solution to all problems, but only possible tools (Augé, 2007).

OTHER ANTHROPIC PRESSURES

Under the pressure of urbanization, in some areas, ditches and wetlands have disappeared due to filling, drainage and soil waterproofing. In order to prevent these alterations, one of the most suitable methods is the implementation of land control methods that allow the control of these areas. For example, it is preferable to reserve a space of several meters (minimum 5) on each side of the watercourse, and this for the entire hydrographic network (Morvan Regional Natural Park, 2010). More restrictive rules may exist, as in Morbihan where the protection of the riversides is ensured in urban planning documents by a non-building band of 35 meters on either side of the banks of the rivers (General Council Morbihan, 2008).

Disappearances of species, such as the white-clawed crayfish, have been observed following the remediation of small villages. A decision grid was adopted at the level of the basin heads in order to select the most respectful purification processes for the receiving environments.

The nozzles installed on some streams can be advantageously replaced by bridges that restore the free flow of water and fauna.

The invasion of invasive species can be assimilated to indirect anthropogenic pressure. Following the destruction of natural habitats, biological invasions are one of the main causes of species extinction and loss of biological diversity (Adam et al., 2008). Studies show that the growth of exotic species is generally inversely proportional to the biodiversity of ecosystems. Thus, all the means of action in favor of ecological continuity make it possible to combat this phenomenon: limitation of the number and height of thresholds, plant engineering techniques in order to favor endemic and varied riparian vegetation or the maintenance of ecological corridors.

Excessive tourist use may also be harmful to these environments. Concerning water sports, a literature review reveals alterations that remain localized (departure and arrival areas of boats) or low impact (trampling of the bed of the watercourse is limited to 5 to 10% of the embedded surface). However, due to the vulnerability of these environments, the author recommends avoiding navigating shallow TBV in order to preserve the spawning grounds (SENS et al., 2004). Birdlife can also be impacted by water sports. Thus, in order to preserve from disturbance the terns that reproduce on the islets of the Loire, biotope protection order prohibit berthing. Compliance with these rules requires awareness-raising among users of the river, through encounters and paneling of islets (Federation of Conservatories of Natural Areas, 2013). Finally, the reduction of trampling of hikers can be done by developing a path away from the bank with some point access perpendicular to the watercourse.

In general, all these actions must be accompanied by awareness campaigns and communication with users, local residents, elected representatives and managers about the fragility of TBV.

CONSERVATION / RESTORATION PROJECTS

Despite their importance in a watershed, basin heads are not always recognized at their true value. Until recently, there were no specific management and / or funding rules to preserve these ecosystems that are in good condition. In fact, since rivers in TBV are not necessarily mapped (rank 0), no regulation is necessary on certain portions, which exposes them directly to deterioration. However, over the last decade some initiatives have been taken to preserve TBV. These actions can be classified according to the stakes involved in their launch. The following table summarizes some of the projects that have taken place in France in recent years. The majority has been guided by requirements of biodiversity and conservation of heritage species. Projects involve rivers that already have good environmental status or good potential. Nevertheless, relatively limited restoration work (effacements of small thresholds, ponds draining) made it possible to obtain good results and this, with quick response times of one to two years: it is the case of crayfish of the Saulny stream or in the Val des Choues stream, the fish population and the riverside vegetation of La Selle stream (EauFrance.fr, 2017). It should be noted that a single project includes only prefectoral orders for the protection of the biotope. Indeed, the department of Orne has several rivers with an exceptional piscicultural wealth (Atlantic salmon, trout fario) and the Superior Council of Fisheries had decided to protect them from 1986 (EauFrance.fr, 2017).

Table 1 : Preservation restoration projects (EauFrance.fr, 2017)

	Hydrographic basin	Stakes	Stakeholders	Actions	Results
Ruisseau de Saulny	Rhin-Meuse	Heritage species : white-clawed crayfish	Onema, Department concil, DDAF, Conserv. sites Department concil lorrains, Water Agency	Reconstruction of the placer matress	Number of individuals multiplied by 3,5
Bassin du Cousin	Seine-Normandie	Heritage species : trout, chabot, brook lamprey	DDAF,Onema,déleg. interreg.Bourgogne, Department concil	Bypass channel, nozzlesreplaced, cattle fences	Chabot increase
Ruisseau de la Maria	Loire-Bretagne	Ecological continuum	PNR Morvan, fishing dep. Fed., Onema, déleg. interreg.Bourgogne Department concil	Destruction of 2m dam	Natural remeandering, riparian vegetation, new spawning grounds
Cours d'eau de l'Orne	Loire-Bretagne et Seine-Normandie	Habitats, heritage species	Conseil Supérieur de la Pêche puis Onema, DDAF, féd. dépt pêche, DREAL	21 prefectorial orders for protection of the biotope	purposeless
Ruisseau du Val des Choues	Seine-Normandie	Heritage species : trout, white-clawed crayfish	PNR Morvan, féd. dépt. pêche, Onema, interreg.delegation Bourgogne-Franche-Comté	Dugouts destruction	White-clawed crayfish back, Végétation increase
Rivière de la Selle	Artois-Picardie	Ecological continuum	Intercommunal association, fishing dep. Fed., DTT	Destruction of 2,3 m dam	Natural remeandering, riparian vegetation and fish population increase
Le Merlue et son marais	Rhône-Méditerranée	Habitats and heritage species	Onema, PNR Morvan, Univ. Franche-Comté	Riverbed move	Natural hydromorphology and, wetlands back, increase population of trout and chabot
Le Trégou	Adour-Garonne	Hydromorphology and agricultural practices	Onema, DDT	Undergrounded part clear	Natural hydromorphology back
La Quilienne	Artois-Picardie	Ecological continuum	Onema, Department council, Fishing and preservation assoc.	Destruction of a unused dam	Increase population of trout and chabot

EMBLEMATIC PROGRAMMES IN FRANCE AND ABROAD

Some examples of projects that are particularly remarkable for their scale and results deserve to be detailed. These achievements can be classified according to the type of issue that motivated their execution.

BIODIVERSITY ISSUES

The objective of the Life Rivers program is to experiment with sustainable development practices on streams and associated environments in order to acquire proven techniques for preserving and restoring water quality and habitats. The LIFE program is a financing program of the European Commission that contributes to the implementation of European environmental policies and legislation. The objective of the program was to safeguard animal species that are highly sensitive to the quality of the habitats: white-clawed crayfish, pearl mussel, Brook lamprey and sculpin (Liferuisseaux.org, 2009). In order to promote the repopulation of these organisms, it was necessary to experiment a whole range of actions of preservation and restoration of the environments. The Morvan Regional Nature Park has been the sponsor and coordinator of the project in partnership with the following local players: the NFB, the Haut-Jura Regional Nature Park and the Association for the Development and Animation of the Jura's Small Mountain.

The European Commission subsidizes up to 50% of the projects selected. The rest is divided between the local actors, AERMC and AESN, the Regional Council of Bourgogne and the Ministry of Sustainable Development.

The LIFE program served as a catalyst for the development of sustainable approaches for the preservation of habitats and species of Community interest. The actions developed in the program and the required follow-up are included in the Natura 2000 objectives documents. A comprehensive contract was signed in November 2009 between the Morvan Regional Nature Park and the Seine-Normandy Water Agency on Yonne, Cure and Cousin basins to continue and amplify the work of preserving the heads of basins already started (Godreau et al., 2010).

ECOLOGICAL ISSUES

The “Rivières Sauvages” program was born of the desire of certain NGOs (WWF and ERN France) to preserve the last "natural" rivers in Europe by developing a specific tool. The “Rivières Sauvages” label makes it possible to create technical, regulatory and financial resources for the local managers involved in the project. This approach is based on two pillars: on the one hand, the Conservation Fund for Wild Rivers, an endowment fund intended to develop partnerships with companies, foundations and raise private funds, and ERN France, an association approved under Law 1901, which has received a nature conservation authorization. A bipartisan agreement links the two structures, to organize the governance of the whole. ERN France agrees with public institutions and manages the Rivières Sauvages project. ERN is a signatory to the national framework agreement which sets out the means of accompanying the labeling tool for the period 2016-2018 with the water agencies, Onema and the Ministry of the Environment (Rivières-Sauvages, 2017).

A river selection grid candidate for the label has been developed by a panel of scientists and river managers. There are 47 criteria, some of which can be eliminated if the score is too low.

Several French rivers have been labeled since 2014. The Valserine is the first that has been chosen as pilot of the project because of its river reputation very little modified by the hand of man. The ERN France fund initially solicited the PNR of Haut-Jura, manager of the river. This

one was joined by the federation of fishermen of the department. Funding was provided by AERMC and the Departmental Councils of Ain and Jura. Depending on the work, five contractors intervene, with the PNR taking care of the biggest projects. If there is no specific strategy for climate change, a study is currently being carried out to determine the cause of early flows (climate, forests, harvesting).

Other labels followed in the Creuse and the Ardèche in particular. The bearer of the project is either the departmental council, the union of rivers or the Regional Natural Park concerned, each time in close collaboration with the departmental federation of fisheries. In order to maintain the quality of these rivers, actions to raise public awareness and maintain the banks are planned during the 5 years of validity of the label. The remaining areas for improvement relate to ecological continuity due to the presence of small thresholds. There is no particular strategy for climate change. The river technicians who answered questions expressed their concern about the lack of a regulatory framework for these watershed areas.

AGRICULTURAL ISSUES, farmers are getting organized

In areas where agriculture is very active, initiatives are being taken to closely involve farmers in preservation activities. Thus, the Chamber of Agriculture of Finistère has decided to become involved in the preservation of watershed heads through an association with the Departmental Council, Onema and the Loire-Brittany Water Agency. The importance of TBV is fundamental in this department because 67% of the water bodies of this territory are in good ecological state. A small film was filmed to promote the protection and improvement actions that the farmers of the department carried out with the technical advisers of Onema. The wish of the Chamber of Agriculture is that the farmers, very present in the territory, are recognized as managers of the natural environment (Burgun, 2016).

A remarkable preservation project in collaboration with the agricultural profession was carried out in the Forez territory to protect peatlands threatened by grazing. A preservation contract was signed between the General Council, the Rhône-Alpes Conservatory of Natural Areas and the operators. This agreement includes the implementation of agri-environmental measures and wetland management measures to avoid damage caused by flocks. Other projects of the same type have been implemented in Vienne, Allier and Limousin, with in each case agreements between the elected representatives, the “Conservatoire des espaces naturels” and the breeders (Federation of Conservatories of Natural Areas, 2013).

WILD SALMON CENTER (WSC), volunteers and scientists together

This organization was founded in 1992 by Pete Soverel, a former American Fleet Captain, a fly fishing enthusiast and a strong advocate of Pacific salmon. Following a few expeditions to the Kamchatka River region in the extreme east of Russia, he embarked on a vast project to defend salmon and thus the rivers that sheltered them. His credo is simple and has the support of many donors and volunteers who follow him: "Protecting a river system before it's broken is a far cheaper and simpler strategy to rebuild a river after it has been degraded" (Wild Salmon Center, 2017).

Wild Salmon Center now has more than 13,000 kilometers of preserved rivers. Its action concerns mainly Russia with 800 000 hectares protected. For the past few years, WSC has been concentrating its efforts on the United States with more than 56,000 hectares secured in the states of Oregon, California, British Columbia, Washington and Alaska.

Scientific members of the association carry out research with various partners involved in this type of fish along the Pacific coast: research institutes and inhabitants. The objective of this

research is to deepen the knowledge on these fish in order to better protect them especially in relation to the effects of climate change.

ASSOCIATION OF RIVERS TRUST (ART), a participative approach

ART is a non-profit English-speaking association founded in 2001 that brings together all the regional Rivers Trust of England and Scotland. The objective of each of these associations is to preserve the quality of rivers, lakes and wetlands in their watershed. One of the leading associations is Eden Rivers Trust (ERT) which was established in 1996 in northern England. The principle of operation is based on the collaboration of all water stakeholders in the region. The concept of actor is very broad, since it encompasses both the inhabitants and the people working in the region. In the first place, very close work is carried out with the farmers and breeders who occupy almost 95% of this territory. Many actions are aimed at reducing the impacts of discharges from farms as well as optimizing water use. The inhabitants are invited to join the ranks of the volunteers in order to contribute to the preservation of the ecosystem (counting of invertebrates, regular cleaning of the banks and the jams on the rivers). To date, ERT claims more than 200 improvement projects, 55 schools involved, 60,000 trees planted and more than 10,000 contributors to the various actions carried out. Funding provided by institutional donors such as the National Lottery and private donations. Some projects are eligible for funding by the European Community (Eden Rivers Trust, 2017).

CONCLUSION

We have seen the fundamental role of headwater streams in the quantity and quality of water bodies, but also in the biodiversity of hydrosystems. After decades when TBVs were removed from the main concerns of resource managers, more or less isolated initiatives were taken in France to protect them. The motivation for these projects is often based on ecological concerns such as the protection of heritage species or the renaturation of habitats. However, in order to take TBV into account in water policies and to sustain their preservation, they must be clearly included in the major programs. The Loire-Bretagne Water Agency has been recognizing TBV for several years in its master plan. The SDAGE 2016-2021 is renewing its chapter devoted to the protection of watershed heads. It specifies the obligation for each SAGE to carry out an inventory of TBV, to plan a program of actions according to the state and the pressures exerted on the territory and to make their importance known to all stakeholders in the basin. The Rhone-Mediterranean-Corsica Water Agency has also initiated a reflection on the conservation of wetlands through the Strategic Wetland Management Plan (PGSZH). The idea is to put in place at the scale of the basin measures of protection (land acquisition) and / or restoration at the level of each SAGE (Charrier, 2016). The Adour-Garonne Water Agency is going in the same direction in its SDAGE 2016-2021, highlighting in addition the economic and tourist potential of the TBV.

While awareness of the importance of TBVs now appears to be gaining, further progress should be made in the methods of monitoring the status of rivers. Indeed, the standard analyzes and surveys that are carried out in order to evaluate the physicochemical, biological and morphological states of a river are costly and time-consuming. This theme may be the subject of another synthesis, but it can be noted that recent studies are being carried out in order to develop new techniques capable of evaluating the overall ecological state of a hydrosystem more quickly and reliably. Thus, a new method allows to automatically evaluate the species present in a river from the analysis of DNA samples (Rey-Brahmi P., 2016). Similarly, the use of biomarkers is currently a complementary technique for assessing the

ecotoxicology of an environment. The development of this tool may make it possible to integrate it into quality monitoring analyzes under certain conditions (Sanchez et al., 2009).

These solutions always have a cost and are not necessarily adapted to the monitoring of the good state of the TBV. The future may be through the development of participatory science in the area of water quality monitoring. This approach is already very present in countries of Anglo-Saxon culture. One can quote The Ipswich River Watershed Association in the state of Massachusetts which carries out a very complete monitoring of the ecological state as well as the physicochemical state of the rivers by trained and equipped volunteers (IpswichRiver.org, 2017). This approach is developing slowly in France. The French Federation of Fly Fishing and Lancer in partnership with the Ministry of Youth and Sports launched the “Vigie Rivières” program in 2011. This initiative encourages fishermen to observe, detect and alert authorities in case of damage proven. Training is provided by technicians to the volunteers so that they are able to recognize macro-invertebrates as well as the first signs of pollution (FFPML, 2017). Within the framework of IWRM (Integrated Water Resource Management), a few initiatives have been launched, notably in the Chartreuse Regional Nature Park. Feedback is mixed due to lack of resources and supervision of volunteers (AERMC, 2016). However, citizen involvement in monitoring and protecting the environment would deserve to be deepened in the perspective of a decrease in the public resource and a connected society increasingly involved in these issues (Tanguy, 2016).

BIBLIOGRAPHY

Adam P., Debiais N., Gerber F., Lachat B., 2008. *Le génie végétal*. Paris, Documentation française, 290 p.

Adams R.K. & Spotila J.A., 2005. The form and function of headwater streams based on field and modeling investigations in the Southern Appalachian Mountains, *Earth Surface Processes and Landforms*, 30, pp. 1521-1546.

AERMC, 2016. Comment impliquer les citoyens dans la gestion de l'eau ? Agence de l'Eau Rhône-Méditerranée-Corse, Lyon, 90 p.

AESN, 2016. SDAGE 2016-2021. Agence de l'Eau Seine-Normandie, Nanterre, 458 p.Alexander R.B., Boyer E.W., Smith R.A., Schwarz G.E., Moore R.B., 2007. The Role of Headwater Streams in Downstream Water Quality. *Journal of the American Water Resources Association*, 43 (1), pp. 41‑59.

Augé V., 2007. *Comment réduire l'impact de l'exploitation forestière et des travaux mécanisés sur le réseau hydrographique ?* 132p. Disponible sur Internet : http://www.liferuisseaux.org/documents_techniques/rapports/Comment_reduire_impact_activite_forestiere.pdf.

Baudoin J.M., 2007. *Biodiversité et fonctionnement de cours d'eau forestiers de tête de bassin: effet de l'acidification anthropique et d'une restauration*. Thèse de Doctorat en Ecologie, Université de Metz, 221 p.

Benda L., Hassan M.A., Church M., May C.L., 2005. Geomorphology of steepland headwaters: the transition from hillslopes to channels. *Journal of the American Water Resources Association*, 41 (4), pp. 835‑851.

Charrier G., 2016. *SAGE et plans de gestion stratégiques des zones humides*. (Séminaire des animateurs de SAGE du bassin Rhône-Méditerranée), 12 p.

Choucard P., 2011. *Elaboration d'une méthodologie d'inventaire cartographique et de hiérarchisation des têtes de bassin versant dans le contexte armoricain*. Mémoire de Master en Gestion des Habitats et des Bassins Versants, Université de Rennes, Rennes, 30 p.

Conseil Général du Morbihan, 2008. *Charte de l'agriculture et de l'urbanisme*, 58 p. Disponible sur Internet http://www.morbihan.gouv.fr/Publications/Publications-des-services/Charte-de-l-Agriculture-et-de-l-Urbanisme-du-Morbihan-Janvier-2008#

Fédération des Conservatoires d'espaces naturels, 2013. *Agir pour l'eau, les espaces, les espèces*. Chromatiques éditions, Nancy, 171 p.

Godreau V., Paris L., Durlet P., Vincent A.S., Chaput E., 2010. *Programme LIFE Ruisseaux de têtes de bassins et faune patrimoniale associée*. Saint-Brisson, Parc naturel régional du Morvan, 38 p.

Godreau V., Paris L., Durlet P., Vincent A.S., Chaput E., Vissant C., 2009. *Rapport technique final 2004-2009*. Saint-Brisson, Parc naturel régional du Morvan, 293 p.

Henner R., 2013. *Les têtes de bassin versant, des espaces à considérer pour une gestion durable et intégrée de la ressource en eau*. Mémoire de Master en Géographie. Université de Caen, Caen, 128 p.

Laboratoire SENS, Association Cohérence, FRAPNA Ardèche, 2004. *Instrument d'évaluation environnementale des espaces, sites et itinéraires ardéchois.* UJF Grenoble, Grenoble, 203p.

Le Bihan M., 2016. *Têtes de bassin versant : Fonctions, services rendus et enjeux*. 7ème rendez-vous du SAGE, Ancenis, 22 p.

Lhéritier N., 2012. *Les têtes de bassin : de la cartographie aux échelles mondiale et française à la caractérisation des ruisseaux limousins*. Thèse de Doctorat en Géographie, Université de Limoges, Limoges, 481 p.

Ockenden M.C., Deasy C., Quinton J.N., Surridge B., Stoate C., 2014. Keeping agricultural soil out of rivers: Evidence of sediment and nutrient accumulation within field wetlands in the UK. *Journal of Environmental Management*, 135, pp. 54‑62.

Onema, 2015. *Les têtes de bassin versant, un enjeu essentiel pour la ressource en eau*. Les rencontres de l'Onema, 36, Paris, 12 p.

Parc naturel régional du Morvan, 2010. *Résumé illustré du programme LIFE Nature Ruisseaux de Têtes de Bassins et Faune Patrimoniale associée / 2004-2009*. Saint-Brisson, Parc naturel régional du Morvan, 36 p.

Pereira V., 2009. *Préconisations techniques pour l'exploitation et la conversion des peuplements forestiers allochtones en bordure des ruisseaux*, Office National des Forêts, Besançon, 21 p.

Rey-Brahmi P., 2016. L'analyse ADN pour déterminer l'état des rivières. *Hydroplus*, 237, pp 88.

Sanchez W., Porcher J.M., 2009. Utilisation des biomarqueurs pour la caractérisation de l'état écotoxicologique des masses d'eau. *T.S.M.*, 5, pp. 29–38.

Schneider J.-B., 2007. Plaidoyer pour une restauration des cordons rivulaires naturels des ruisseaux et ruisselets forestiers. *Forêt Wallonne*, 86, pp. 43–57.

Siauve S., Amorsi N., Vasseur L., Martini F., Billy C., 2016. *Pollution diffuse et protection de la ressource en eau : pratiques à l'échelle du territoire dans l'Union européenne*. Comprendre pour agir, Onema, Vincennes, 12 p.

Tanguy J.M., 2016. ANSWER : une opération de sciences participatives dans le domaine de l'eau. *La Houille Blanche.*, 3, pp. 22–26.

Uchida T., Asano Y., Onda Y., Miyata S., 2005. Are headwaters just the sum of hillslopes?. *Hydrological Processes*, 19, pp. 3251- 3261.

Wipfli M.S., Richardson J.S., Naiman R.J., 2007. Ecological linkages between headwaters and downstream ecosystems: transport of organic matter, invertebrates, and wood down headwater channels. *Journal of the American Water Resources Association (JAWRA),* 43 (1), pp. 72-85.

INTERVIEWS

Delacroix S. Technicien de rivières, Parc Naturel Régional du Haut-Jura. Entretien téléphonique le 12/12/2016

Fraces F. Ingénieur eau, Syndicat des rivières Beaume et Drobie. Entretien téléphonique le 22/11/2016

Iribarne F. Responsable milieux aquatiques, Conseil Général de la Creuse. Entretien téléphonique le 05/12/2016

WEB SITES

Eden Rivers Trust, 2017. Disponible sur Internet: http://www.edenriverstrust.org.uk/ [Consulté le 01/02/2017].

Fédération Française de pêche à la Mouche et au Lancer, 2017. Disponible sur Internet: http://www.ffpml.fr/vigie-riviere/ [Consulté le 26/04/2017].

Ipswich River Watershed Association, 2017. Disponible sur Internet: http://www.IpswichRiver.org/ [Consulté le 5/05/2017].

Programme LIFE Nature Ruisseaux de têtes de bassins et faune patrimoniale associée – Morvan, 2009. Disponible sur Internet: http://www.liferuisseaux.org/ [Consulté le 03/10/2016].

Rivieres-Sauvages, 2017. Disponible sur Internet: https://www.rivieres-sauvages.fr/ [Consulté le 18/10/2016].

Wild Salmon Center, 2017. Disponible sur Internet: https://www.wildsalmoncenter.org/ [Consulté le 15/01/2017].

EauFrance, 2015. Disponible sur Internet : http://www.zones-humides.eaufrance.fr/agir/retours-d-experiences-cours-d-eau-et-zones-humides [Consulté le 12/01/2017].

MOVIE

Burgun P., 2016. *Les petits cours d'eau font les grandes rivières*. Finistère. Onema, Agence de l'Eau Loire-Bretagne, Chambre d'agriculture, Conseil départemental du Finistère, 15 min. 55 sec.

OTHER USEFUL REFERENCES

Parlement européen et Conseil de l'Union européenne, 2000. *Directive Cadre Européenne sur l'Eau*. Disponible sur Internet : http://www.developpement-durable.gouv.fr/IMG/pdf/DGALN_directive-cadre-eau_1_.pdf.

Nos dernières synthèses techniques :

L'écoulement des cours d'eau en période estivale en France sur la période 2012-2016 - 2017

L'état de conservation des espèces aquatiques d'intérêt communautaire - 2017

Adaptation des services d'eau potable au changement climatique en France - 2016

Etat des lieux des démarches de réduction de la vulnérabilité sur le bâti face à l'inondation - 2016

La Trame Verte et Bleue dans trois pays transfrontaliers - 2016

Using Water Smarter – Economie de la ressource et potentiel de réutilisation des eaux usées dans le secteur agricole - 2016

Les techniques d'animation de concertation sur la gestion des ressources naturelles - 2016

Les modes de gestion des périmètres d'irrigation en métropole et dans les DROM (Guadeloupe, Réunion, Martinique) - 2016

L'utilisation des membranes en assainissement - 2016

Les concentrations en nitrates d'origine agricole dans les cours d'eau et les eaux souterraines en France - *Données 2013-2014* - 2016

Renforcement des compétences sur les aires d'alimentation de captages - 2016

Protection des aires d'alimentation des captages en eau potable. Etude de pratiques en Europe - 2015

Les stratégies de pays européens vis-à-vis des espèces exotiques envahissantes en milieux aquatiques - 2015

Agroforesterie et ressources en eau : les pratiques anciennes en réponse aux problématiques modernes - 2015

Les énergies renouvelables : une alternative pour la production et l'économie d'énergie dans le domaine de l'eau et de l'assainissement - 2015

Animation, coordination de la communauté d'acteurs de gestion locale de l'eau (Gest'eau). Expression des besoins des animateurs(trices) de SAGE/contrats pour renforcer leurs compétences - 2015

Les démarches territoriales de gestion de l'eau en Europe : Quels enseignements pour la mise en œuvre de la DCE ? - 2014

Retrouvez tous les titres disponibles sur www.oieau.fr/eaudoc/publications

Some titles are available in english : check it on www.oieau.fr/eaudoc/publications

AgroParisTech
ENGREF
INSTITUT DES SCIENCES ET INDUSTRIES DU VIVANT ET DE L'ENVIRONNEMENT
PARIS INSTITUTE OF TECHNOLOGY FOR LIFE, FOOD AND ENVIRONMENTAL SCIENCES

648 rue Jean-François Breton – BP 44494
34093 MONPELLIER CEDEX 5

Tél. : (33) 4 67 04 71 00
Fax. : (33) 4 67 04 71 01
www.agroparistech.fr

15 rue Edouard Chamberland
87065 Limoges Cedex

Tél. (33) 5 55 11 47 80
Fax. (33) 5 55 11 47 48
www.oieau.org